
**Road vehicles — Air and air/hydraulic
braking systems of motor vehicles,
including those with electronic control
functions — Test procedures**

*Véhicules routiers — Systèmes de freinage à air comprimé ou
hydropneumatiques pour les véhicules à moteur, y compris les
systèmes à fonctions de commande électroniques — Méthodes 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 third edition cancels and replaces the second edition (ISO 7635:2003), which has been technically revised.

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Road vehicles — Air and air/hydraulic braking systems of motor vehicles, including those with electronic control functions — Test procedures

1 Scope

This International Standard specifies the method of testing the air or air over hydraulic braking systems of vehicles of categories M and N (excluding M1 and N1) as defined in Annex 7 to the UN-ECE Consolidated Resolution on the Construction of Vehicles (R.E.3.) which are built to comply with UN-ECE Regulation 13/09 including supplements 1-6. Test methods covering lock actuators or the electrical regenerative braking systems of electric and hybrid vehicles are not included in this edition.

NOTE Requirements of UN-ECE Regulation 13 related purely to the design of braking systems and braking system components are not part of this International Standard.

The values in square brackets [] and the values in tables are taken from UN-ECE Regulation No. 13.

2 Normative references (standards.iteh.ai)

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 611:2003, *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 7638-1, *Road vehicles — Connectors for the electrical connection of towing and towed vehicles — Part 1: Connectors for braking systems and running gear of vehicles with 24 V nominal supply voltage*

ISO 7638-2, *Road vehicles — Connectors for the electrical connection of towing and towed vehicles — Part 2: Connectors for braking systems and running gear of vehicles with 12 V nominal supply voltage*

ISO 11992 (all parts), *Road vehicles — Interchange of digital information on electrical connections between towing and towed vehicles*

ISO 12161, *Road vehicles — Endurance braking systems of motor vehicles and towed vehicles — Test procedures*

ISO 21069-1:2004, *Road vehicles — Test of braking systems on vehicles with a maximum authorized total mass of over 3,5 t using a roller brake tester — Part 1: Pneumatic braking systems*

ISO 21069-2 ¹⁾, *Road vehicles — Test of braking systems on vehicles with a maximum authorized total mass of over 3,5 t using a roller brake tester — Part 2: Air over hydraulic braking systems*

UN-ECE Regulation N° 13, *Uniform provisions concerning the approval of vehicles with regard to braking*

NOTE UN-ECE Regulation 13 is periodically updated through amendments and supplements, with this International Standard having been prepared in accordance with the 09 series of amendments including supplements 1 to 6. When using this International Standard, care should be taken to ensure that changes have not subsequently occurred that affect the test methods or values given.

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 braking systems

3.1.1 air-over hydraulic braking system

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

NOTE For a typical system diagram, see Figure A.1.

3.1.2 pneumatic (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

NOTE For a typical system diagram, see Figure A.2.

3.1.3 electronic braking system EBS

braking system in which control is generated and processed as an electrical signal in the control transmission

NOTE Electrical output signals control devices, which produce actuation forces from stored pneumatic energy.

3.1.4 antilock braking systems

ABS 3.1.4.1 categories of ABS

- Category 1: ABS which meets all the requirements of ECE R 13 Annex 13;
- Category 2: ABS which meets the requirements of ECE R 13 Annex 13, except paragraph 5.3.5 of ECE R 13 Annex 13 (no braking rate on split-adhesion surfaces is prescribed);
- Category 3: ABS which meets the requirements of ECE R 13 Annex 13, except paragraphs 5.3.4 and 5.3.5 of ECE R 13 Annex 13 (all split adhesion tests are omitted).

1) To be published.

3.1.4.2 wheel control

3.1.4.2.1

directly controlled wheel

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

3.1.4.2.2

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.

3.1.4.3

full cycling ABS

ABS which is repeatedly modulating the brake force to prevent the directly controlled wheels from locking

NOTE Brake applications where modulation only occurs once during the stop shall not be considered to meet this definition.

3.2

vehicle loading

3.2.1

laden vehicle

vehicle laden so as to reach its maximum mass

3.2.1.1

laden motor vehicle other than semi-trailer tractor

vehicle laden to technically feasible maximum design total mass specified by the vehicle manufacturer and acknowledged by the Technical Services

NOTE This mass may exceed the "maximum authorized total mass" permitted by national regulations. Mass distribution on the axles is 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.

3.2.1.2

laden semi-trailer tractor

vehicle laden as in 3.2.1.1, except that the load defined by the manufacturer may be repositioned halfway between the fifth wheel coupling pin position and the centre-line of the rear axle(s), so as to compensate for the dynamic load transfer from the semi-trailer

NOTE This additional load, representing the semi-trailer loading may be carried in a specially designed load frame.

3.2.2

unladen vehicle

3.2.2.1

unladen motor vehicle other than semi-trailer tractor

vehicle laden to complete vehicle kerb mass without load or occupant but with the fuel tank filled to at least 90 % of the capacity specified by the vehicle manufacturer at the start of test and complete with cooling fluid and lubricants, and tools and spare wheel, if provided

NOTE During the tests, the fuel quantity in the fuel tank is maintained at least to 50 % of its capacity. 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. For a vehicle without body, the manufacturer declares the minimum axle loads for a bodied vehicle.

3.2.2.2

unladen semi-trailer tractor

vehicle laden as in 3.2.2.1 including the fifth wheel coupling or an equivalent load (in value and in position)

3.3

Air system pressures

3.3.1

pressure indicated by manufacturer

reservoir pressure specified by the manufacturer from which it is possible to achieve the required efficiency for service braking and which is the basis for the tests prescribed in 15.7.

3.3.2

maximum pressure

pressure available for normal operation:

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

3.3.3

minimum pressure

pressure available for normal operation:

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

3.4

vehicle types

vehicles subject to the European Agreement Concerning the International Carriage of Dangerous Goods, e.g. ADR vehicles

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4 Symbols

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

Table 1 — Symbols

Symbol	Meaning	Unit
a_m	mean deceleration	m/s ²
d_m	mean fully developed deceleration	m/s ²
E	wheelbase	m
ε	the adhesion utilised 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	N
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

Table 1 (continued)

Symbol	Meaning	Unit
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}^a	$0,01 F_{Mnd} + 0,015 F_{Md}$ (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 (king pin)	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"	
k_r	k -factor of one rear axle	
n	number of brake applications	
p_{max}	maximum pressure supplied by the towing vehicle in the supply circuit for the trailer	bar
p_1	65 % of p_2	bar
p_2	pressure level specified by the manufacturer enabling the prescribed performance of the service braking system to be achieved	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 should 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 of;

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

5.2 Road surface condition

5.2.1 Surface

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

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

The ratio $R = k_{peak}/k_{lock}$ and the adhesion vs. slip curve have to be available for this surface in line with ECE R 13, Annex 13, Appendix 4.

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

For testing 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 to enable the split-adhesion tests to be performed. Both surfaces shall be sufficiently wide to be able to determine, using the vehicle under test, the peak coefficients of adhesion separately.

The above described surfaces shall be such that k_H is equal to or greater than [0,5], and k_H/k_L is equal to or greater than [2]. If any doubt arises that this requirement is met (e.g. the high adhesion surface is wet), the peak coefficients of adhesion shall be ascertained by using the procedure detailed in subclauses 12.2 and 12.4. However, the peak coefficients of adhesion shall always be measured when testing a vehicle fitted with antilock brakes of category 1 to check the braking rate on the split surface (reference 13.1).

5.2.2 Gradient

5.2.2.1 Road surface shall be level with a tolerance of $\pm 1\%$ of the average gradient, measured over a minimum distance of 50 m.

5.2.2.2 Type II and type IIA test site conditions

Table 2 — Type II and type IIA test site conditions

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

NOTE In support of the tests specified in 15.8, additional information regarding practical test site conditions can be taken from ISO 12161, including a test procedure using a vehicle dynamometer test bench.

5.2.2.3 The parking braking system hill holding test may be conducted on an appropriate gradient or on a level road as specified in 10.3 and 15.1.

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 must 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 the determination of braking performance

- a) vehicle speed (reference 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 should be carried out with the vehicle laden and unladen.

6.2 During all phases of the following test procedures, any unusual braking performance characteristics and/or vehicle behaviour 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 UN-ECE Regulation 13 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 listed in 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 order (Clause 7), and with particular emphasis on the vehicle preparation and bedding in procedures.