
**Road vehicles — Air or air-over hydraulic
braking systems for motor vehicles
(including those with electronic control
functions) — Test procedures**

*Véhicules routiers — Dispositifs de freinage à air comprimé ou
hydropneumatiques pour automobiles (y compris ceux à fonctions de
commande électronique) — Mode opératoire d'essai*

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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.

International Standards are drafted in accordance with the rules given in the ISO/IEC Directives, Part 2.

The main task of technical committees is to prepare International Standards. 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.

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights.

ISO 7635 was prepared by Technical Committee ISO/TC 22, *Road vehicles*, Subcommittee SC 2, *Braking systems and equipment*.

This second edition cancels and replaces the first edition (ISO 7635:1991), which has been technically revised.

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Road vehicles — Air or air-over hydraulic braking systems for motor vehicles (including those with electronic control functions) — Test procedures

1 Scope

This International Standard specifies procedures for testing the air or air-over hydraulic braking systems, with and without antilock braking system (ABS), of vehicles of categories M and N (excluding M₁ and N₁) as defined in UNECE R.E.3. The values given in square brackets and the values in the tables are taken from ECE Regulation No. 13 for information.

2 Normative references

The following referenced documents are indispensable for the application of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

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

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

ISO 3833, *Road vehicles — Types — Terms and definitions*

ISO 6786, *Road vehicles — Air braking systems — Identification of connections on units*

ISO 7634:2003, *Road vehicles — Compressed-air braking systems — Test procedures*

ECE Regulation N° 10, *Uniform Provisions Concerning the Approval of Vehicles of Categories M, N and O with Regard to Electromagnetic Stability*

ECE Regulation N° 13:1996, *Uniform Provisions Concerning the Approval of Vehicles of Categories M, N and O with regard to braking, incorporating the 09 series of amendments without supplements*

UNECE¹⁾ R.E.3:1997, *Consolidated Resolution on the Construction of Vehicles*

3 Terms and definitions

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

3.1

air-over hydraulic braking system

braking system having stored pneumatic energy, hydraulically actuated brakes and transmission means incorporating a pneumatic-to-hydraulic converter

1) United Nations Economic Commission for Europe

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See Figure A.1.

[ISO 611:2003, definition 4.2.2]

3.2
pneumatic braking system
full-air braking system
braking system in which the control and energy are transmitted from the point of application to the brakes by pneumatic transmission devices

[ISO 611:2003, definition 4.2.3]

See Figure A.2.

3.3 Antilock braking system (ABS)

3.3.1 Categories of ABS

3.3.1.1

Category 1

ABS which meets all the requirements of ECE Regulation No. 13:1996, Annex 13

3.3.1.2

Category 2

ABS which meets the requirements of ECE Regulation No. 13:1996, Annex 13, excepting paragraph 5.3.5 (no braking rate on split-adhesion surfaces is prescribed)

3.3.1.3

Category 3

ABS which meets the requirements of ECE Regulation No. 13:1996, Annex 13, excepting paragraphs 5.3.4 and 5.3.5 (all split-adhesion tests are omitted)

3.3.2 Wheel control

3.3.2.1

directly controlled wheel

wheel whose braking force is modulated according to data provided at least by its own sensor

3.3.2.2

indirectly controlled wheel

wheel whose braking force is modulated according to data provided by sensor(s) of other wheel(s)

NOTE ABS with select-high control are deemed to include both directly and indirectly controlled wheels. In systems with select-low control, all sensed wheels are deemed to be directly controlled wheels.

3.4 Vehicle loading

3.4.1

laden vehicle

vehicle laden so as to reach its maximum design total mass (Code: ISO-M07)

NOTE See ISO 1176:1990, 4.7.

3.4.1.1

laden motor vehicle other than semi-trailer tractor

motor vehicle laden to the maximum design total mass (Code: ISO-M07) specified by the vehicle manufacturer and acknowledged by the technical services

NOTE 1 See ISO 1176:1990, 4.7.

NOTE 2 This mass may exceed the *maximum authorized total mass* (Code: ISO-M08) permitted by national regulations. See ISO 1176:1990, 4.8.

NOTE 3 Mass distribution on the axles is to be stated by the vehicle manufacturer. In the event of several load distribution patterns being planned, the distribution of the maximum design total mass among the axles is such that the load on each axle is proportional to the maximum load for each axle defined by the manufacturer.

3.4.1.2

laden semi-trailer tractor

semi-trailer tractor laden to the maximum design total mass (Code: ISO-M07) that is technically feasible, as specified by the vehicle manufacturer and acknowledged by the technical services, except that the load defined by the manufacturer may be repositioned halfway between the kingpin position and the centre-line of the rear axle(s), so as to compensate for the dynamic load transfer from the semi-trailer

NOTE See ISO 1176:1990, 4.7.

3.4.2

unladen vehicle

vehicle at its complete vehicle kerb mass (Code: ISO-M06) plus the mass of the required instrumentation

NOTE See ISO 1176:1990, 4.6.

3.4.2.1

unladen motor vehicle other than semi-trailer tractor

motor vehicle laden to complete vehicle kerb mass (Code: ISO-M06)

NOTE 1 See ISO 1176:1990, 4.6.

NOTE 2 During the tests, the fuel quantity in the fuel tank is to be maintained at least to 50 % of its capacity.

NOTE 3 An increase up to 200 kg mass over this mass is allowed. This corresponds, for instance, to the driver, one observer and instrumentation. If necessary, the appropriate vehicle mass may be removed.

NOTE 4 For a vehicle without body, the manufacturer is to declare the minimum axle loads for a bodied vehicle.

3.4.2.2

unladen semi-trailer tractor

vehicle laden to complete vehicle kerb mass (Code: ISO-M06) and including the fifth wheel or a load equivalent in value and position

NOTE See ISO 1176:1990, 4.6.

3.5 Air system pressures

3.5.1

pressure indicated by the manufacturer (of the vehicle)

reservoir pressure specified by the manufacturer from which it is possible to achieve the required efficiency for service braking

NOTE It is the basis for the energy storage capacity test (see 15.6).

3.5.2

maximum pressure

pressure available for normal operation, i.e.

- the cut-out pressure, in the case of an installation with a pressure regulating device
- [90] % of the asymptotic pressure, in the case of an installation with a pressure-limited compressor

3.5.3

minimum pressure

pressure available for normal operation, i.e.

- the cut-in pressure, in the case of an installation with a pressure regulating device
- [90] % of the pressure indicated by the manufacturer, in the case of an installation with a pressure-limited compressor

4 Symbols

Table 1 — Symbols used in this International Standard

Symbol	Description	Unit
a_m	Mean deceleration	m/s ²
d_m	Mean fully developed deceleration	m/s ²
E	Wheelbase	m
ε	The adhesion utilized by the vehicle: quotient of the maximum braking rate with the ABS operative (z_{AL}) and the coefficient of adhesion (k)	
ε_i	The ε value measured on axle i (in case of a power-driven vehicle with a Category 3 ABS)	
ε_H	The ε value on the high-adhesion surface	
ε_L	The ε value on the low-adhesion surface	
F	Actuating force	daN
F_{dyn}	Normal reaction of road surface under dynamic conditions with the ABS operative	N
F_{idyn}	F_{dyn} on axle i	N
F_i	Normal reaction of road surface on axle i under static conditions	N
F_M	Total normal static reaction of road surface on all wheels of power-driven (towing) vehicles	N
F_{Mnd}^a	Total normal static reaction of road surface on the unbraked and non-driven axles of the power-driven vehicle	N
F_{Md}^a	Total normal static reaction of road surface on the unbraked and driven axles of the power-driven vehicle	N
F_{Wm}	0,01 F_{Mnd} + 0,015 F_{Md} (rolling resistance)	N
g	Acceleration due to gravity (9,81 m/s ²)	m/s ²
h	Height of centre of gravity specified by the manufacturer and agreed by the Technical Service conducting the approval test	m
h_k	Height of fifth wheel coupling (kingpin)	m
k	Coefficient of adhesion between tyre and road	
k_f	k -factor of one front axle	
k_H	k -value determined on the high adhesion surface	
k_i	k -value determined on axle i for a vehicle with a Category 3 ABS	
k_L	k -value determined on the low adhesion surface	
k_{lock}	value of adhesion for 100 % slip	
k_M	k -factor of the power driven vehicle	
k_{peak}	Maximum value of the curve "adhesion versus slip"	

Table 1 (continued)

Symbol	Meaning	Unit
k_T	k -factor of one rear axle	
p_{\max}	Maximum pressure supplied by the towing vehicle in the supply circuit for the trailer	kPa (bar)
p_1	65 % of p_2	kPa (bar)
p_2	Pressure level specified by the manufacturer enabling the prescribed performance of the service braking system to be achieved	kPa (bar)
P_M	Mass of motor vehicle	kg
P_T	Maximum permissible mass of the trailer allowed to be towed by the power-driven vehicle	t
R	Ratio of k_{peak} to k_{lock}	
s	Stopping distance	m
$t, t_i, \Delta t$	Time interval	s
t_1, t_2, t_3	Pump-up times (ref. 9.2.1)	min
t_m	Mean value of t	s
t_{\min}	Minimum value of t	s
v	Vehicle speed	km/h
v_{\max}	Maximum speed of the vehicle	km/h
v_u	Lower speed limit for the antilock energy consumption test	km/h
V	Reservoir volume	l
z	Braking rate	
z_{AL}	Braking rate of the vehicle with the ABS operative	
z_m	Mean braking rate	
z_{\max}	Maximum value of z	
z_{mf}	Mean braking rate of front axle	
z_{mr}	Mean braking rate of rear axle	
z_{MALS}	z_{AL} of the power-driven vehicle on a "split-surface"	
^a F_{Mnd} and F_{Md} : in case of two-axle power-driven vehicles these symbols may be simplified to corresponding F_i symbol.		

5 Test site conditions

5.1 Test site

The test site shall be of sufficient size, without obstacles, to provide a safe testing environment.

The test site shall have a road of sufficient length prior to the test area to enable the test speeds to be attained. The test area should be

- a) of sufficient length to allow for poor braking performance, and
- b) of sufficient width to allow for poor directional stability under braking.

5.2 Road surface conditions

5.2.1 Surface

5.2.1.1 The test area shall be a dry, smooth, hard surface, free of loose material and providing a peak coefficient of adhesion of about [0,8].

5.2.1.2 Additionally, for the testing of vehicles equipped with ABS, a surface providing a peak coefficient of adhesion k_{peak} of [0,3] or less is required. It shall be preceded and followed by a surface in accordance with 5.2.1.1 of sufficient length on the approach side to enable the test speeds to be attained.

Until such test surfaces become generally available, tyres at the limit of wear, and higher values of k_{peak} up to [0,4] may be used. The actual value obtained and the type of tyres and surface shall be recorded.

For testing of vehicles fitted with ABS of Category 1 or 2, it is also necessary for a low-adhesion surface (k_L) to have a high-adhesion surface (k_H) on at least one side so that the split-adhesion tests can be performed. Both surfaces shall be sufficiently wide to allow, using the vehicle under test, the peak coefficients of adhesion to be determined separately.

The above-described surfaces shall be such that k_H is \geq [0,5] and k_H/k_L is \geq [2]. If any doubt arises as to whether this requirement has been met, it is necessary to ascertain the peak coefficients of adhesion using the procedure detailed in 12.2 and 12.4. It is always necessary to measure the peak coefficients of adhesion when testing a vehicle fitted with antilock brakes of Category 1.

5.2.2 Gradient

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

5.2.2.2 Type II and Type IIA test site conditions

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See Table 2.

Table 2 — Type II and Type IIA test site conditions

	Gradient	Length of gradient
	%	km
Type II	6	6
Type IIA	7	6

5.2.2.3 The parking braking system hill-holding test may be conducted on either an appropriate gradient or on a level road as specified in 10.3.

5.2.3 Camber

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

5.3 Ambient conditions

5.3.1 Wind speed

The tests shall be performed when there is no wind liable to affect the results. The wind speed shall not exceed an average of 5 m/s.

5.3.2 Air temperature

The air temperature shall be recorded in the test report.

6 General requirements

6.1 General test conditions to be followed during determination of braking performance:

- a) vehicle speed (see 6.11);
- b) without exceeding the maximum permissible control force;
- c) engine disconnected or connected (as prescribed);
- d) without wheel-locking, except immediately before stopping, unless specifically allowed;
- e) without deviation of the vehicle from its course (steering corrections of less than 90° allowed, if not otherwise specified);
- f) loading condition — unless otherwise specified, all tests shall be carried out with the vehicle laden and unladen.

6.2 During all phases of the following test procedures, any unusual braking performance characteristics or vehicle behaviour on both (e.g. course deviation or abnormal vibration) shall be observed and reported.

6.3 During the tests with the engine connected on vehicles with a manual gearbox, the clutch may be disengaged just before the vehicle stops, to avoid the engine stalling.

6.4 Deceleration measurements used in the following test procedures, unless otherwise stated, refer to the “mean fully developed deceleration” as defined in ECE Regulation 13/1996, Annex 4, paragraph 1.1.2.

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

6.6 The recommended sequence of the tests is in accordance with Clause 7.

6.7 Full or partial re-tests, after a failed test or to test alternative braking system components, shall again follow the recommended sequence (see Clause 7), with particular emphasis on the vehicle preparation and bedding-in procedures.

6.8 Control forces shall be applied rapidly, but without significant overshoot, and shall then be maintained constant during the stop (if not otherwise specified). An adjustable pressure regulating device should be used.

6.9 Skilled test drivers shall determine the optimum vehicle braking performance without wheel-locking except immediately before stopping and without course deviation [see 6.1 e) for allowable steering correction] after appropriately familiarizing themselves with the vehicle braking, steering and suspension systems.

6.10 The brakes are deemed to be cold when the initial temperature of the hottest brake measured on the disc, on the outside of the drum or on the brake linings is lower than [100] °C before each test stop.

6.11 The speed of the vehicle before actuating the braking system control shall be stabilized at a level not less than [98] % of the prescribed speed for the test in question unless there is any other overriding requirement.

6.12 Where a vehicle is so constructed that its maximum speed is lower than that prescribed for any test, the test shall be performed at the maximum speed of the vehicle.