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**Towed road vehicles — Compressed-air
braking systems — Measurement of
braking performance**

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*Véhicules routiers remorqués — Dispositifs de freinage à air
comprimé — Mesurage des performances de freinage*

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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 7634 was prepared by Technical Committee ISO/TC 22, *Road vehicles*, Subcommittee SC 2, *Brake systems and equipment*.

[ISO 7634:1995](#)

Annexes A and B form an integral part of this International Standard. Annex C is for information only.

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Towed road vehicles — Compressed-air braking systems — Measurement of braking performance

1 Scope

This International Standard specifies a uniform test method for braking systems of full trailers, semi-trailers and centre-axle trailers with compressed-air braking systems, pending the harmonization of national and international braking standards, regulations and directives.

The brake test procedure specified in this International Standard has been developed based on the UN-ECE Regulation No. 13. It applies to full trailers, semi-trailers and centre-axle trailers, as defined in ISO 3833, equipped with compressed-air braking systems and corresponding to vehicle category O in UN-ECE Regulation No. 13.

The values in square brackets [] are extracted from UN-ECE Regulation No. 13 and are marked 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 3583:1984, *Road vehicles — Pressure test connection for compressed-air pneumatic braking equipment*.

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

UN-ECE Regulation No. 13, *Uniform provisions concerning the approval of vehicles with regard to braking*, incorporating the 06 series of amendments (including supplement 01).

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 compressed-air braking system: System in which the energy-supplying device and the transmission device work exclusively by compressed air.

NOTE 1 Figures C.1 and C.2 show examples of typical full trailer and semi-trailer air braking systems.

3.2 Vehicle loading

3.2.1 laden vehicle: Vehicle laden so as to reach its total maximum calculated mass (ISO-MO7) in accordance with ISO 1176.

In the case of semi-trailers and centre-axle trailers being road-tested, excluding the parking braking system (see 10.2), the loading may be such that the maximum mass calculated per axle (ISO-M11) is reached without loading the fifth wheel for semi-trailers or the mechanical coupling for centre-axle trailers.

3.2.2 unladen vehicle: Vehicle at its kerb mass plus the mass of the required instrumentation. (See 6.3.)

4 Symbols

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

For the calculations, additional indices as listed below may be used, in the following order:

- 1, 2, 3, etc., to indicate axles No. 1, No. 2, No. 3, etc., respectively;

— I or II to indicate the test type (type I or type II test respectively);

— e to indicate the reference axle.

NOTES

2 These additional indices are also used in UN-ECE Regulation No. 13, with the exception of the test type indication.

3 The units are the same as those in UN-ECE Regulation No. 13.

Table 1

Symbol	Unit ¹⁾	Description	Symbol used in UN-ECE Regulation No. 13
a	m/s^2	Deceleration	J
a_{mC}	m/s^2	Achieved mean fully developed deceleration of vehicle combination	—
C	N·m	Camshaft input torque	C, C_i
C'	N·m	Converted camshaft input torque (see 11.2.4.5)	—
C_o	N·m	Threshold camshaft input torque (i.e. minimum camshaft input torque necessary to produce a measurable braking torque)	C_o
C_h	N·m	Camshaft input torque to heat the brake	V_i
C_{max}	N·m	Maximum technically admissible camshaft input torque	C_{max}
C_{adm}	N·m	Technically admissible camshaft input torque at a pressure in the brake actuator lower than the maximum pressure (see 11.2.4.4)	—
F_A	N	Average output thrust of one brake actuator at a pressure p_A corresponding to $p_m = 6,5$ bar	Th_A, Th_{Ai}
F_B	N	Braking force at the periphery of the wheel(s) (if no other indication is given)	T
F_{BR}	N	Sum of braking forces at the periphery of all wheels of towed vehicle	T_R, TR
F_{B1} F_{B2} F_{B3}	N	Sum of braking forces at the periphery of all wheels of axle No. 1, 2 or 3	T_i
F_{BW}	N	Braking force at the periphery of one wheel	—
F_{Ba}	N	Braking force resulting at the periphery of the wheel(s) for hot braking	T
F_{BaR}	N	Sum of braking forces resulting at the periphery of all wheels of towed vehicle for hot braking	T_R, TR

Symbol	Unit ¹⁾	Description	Symbol used in UN-ECE Regulation No. 13
F_{Ba1} F_{Ba2} F_{Ba3}	N	Sum of braking forces resulting at the periphery of all wheels of axle No. 1, 2 or 3 for hot braking	T_i
F_{BaW}	N	Braking force resulting at the periphery of one wheel for hot braking	—
F_{Bh}	N	Braking force at the periphery of the wheel(s) for heating the brake(s)	—
F_{BhR}	N	Sum of braking forces at the periphery of all wheels of towed vehicle for heating the brakes	—
F_{Bh1} F_{Bh2} F_{Bh3}	N	Sum of braking forces at the periphery of all wheels of axle No. 1, 2 or 3 for heating the brakes	T_i
F_{BhW}	N	Braking force at the periphery of one wheel for heating the brake	—
F_{BBP}	N	Sum of braking forces at effective radii of all those brakes which are used in application of the parking braking system of towed vehicle	—
F_K	N	Normal static reaction of fifth wheel of semi-trailer tractor on semi-trailer at kingpin, or of mechanical coupling of towing vehicle on drawbar of centre-axle trailer	—
F_L	N	Longitudinal force on mechanical coupling	D
F_M	N	Total normal static reaction of road surface on all wheels of the towing vehicle	P_M, PM
F_R	N	Total normal static reaction of road surface on all wheels of the towed vehicle	$P_R, PR, P_{Rmax}, PR_{max}$
F_{Rb}	N	Total normal static reaction of road surface on all braked wheels of the towed vehicle	P_2
F_{Ru}	N	Total normal static reaction of road surface on all unbraked wheels of the towed vehicle	P_1
F_{R1} F_{R2} F_{R3}	N	Total normal static reaction of road surface on all wheels of axle No. 1, 2 or 3 of the towed vehicle	P_i
F_{RW}	N	Normal static reaction of road surface on one wheel of the towed vehicle	—
g	m/s^2	Acceleration due to gravity	g
K_c	1	Correction factor, semi-trailer laden ²⁾	K_c
l	mm	Length of brake lever	l, l_i

Symbol	Unit ¹⁾	Description	Symbol used in UN-ECE Regulation No. 13
m	kg	Mass	P
p_A	bar	Pressure in the brake actuator(s)	—
p_{A1} p_{A2} p_{A3}	bar	Pressure in the brake actuators on all wheels of axle No. 1, 2 or 3 of towed vehicle	p
p_m	bar	Pressure in the trailer control line	p_m
p_{res}	bar	Pressure in the energy reservoir(s) of the service braking system of the towed vehicle, when the control device of the service braking system is fully applied for the first time	—
p'_{res}	bar	Pressure in the energy reservoir(s) of the service braking system of the towed vehicle, when the control device of the service braking system has been fully applied for the ninth time	—
p_s	bar	Pressure in the trailer supply line	—
R	mm	Dynamic tyre rolling radius	R, R_i
r_{BD}	mm	Nominal effective radius of brake drum or disc	r
s_A	mm	Stroke of brake actuator	s, s_i
s_{Ap}	mm	Stroke of brake actuator at which output thrust is $0,9F_A$	s_p
v	km/h	Vehicle speed	v
v_i	km/h	Initial vehicle speed at beginning of a test or a braking; test speed	v, V, v_1, V_1
v_f	km/h	Final vehicle speed at end of a test or a braking	v_2, V_2
z	1	Braking rate [i.e. F_B of vehicle (or axle or wheel) divided by normal static reaction of road surface on vehicle (or axle or wheel), thus e.g. F_{BR}/F_R]	$z, \frac{T_M}{P_M}, \frac{T_R}{P_R}$
z_a	1	Achieved braking rate	—
z_{aC}	1	Achieved braking rate of vehicle combination	$Z_R + M$
z_{aR}	1	Achieved braking rate of towed vehicle, evaluated by calculation	Z_R, E
z_{aA}	1	Achieved braking rate of an axle, evaluated by calculation	T_e/P_e
z_{BaR}	1	Calculated hot braking rate of towed vehicle	D
z_h	1	Braking rate for heating the brakes	—
z_{ha}	1	Hot braking rate	T_e/P_e
z_p	1	Prescribed braking rate	—
z_{pR}	1	Prescribed braking rate for service braking system of the towed vehicle	X

Symbol	Unit ¹⁾	Description	Symbol used in UN-ECE Regulation No. 13
z_{pHR}	1	Prescribed braking rate for heating the brakes of the towed vehicle	X, A _i
z_{pW}	1	Prescribed braking rate for one wheel	—
z_{paW}	1	Prescribed hot braking rate for one wheel	—
z_{rr}	1	Total braking rate as a result of rolling resistance ³⁾	R

1) In accordance with ISO 31-3:1992, *Quantities and units — Part 3: Mechanics*.
2) See UN-ECE Regulation No. 13, annex 10, diagram 4B.
3) Value is 0,01 (see UN-ECE Regulation No. 13, annex 4, subclause 1.4.5.3).

5 Test site conditions

The conditions indicated below represent reasonable limits at which the braking tests may be conducted. Testing beyond these limits shall meet the conditions in 7.2.

5.1 Road surface conditions

5.1.1 Road

The road shall be suitable for the dimensions and mass of the vehicle under test.

5.1.2 Surface

The road surface shall be a dry, smooth, hard-surface roadway of Portland cement concrete, or other surface with equivalent coefficient of adhesion of tyre to road (see for example 10.2.2.1).

5.1.3 Gradient

The road surface shall be substantially level; a tolerance of $\pm 1\%$ average gradient, measured over a minimum distance of 50 m, is allowed.

NOTE 4 Type I and/or type II tests and the parking braking system hill-holding test (see 10.2) may be conducted on a specified gradient.

5.1.4 Camber

The camber (transverse gradient) across the road surface shall not exceed 2 %.

5.2 Ambient conditions

5.2.1 Wind speed

The wind speed during road tests should not exceed 5 m/s on average.

5.2.2 Air temperature

The air temperature should not exceed 35 °C.

6 Vehicle preparation

6.1 Towing vehicle

To carry out the road tests, a towing vehicle is needed. The ratio of the mass of this towing vehicle to the mass of the trailer, semi-trailer or centre-axle trailer to be tested (test vehicle) should be as small as practical.

In addition, the braking rate of this towing vehicle, in relation to the pressure, p_m , in the trailer control line, shall comply with the compatibility requirements of UN-ECE Regulation No. 13, annex 10.

6.2 Towing vehicle preparation

The towing vehicle shall be prepared such that, when coupled to the test vehicle, braking in the test vehicle alone and/or the measurement of the longitudinal force F_L on the mechanical coupling are possible.

6.3 Instrumentation

The combination of vehicles shall be prepared for testing by addition of the following instruments and/or calibration of existing standard instruments, as required.

Other instruments may be useful in providing accurate data, but care shall be exercised to ensure that instruments added to the standard vehicle braking equipment do not significantly affect the braking system performance.

6.3.1 Control force gauge for parking braking system.

6.3.2 Towing force measuring device (if the test in accordance with 8.1.1.2 is carried out, and for types I and II road tests), including an information device for the benefit of the person conducting the test.

6.3.3 Decelerometer.

6.3.4 Speed-measuring device or calibrated speedometer.

6.3.5 Brake temperature indicating system.

6.3.6 Response time measuring device, in conjunction with simulator (see figure C.3).

6.3.7 Line pressure gauges/transducers.

6.3.8 Pressure test connections, complying with ISO 3583, for checking the setting of load-sensing devices (see 10.1.2), the response time (see 10.3), and the energy depletion (see 10.5).

6.4 Provision for failure simulation

The vehicle shall be equipped with the necessary added devices and piping to provide the required failure simulations (see 7.8). Such added devices and piping shall not interact with the standard vehicle braking equipment such as to affect the intact and/or failed system performance significantly.

In the pneumatic part of the braking system, a leakage failure is simulated by disconnecting the relevant pipe.

6.5 Loading condition

The loading condition of the vehicle combination (including the test vehicle), of the test axle or of the test wheel shall be that indicated for each test procedure.

Mass distribution on the axles shall be as stated by the vehicle manufacturer. In the case of several possible mass distribution patterns, the distribution of the load among the axles shall be such that the mass on each axle is proportional to the maximum permissible mass for each axle.

6.6 Tyre condition

The tyres shall be inflated to the vehicle manufacturer's recommended pressure levels.

It is recommended that tyre tread wear should not exceed 50 % of the new condition.

6.7 Adjustment of brakes

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.

6.8 Braking system condition

Braking system components shall be new or capable of functioning as new, and within the vehicle manufacturer's specifications. The brakes shall be bedded in accordance with the vehicle manufacturer's requirements.

6.9 Additional vehicle to tow combination of normal towing vehicle and test vehicle

An additional towing vehicle may be required for the type I test heating and/or the type II test heating (see 8.2.3 and 8.3.2). This additional vehicle needs no special instrumentation.

7 Tests — General

7.1 During all phases of this procedure, any unusual braking performance characteristics, such as undue deviation or abnormal vibration, shall be observed and reported.

7.2 Tests may be carried out under adverse conditions to avoid delays, but with due consideration for safety; such adverse conditions shall be reported. Any test which failed under such conditions shall be repeated under the correct conditions, but not all tests need necessarily be repeated.

7.3 Re-testing in the course of the full procedure shall be avoided, although one or two extra stops are unlikely to prejudice subsequent road test results.

7.4 Full or partial re-tests, after a test failure or to approve alternative brake components, shall again follow this procedure, with particular emphasis on vehicle preparation and bedding procedures.

7.5 Control forces shall be applied rapidly, but without significant overshoot, and then be maintained constant during the stop or varied progressively as required.

7.6 Skilled test drivers shall be used to determine the optimum vehicle braking performance without wheel-locking (except immediately before stopping), and without significant deviation, after appropriately familiarizing themselves with the vehicle combination.

7.7 Unless otherwise stated, all braking tests shall be carried out with cold brakes, i.e., when the initial temperature of the hottest brake measured on the disc or on the outside of the drum or on the brake linings/pads before starting each test is between 50 °C and 100 °C.

7.8 If the test vehicle is equipped with one or more load-sensing devices, the tests for failure of its control device in 8.4 and 10.4.1 are deemed to be equivalent and may be chosen by the manufacturer.

7.9 The pressure p_s in the trailer supply line at the beginning of each test, excluding the energy depletion test according to 10.5 shall be [6,5] bar. The pressure p_m in the trailer control line at full application of the control device of the service braking system of the towing vehicle shall not exceed [6,5] bar for the purposes of this International Standard.

7.10 For identification purposes of the test vehicle, test axle or test brake, and for the purposes of test result transfer to other vehicles or axles as in clause 11, the data listed in annex A are needed and shall be recorded.

8 Road tests

All road tests shall be carried out with the test vehicle laden. The cold effectiveness test specified in 8.1 shall additionally be carried out with the test vehicle unladen.

The relation of the masses of the towing vehicle and test vehicle is given in 6.1.

8.1 Cold effectiveness test (UN-ECE type 0 test)

8.1.1 Test procedure

The service braking system performance of the test vehicle can be calculated either from the achieved braking rate z_{aC} of the vehicle combination (towing vehicle plus the test vehicle) with only the test vehicle being braked (see 8.1.1.1) or from the achieved braking rate z_{aC} of the vehicle combination (towing vehicle

plus the test vehicle) and the measured force F_L on the coupling (see 8.1.1.2).

The towing vehicle engine shall be disconnected during the braking test.

A preliminary series of five service braking system applications may be carried out for vehicle familiarization.

The values of z_{aR} shall be plotted in relation to p_m . With neither p_s nor p_m exceeding [6,5] bar, one value of z_{aR} at least shall be greater than or equal to the prescribed braking rate, which is

$z_{pR} = [0,5]$ for drawbar trailers and centre-axle trailers;

or

$z_{pR} = [0,45]$ for semi-trailers.

8.1.1.1 The following procedure applies when only the test vehicle is braked. It does not apply to drawbar trailers, where the braking forces change during braking as a result of dynamic axle load shifting.

This test shall consist of a maximum of five service braking system applications from $v_i = [60]$ km/h. The final speed shall be calculated by the following formula:

$$v_f = v_i \sqrt{\frac{F_M + F_{Ru}}{F_M + F_{Ru} + F_{Rb}}}$$

Determine the maximum braking rate z_{aC} of the vehicle combination, with the towing vehicle unbraked, without wheel locking. For this purpose, various pressures p_m are fed into the trailer control line with the preparation given in 6.2.

Achieved braking rate of the test vehicle is calculated as follows:

$$z_{aR} = (z_{aC} - z_{rr}) \times \frac{F_M + F_R}{F_R} + z_{rr}$$

8.1.1.2 As an alternative, the following procedure may be applied when both vehicles of the vehicle combination are braked.

Measure the braking rate of the towing vehicle plus the test vehicle and the force F_L on the coupling with various pressures p_m . The braking rate of the test vehicle is calculated as follows:

$$z_{aR} = z_{aC} + \frac{F_L}{F_R}$$

8.1.2 Presentation of results

8.1.2.1 During each test braking, the following information shall be recorded:

- actual speed of the vehicle at the initiation of braking;
- supply line pressure p_s ;
- control line pressure p_m ;
- pressure in the brake actuators p_A ;
- mean fully developed deceleration a_{mC} (in the case of tests in 8.1.1.1);
- braking rate z_{aC} (in the case of tests in 8.1.1.1, $z_{aC} = a_{mC}/g$);
- longitudinal force on mechanical coupling F_L (in the case of tests in 8.1.1.2);
- any locking of the wheels, deviation of the vehicle from its course or abnormal vibration.

8.1.2.2 The following additional information shall be recorded for the test series:

- ambient conditions;
- vehicle identification;
- vehicle loading condition (including individual axle masses);
- tyre size.

8.1.2.3 All the results given in 8.1.2.1 and 8.1.2.2 may be presented in a table. The calculated values of z_{aR} shall be presented in a graph.

8.2 Fade test after heating (UN-ECE type I test)

This test applies:

- to a test vehicle, and/or
- to an axle or axles intended to serve as reference axle(s).

The complete type I test may alternatively be carried out on a dynamometer (see 9.1).

Under certain conditions, the road test specified below may not be required (see clause 11).

8.2.1 Basic test

A basic cold effectiveness test for the purposes of the type I test shall be carried out prior to the heating.

8.2.1.1 If the type I test is conducted with all axles of the test vehicle being braked, a cold effectiveness test similar to that described in 8.1, but with $v_i = [40]$ km/h and in laden condition shall be carried out, constituting the basic test.

8.2.1.2 However, if the type I test is limited to one or several axles of the test vehicle (see 8.2.3.2), the basic test shall be conducted in accordance with 8.2.1.1, with the exception that only one or several axles of the test vehicle are braked.

Evaluation of the results of this basic test shall take the indications in 8.2.3.2.

8.2.1.3 The highest value of the braking rate z_{aR} which results by calculation from the measurements in accordance with 8.2.1.1 or 8.2.1.2 is the braking rate of the basic test; this serves as the reference value for the braking efficiency test with hot brakes, in accordance with 8.2.4. The pressure p_A in the brake actuators used to obtain this value shall be recorded.

8.2.2 Test conditions

The heating of the brakes is carried out by driving on a level road.

NOTE 5 The alternative, given in UN-ECE Regulation No. 13, annex 4, subclause 1.5.2.1 (type I test), or 1.6.1 (type II test), to provide the energy input to the brakes of the test vehicle by braking during downhill driving, is not applied in practice on account of the difficulty of fixing the correct test conditions.

8.2.3 Test procedure

8.2.3.1 This drag test shall be carried out with a towing vehicle in accordance with 6.1 and if necessary with an additional towing vehicle in accordance with 6.9.

8.2.3.2 In order to permit application of the results of this test to other towed vehicles in accordance with clause 11, it is preferably carried out on a single axle only. However, this test also may be carried out with braking of several or all axles of the test vehicle.

In these cases the conditions of 8.1.1.1 or 8.1.1.2 shall be adapted as follows:

$$z_{aA} = (z_{aC} - z_{rr}) \times \frac{F_M + F_{Ru} + F_{Rb}}{F_{Rb}} + z_{rr}$$