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Road vehicles — Compressed air braking systems for towed vehicles including those with electronic braking control functions — Test procedures

Véhicules routiers — Dispositifs de freinage à air comprimé pour véhicules remorqués, y compris ceux avec fonctions de commande de freinage électroniques — Modes opératoires 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 7634 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 7634:2003), which has been technically revised.

Road vehicles — Compressed air braking systems for towed vehicles including those with electronic braking control functions — Test procedures

1 Scope

This International Standard specifies the test procedures for testing the operational performance requirements of towed vehicles of Category O (full trailers, semi-trailers, and centre-axle trailers) as defined in Annex 7 of the UN-ECE Consolidated Resolution on the Construction of Vehicles (R. E. 3). This includes vehicles fitted with compressed air braking systems (with and without an antilock braking system or an electronically controlled braking system), in accordance with UN-ECE Regulation No. 13, 09 series of amendments, supplements 1 to 6. Test methods covering lock actuators are not included.

The values 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, *Road vehicles — Masses — Vocabulary and codes*

ISO 3583, *Road vehicles — Pressure test connection for compressed-air pneumatic braking equipment*

ISO 3833, *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/PAS 12158, *Road vehicles — Braking systems — Temperature measuring methods*

UN-ECE Regulation No. 13, *Uniform provisions concerning the approval of vehicles with regard to braking.*

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

3 Terms and definitions

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

3.1
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 Figures C.1 and C.2 show examples of typical full trailer and semi-trailer air braking systems.

3.2
electronic braking system
EBS
braking system in which the 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.

3.3
categories of ABS

3.3.1
Category A:
ABS system which meets all the requirements of UN-ECE Regulation No. 13, Annex 13

3.3.2
Category B:
ABS system which meets all the requirements of UN-ECE Regulation No. 13, Annex 13, except paragraph 6.3.2 (no braking rate on split-adhesion surface is prescribed)

3.4
wheel control

3.4.1
directly controlled wheel
wheel whose braking force is modulated according to data provided by at least its own sensor

3.4.2
indirectly controlled wheel
wheel whose braking force is modulated according to data provided by the sensor(s) of other wheel(s)

NOTE ABS systems 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.

3.5
ABS – full cycling
state of the antilock system in which the brake force is repeatedly modulated to prevent the directly controlled wheels from locking

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

3.6
laden trailer
trailer laden so as to reach its total maximum design mass (ISO 1176 code: ISO-M07)

NOTE In the case of semi-trailers and centre-axle trailers being road tested, the loading may be such that the maximum design load per axle (ISO 1176 code: ISO-M11) is reached without loading the fifth wheel for semi-trailers or the mechanical coupling for centre-axle trailers. However, for the testing of the parking braking system (see 20.1) the loading on the fifth wheel or mechanical coupling in the case of semi-trailer and centre-axle trailers is included.

3.7
unladen trailer
trailer at its shipping mass (ISO 1176 code: ISO-M05) minus spare wheel(s) and spare wheel carrier(s) and other optional items, plus the mass of the required instrumentation (see 8.6, 8.10 and 8.11)

3.8
electric control line
electrical connection between an electronic braking system equipped power-driven vehicle and an electronic braking system equipped trailer which provides the braking control function to the trailer

NOTE It comprises the electrical wiring and connector and includes the parts for data communication and the electrical energy supply for the trailer control transmission.

4 Symbols

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

Table 1 — Symbols

Symbols	Unit [a]	Description	Symbol used in ECE Reg. No. 13
C	Nm	Brake camshaft input torque	C
C'	Nm	Converted camshaft input torque (reference paragraph 15.2.3.4)	
C_o	Nm	Threshold camshaft input torque (i.e. minimum camshaft torque necessary to produce a measurable braking torque)	C_o
C_{adm}	Nm	Technically admissible camshaft input torque at a pressure in the brake actuator lower than the maximum pressure (reference paragraph 15.2.3.3)	
C_{max}	Nm	Maximum technically admissible camshaft input torque	C_{max}
E	m	Wheelbase	E
E_R	m	Distance between kingpin and centre of axle or axles of semi-trailer (or distance between drawbar coupling and centre of axle or axles of centre-axle trailer)	E_R
e		Index to indicate the reference axle	e
ε		Adhesion utilization of the trailer	ε
ε_H		ε value on the high adhesion surface	ε_H
ε_L		ε value on the low adhesion surface	ε_L
F_A	N	Average output thrust of one brake actuator at a pressure p_A corresponding to p_m = 0,65 MPa (= 6,5 bar)	
F'_A	N	Converted brake actuator output thrust (to allow for difference between p_{Ae} and p_A) (reference paragraph 15.2.3.4)	
F_{AO}	N	Threshold brake actuator output thrust (i.e. minimum output thrust necessary to produce a measurable braking torque)	

Table 1 (*continued*)

Symbols	Unit [a]	Description	Symbol used in ECE Reg. No. 13
F_{Aadm}	N	Maximum technically admissible brake actuator output thrust at a pressure in the brake actuator lower than the maximum pressure (reference paragraph 15.2.3.3)	
F_{Amax}	N	Maximum technically admissible brake actuator output thrust	
F_{B}	N	Braking force at the periphery of the wheel(s) (if no other indication is given)	T
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 the trailer for hot braking	T_R
F_{Bh}	N	Braking force at the periphery of the wheel(s) for heating the brake(s)	
F_{BR}	N	Sum of braking forces at the periphery of all wheels of the trailer	T_R
F_{bR}	N	Braking force of the trailer with the antilock system inoperative	F_{bR}
F_{bRAL}	N	Braking force of the trailer with the antilock system operative	F_{bRAL}
F_{bRALS}	N	F_{bRAL} on split adhesion surface	
F_{bRmax}	N	Maximum value of F_{bR}	F_{bRmax}
F_{Cd}	N	Total normal reaction of road surface on those axles of the motor vehicle and trailer combination which are both unbraked and driven	F_{Cd}
F_{Cnd}	N	Total normal static reaction of road surface on those axles of the motor vehicle and trailer combination which are unbraked yet non-driven	F_{Cnd}
F_{dyn}	N	Normal dynamic reaction of road surface on the trailer axles, with the antilock system operative	F_{dyn}
F_{fdyn}	N	F_{dyn} on front axle of a full trailer	F_{fdyn}
F_{i}	N	Normal static reaction of road surface on axle i	P_i, F_i
F_{idyn}	N	F_{dyn} on axle i of a full trailer	F_{idyn}
F_{K}	N	Normal static reaction at a tractor fifth wheel on semi-trailer kingpin, or at mechanical coupling of a towing vehicle on the drawbar of a centre-axle trailer	
F_{L}	N	Longitudinal force on a mechanical coupling	D
F_{M}	N	Total normal reaction of road surface on all wheels of the motor (towing) vehicle	P_M, F_M
F_{Md}	N	Total normal static reaction of road surface on the unbraked, driven axles of the motor (towing) vehicle	F_{Md}
F_{Mnd}	N	Total normal static reaction of road surface on the unbraked, non-driven axles of the motor (towing) vehicle	F_{Mnd}
F_{R}	N	Total normal static reaction of road surface on all wheels of the trailer	P_R, F_R
F_{Rb}	N	Normal dynamic reaction of road surface on all braked wheels of the trailer	P_2
F_{Rdyn}	N	Normal dynamic reaction of road surface on all wheels of a semi-trailer or a centre-axle trailer	F_{idyn}, F_{Rdyn}

Table 1 (*continued*)

Symbols	Unit [a]	Description	Symbol used in ECE Reg. No. 13
F_{Ru}	N	Total normal static reaction of road surface on all unbraked wheels of the trailer	P_1
F_{rdyn}	N	F_{dyn} on rear axle of a full trailer	
F_{WM}	N	Rolling resistance of the motor (towing) vehicle: 0,01 F_{Mnd} + 0,015 F_{Md}	F_{WM}
g	m/s²	Acceleration due to gravity	G, g
h_D	m	Height of drawbar (hinge point on trailer)	h_D
h_K	m	Height of fifth wheel coupling (kingpin)	h_K, h_S
h_R	m	Height of centre of gravity of the trailer	h_R
k		Coefficient of adhesion between tyre and road	k
K_c		Correction factor, semi-trailer laden [b]	K_c
k_f		k-factor of one front axle	k_f
k_H		k-factor for high adhesion surface	k_H
k_L		k-factor for low adhesion surface	k_L
k_{peak}		Peak k-factor	k_{peak}
k_r		k-factor of one rear axle	k_r
k_R		k-factor of the trailer	k_R
I	m	Lever length	I
P_M, P_R	kg	Mass of the individual motor vehicle / trailer	P
p_A	bar	Pressure in brake actuator(s)	
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 trailer, 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 trailer, when the control device of the service braking system has been fully applied 9 times	
p_s	bar	Pressure in the trailer supply line	
R	mm	Dynamic tyre rolling radius	R
R_s	mm	Static tyre radius	
r_{BD}	mm	Normal effective radius of brake drum or disc	R
S_A	mm	Stroke of brake actuator	
S_{Ap}	mm	Stroke of brake actuator at which output thrust is 0,9 F_A	s_p
$S_{re\text{-}adjust}$	mm	Automatic brake adjustment device re-adjustment stroke (at an actuator pressure of 1 bar)	$s_{re\text{-}adjust}$

Table 1 (*continued*)

Symbols	Unit [a]	Description	Symbol used in ECE Reg. No. 13
t	s	Time interval	t
t_m	s	Mean value of t	t_m
t_{min}	s	Minimum value of t	t_{min}
v	km/h	Vehicle speed	v
v_{air}	km/h	Velocity of cooling air flow	v_{air}
v_f	km/h	Final vehicle speed at the end of braking test	v_2
v_s	km/h	Vehicle speed at beginning of braking test	v, v_1
z		Braking rate [total braking force of vehicle divided by the normal static reaction of road surface (can be calculated for the whole vehicle, a single axle or a single wheel)]	z
z_a		Achieved braking rate	
z_{aA}		Achieved braking rate of an axle, evaluated by calculation	
z_{aC}		Achieved braking rate of the vehicle combination	z_R + M
z_{aR}		Achieved braking rate of trailer, evaluated by calculation	
z_{BaR}		Calculated braking rate of vehicle with hot brakes	
z_C		Braking rate of vehicle combination with the trailer only braked and the antilock system inoperative (towing vehicle engine disconnected)	z_C
z_{CAL}		Braking rate of vehicle combination with the trailer only braked and antilock system operative	z_{CAL}
z_{CALS}		z_{CAL} on the split-adhesion surface	
z_{Cmax}		Maximum value of z_C	z_{Cmax}
z_{hae}		Braking rate resulting from F_{Bae}	
z_{he}		Braking rate resulting from F_{Bhe}	
z_{pW}		Braking rate for one wheel	
z_{paW}		Hot braking rate for one wheel	
z_{phR}		Braking rate for heating the brakes of the trailer	
z_{pR}		Trailer service braking rate	
z_{RAL}		Braking rate of the trailer obtained by calculation from z_{CAL}	
z_{RALH}		z_{RAL} on the high friction surface	z_{RALH}
z_{RALL}		z_{RAL} on the low friction surface	z_{RALL}
z_{RALS}		z_{RAL} on the split-surface	z_{RALS}
z_r		Total braking rate as a result of rolling resistance [c]	R

[a] In accordance with ISO 31-3:1992. Quantities and units-Part Mechanics.

[b] See UN-ECE Regulation No. 13 Annex 10, diagram 4B.

[c] Value is 0,01 (see UN-ECE Regulation No. 13 Annex 4, sub-clause 1.4.4.3).

NOTE For some calculations, additional indices as listed below may be used:

— subscripts $_{1, 2, 3,}$ etc., indicate axles no. 1, no. 2, no. 3, etc., respectively;

— I or III indicate the fade test type (type I or III test respectively);

— e_i indicates the reference axle for the calculation of the values for the axle i;

— $_f$ or $_r$ indicates a front or rear axle.

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 sufficient length to allow for poor braking performance and 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 (k_{peak}) of about [0,8].

5.2.1.2 Additionally, for the testing of trailer(s) equipped with an antilock braking system of category A, a surface providing a 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.

NOTE 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 trailers fitted with antilock braking systems of category A, 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 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 divided by k_L is equal to or greater than [2]. If any doubt arises that this requirement is met, it is necessary to ascertain the peak coefficients of adhesion by using the procedure detailed in 19.2. It is always necessary to measure the peak coefficients of adhesion when testing a trailer fitted with an antilock braking system of category A.

5.2.2 Gradient

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

5.2.2.2 Type I and type III tests may be conducted on a specified gradient or on a level road as specified in 20.4.4 (type I) and 20.5.4 (type III).

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 20.1.2.3.

5.2.3 Camber

The camber (transverse gradient) across the road surface should 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 however 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 The general test conditions to be followed during the determination of braking performance are listed below:

— motor vehicle and trailer combination speed (as defined in paragraph 6.11);

— without exceeding the maximum permissible control force/pressure;

— without wheel-locking, except immediately before stopping unless specifically allowed;

— without deviation of the motor vehicle and trailer combination from its course;

— loading condition: unless otherwise specified, all tests should be carried out with the trailer unladen.

6.2 During all phases of the following test procedures, any unusual braking performance characteristics and/or motor vehicle and trailer combination behaviour, e.g. course deviation or abnormal vibration, shall be observed and reported.

6.3 Deceleration measurements used in the following test procedures, unless otherwise stated, refer to the "mean fully developed deceleration" as defined in UN-ECE Regulation No. 13, Annex 4, paragraph 1.1.2.

6.4 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.

6.5 The recommended sequence of the tests is listed in Clause 7.

6.6 Re-testing in the course of carrying-out the full test procedure is to be avoided, although one or two extra stops are unlikely to prejudice subsequent test results.

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

6.8 Control force/pressure shall be applied rapidly, but without significant overshoot, and then be maintained constant during the stop (if not otherwise specified). The use of adjustable pressure regulating devices is recommended.

6.9 Skilled test drivers should be used who shall familiarize themselves with the optimum trailer braking performance without wheel-locking, except immediately before stopping, and without course deviation.

6.10 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 is lower than [+100] °C.

6.11 The speed of the motor vehicle and trailer combination 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 If the semi-trailer, centre-axle trailer or full trailer is equipped with a load-sensing device/function, the tests relating to the failure of its control as detailed in 16 and 20.3 are deemed to be equivalent and the manufacturer may choose which test is to be carried out.

6.13 The pressure p_s in the trailer supply line at the start of each test, shall be [7] bar and the trailer control line pressure p_m at each full service brake application shall not exceed [6,5] bar.

The energy depletion test of Clause 9 has special extended limits of: p_s = [8,5] bar and p_m = [7,5] bar.

6.14 To enable the brake response time to be measured, a simulator(s) representing a standard towing vehicle is required (reference Clause 10). A pneumatic control line simulator is required for all trailers together with an electric/pneumatic simulator if the trailer is also equipped with an electric control line. (At the present time, UN-ECE Regulation No. 13 does not allow trailers with only an electric control line.)

7 Recommended sequence of tests

7.1 Preparation and static checks and tests

See Table 2.

Table 2 — Preparation and static checks and tests

No.	Test	Status	Reference to this International Standard	Reference to ECE R 13.09
1	Vehicle preparation (documents, instrumentation, bedding, etc.)	—	8	§ 1 - 4, 5.1.1.4, A2, A17, A18
2	Capacity of energy storage devices	static	9	A7 § 1.3
3	Response time	static	10	A6 § 3.1 - 3.5
5	Automatic braking	static	11	5.2.1.18.4.2, A4 § 3.3
6	Brake defect and failure warning signals	static	12	5.2.1.29.2, A13 § 4.1, 4.1.1, 4.1.2, A17 § 4.2.2.2
7	Spring brake system	static	13	A8 § 2.4, 2.5
8	Dynamometer test - type I		14.2	A11-App2
9	Dynamometer test - type III		14.3	A11-App2
10	Transfer of type I and type III test results to other trailers		15	A11
11	Load-sensing device/function control failure	static	16	A10 § 1.1, A10 § 6
12	Auxiliary equipment failure	static	17	5.2.2.14