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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

Reference number
ISO 7634:2007(E)

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Contents

Page

Foreword ... v
1 Scope ... 1
2 Normative references ... 1
3 Terms and definitions ... 2
4 Symbols ... 3
5 Test site conditions ... 7
5.1 Test site ... 7
5.2 Road surface condition ... 7
5.3 Ambient conditions ... 8
6 General requirements ... 8
7 Recommended sequence of tests ... 9
7.1 Preparation and static checks and tests ... 9
7.2 Basic performance tests – unladen ... 10
7.3 Antilock braking system/electronically controlled braking system (ABS/EBS) tests — unladen ... 10
7.4 Basic performance tests — Laden ... 10
8 Vehicle preparation ... 11
8.1 Documents and basic data ... 11
8.2 Braking system condition and bedding ... 11
8.3 Adjustment of braking equipment ... 11
8.4 Tyre conditions ... 12
8.5 Towing vehicles ... 12
8.6 Instrumentation — General ... 12
8.7 Provision for failure simulation ... 12
8.8 Loading condition ... 13
8.9 Additional vehicle to tow the combination of normal towing vehicle and test trailer ... 13
8.10 Additional instrumentation for ABS equipped trailers ... 13
8.11 Additional instrumentation for trailer with an electric control line ... 13
9 Energy storage capacity test ... 14
9.1 Test conditions ... 14
9.2 Test procedure ... 14
9.3 Test requirement ... 14
9.4 Presentation of results ... 14
10 Service braking system — Response time measurement ... 14
10.1 General ... 14
10.2 Towing vehicle simulator ... 15
10.3 Test conditions ... 15
10.4 Test procedure ... 15
10.5 Presentation of results ... 16
11 Automatic braking ... 16
12 Brake defect and failure warning signals ... 16
12.1 Antilock braking system warning signal ... 16
12.2 EBS warning signal check ... 16
13 Tests on trailers equipped with spring brake actuators ... 16
13.1 Initial conditions ... 16
13.2 Energy depletion test ... 17

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13.3 Spring brake actuation test ... 17
13.4 Auxiliary release system check ... 17

14 Dynamometer tests (alternative to vehicle tests) ... 17
14.1 General ... 17
14.2 Alternative type I tests (fade test for trailers of categories O_2 and O_3) ... 17
14.3 Alternative type III tests (fade test for category O_4 trailers) ... 19

15 Transfer of results of type I or type III tests to other vehicles ... 21
15.1 General ... 21
15.2 Presentation of results ... 22

16 Control failure of load-sensing device/function — Stationary test ... 23

17 Auxiliary equipment failure ... 24

18 Basic performance tests — Unladen ... 24
18.1 Type O test (Service braking system cold brake effectiveness) ... 24

19 Antilock braking system/electronically controlled braking system (ABS/EBS) tests — Unladen ... 26
19.1 Determination of adhesion utilization on high adhesion surface ... 26
19.2 Determination of the peak coefficient of adhesion on the high adhesion surface ... 27
19.3 Wheel behaviour ... 30
19.4 Split adhesion tests ... 30
19.5 Energy consumption of the antilock braking system (on a high adhesion surface) ... 31
19.6 Antilock braking system failure ... 33
19.7 Additional tests on trailers equipped with EBS ... 33

20 Basic performance tests — Laden ... 34
20.1 Parking braking system tests ... 34
20.2 Type O test (Service braking system cold brake effectiveness) ... 37
20.3 Control failure of load-sensing device/function — Road test ... 37
20.4 Type I test (fade test for trailers of categories O_2 and O_3) ... 37
20.5 Type III test (fade test for vehicles of category O_4) ... 40

Annex A (normative) Description of test vehicle, axle or brake ... 44

Annex B (normative) Test report ... 47

Annex C (informative) Figures ... 50

Bibliography ... 54

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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.

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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.

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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)

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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)	

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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}

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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)	$s_{re\text{-}adjust}$

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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).

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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 %.

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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.

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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

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7.2 Basic performance tests – unladen

See Table 3.

Table 3 — Basic performance tests — Unladen

No.	Test	Status	Reference to this International Standard	Reference to ECE R 13.09
1	Type O test	Motor veh./trailer	18	A4 § 1.4.4

7.3 Antilock braking system/electronically controlled braking system (ABS/EBS) tests — unladen

See Table 4.

Table 4 — Antilock braking system/electronically controlled braking system (ABS/EBS) tests — Unladen

No.	Test	Status	Reference to this International Standard	Reference to ECE R 13.09
1	Adhesion utilization on high adhesion	Motor veh./trailer	19.1	A13 § 6.2
2	Determination of k_L peak	Motor veh./trailer	19.2	A13-App.2 § 2
3	Wheel behaviour test	Motor veh./trailer	19.3	A13 § 6.3.1, A13 § 6.3.3
4	Split adhesion test	Motor veh./trailer	19.4	A13 § 6.3.2
5	Energy consumption	Motor veh./trailer	19.5	A13 § 6.1
6	Antilock braking system failure	static	19.6	A13 § 4.3
7	Additional tests with EBS	Motor veh./trailer	19.7	5.1.3.4, 5.2.2.15.2, 5.2.2.19

7.4 Basic performance tests — Laden

See Table 5.

Table 5 — Basic performance tests — Laden

No.	Test	Status	Reference to this International Standard	Reference to ECE R 13.09
1	Parking braking system test	static	20.1	A 4 § 3.2
2	Type O test	Motor veh./trailer	20.2	A 4 § 1.4.4
3	Load-sensing device/function control failure	Motor veh./trailer	20.3	A10 § 1.1, A10 § 6
4	Type I test (fade test)	Motor veh./trailer	20.4	A 4 § 1.5.2 - 4
5	Type III test (fade test)	Motor veh./trailer	20.5	A 4 § 1.7

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8 Vehicle preparation

8.1 Documents and basic data

NOTE The control of the data as per the definitions in 3.3 is also an integral part of the vehicle preparation.

The vehicle shall be verified based upon the documentation as follows:

a) Main technical data according to Annex 2 of UN-ECE Regulation No. 13;

b) Piping diagram, layout and list of the elements of the braking system;

c) Braking system performance calculation according to Annex 10 of UN-ECE Regulation No. 13, including:

— compatibility diagrams: the relationship between p_m (also digital equivalent if applicable) and braking rate z_{pR}; for vehicles with an antilock braking system, this is only required to cover the laden state;

— adhesion utilization curves (only for full trailers without an antilock braking system);

— for semi-trailers with K_C less than [0,8] evidence that z_{pR} is at least [0,45];

— for full trailers and centre-axle trailers evidence that z_{pR} is at least [0,5];

d) Documentation according to Annex 18 of UN-ECE Regulation No. 13, if the vehicle is equipped with EBS. This documentation includes an explanation of design provisions guaranteeing compliance with all relevant parts of UN-ECE Regulation 13 (paragraph 5.2.2 and the appropriate sub-paragraphs) which deal with the special requirements for brake force compensation and for EBS. This documentation may also indicate the worst case failures for EBS.

e) Report/approval of electromagnetic compatibility (EMC) (in accordance with UN-ECE Regulation No. 10, 02 series of amendments) if the vehicle is equipped with an ABS or EBS.

f) Report that the vehicle has been satisfactorily tested to the method described in Annex 17 of UN-ECE Regulation No. 13, if the vehicle is equipped with an electric control line.

8.2 Braking system condition and bedding

8.2.1 The braking system components shall be new, or capable of functioning as if new, and within the vehicle manufacturer's specifications.

It is recommended to measure individual brake forces on a roller test bench prior to the braking performance tests.

8.2.2 The brake linings shall be bedded. Until a uniform procedure is established, the bedding of the service and parking brake linings should be carried out according to the manufacturer's recommendations.

The brake linings may be regarded as bedded if at least 80 % of their surface contacts with the brake drums or discs. Neither glazed nor burned or damaged surfaces are acceptable.

8.3 Adjustment of braking equipment

Adjustable brake components shall be set according to the vehicle manufacturer's recommendations. Re-adjustment of the brakes, including automatically adjusted brakes, in accordance with the vehicle manufacturer's recommendations, may be made prior to each specific test.

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8.4 Tyre conditions

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

8.4.2 It is recommended that the tyre tread wear should not exceed 50 % of the new condition, and that totally new tyres are not used.

8.5 Towing vehicles

8.5.1 Vehicle choice

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 full trailer, semi-trailer, or centre-axle trailer to be tested 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 requirements of UN-ECE Regulation 13, Annex 10, paragraph 3.1.3.

8.5.2 Towing vehicle preparation

The towing vehicle shall be prepared such that, when coupled to the test vehicle, it is possible to brake the test vehicle alone or to brake both vehicles and measure the longitudinal force F_{L} on the mechanical coupling.

8.6 Instrumentation — General

The towing vehicle and trailer shall be prepared for testing by the addition of the following instruments and/or calibration of existing standard instruments, as required:

- control force gauge for measuring the force required to apply the parking braking system;
- coupling force measurement system. Required for types I and III road tests, and if tests according to paragraph 18.1.1.2 are carried out, and should include an information display for the benefit of test personnel;
- decelerometer;
- speed measuring device or calibrated speedometer. (For ABS equipped trailers, refer to paragraph 8.10);
- brake temperature indicating system (see ISO/PAS 12158 for recommendations on brake temperature measurement methods);
- response time measurement system, in conjunction with a towing vehicle air system simulator (see Figures C.3 and C.4);
- line pressure gauges and pressure transducers to measure and record, where necessary, reservoir, control line and actuator pressures;
- pressure test connections complying with ISO 3583, for checking the setting of load-sensing devices, the capacity of the energy storage devices (see Clause 9) and the response time (see Clause 10).

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.

8.7 Provision for failure simulation

8.7.1 The vehicle shall be equipped with the necessary added devices, piping and wiring as agreed with the vehicle manufacturer to provide the required failure simulations.

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Such added devices, piping and wiring shall not interact with the standard vehicle braking equipment such as to significantly affect the intact system performance or introduce side-effects in the failed case.

8.7.2 In the pneumatic part of the braking system, a failure should correspond to an uncoupled pipe.

8.7.3 In the electric part of the braking system, a failure should generally correspond to a disconnection, but a short circuit or a ground connection may be specified by the manufacturer in certain instances. This may be done by using prepared components or sections of wiring.

8.7.4 Fault conditions should be removed after the appropriate test has been conducted and the correct operation of the braking system should then be verified.

8.8 Loading condition

The loading condition of the towing vehicle, the trailer, the test axle or of the test wheel shall be that indicated in each test procedure.

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

For identification purposes of the trailer, test axle, or test brake, and for the purpose of test result transfer to other trailers or axles as in section 15, the data listed in Annex A shall be recorded.

Each axle shall be weighed and the results recorded prior to the test, or if previously weighed, the load and load positions are also to be recorded so that the loading condition can be reproduced.

8.9 Additional vehicle to tow the combination of normal towing vehicle and test trailer

An additional towing vehicle may be required for the type I or the type III heating test (see 20.4.4.2 and 20.5.4.1.2). This additional vehicle needs no special instrumentation.

8.10 Additional instrumentation for ABS equipped trailers

Additional instrumentation for ABS equipped trailers includes:

- vehicle speed measuring equipment capable of producing a permanent record of speed and time during braking;
- suitable equipment to ascertain when and for what period the wheels, directly controlled by the antilock braking system, actually lock during the test;
- suitable valves and regulators to enable the supply to the trailer energy reservoir to be cut off (without venting the trailer supply line) and to allow the trailer brakes to be operated without a corresponding operation of those on the towing vehicle; the installation shall be such that it is possible to operate the service braking system a number of times with both maximum and reduced control line pressures;
- suitable pressure regulators to enable the pressure to a braked wheel to be adjusted individually (see 19.2.1.2).

8.11 Additional instrumentation for trailer with an electric control line

A device(s) that enables a digital and a pneumatic control line signal to be generated independently of each other.

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9 Energy storage capacity test

9.1 Test conditions

The pressure in the reservoir(s) shall correspond to p_S = [0,85] MPa (= 8,5 bar) in the supply line (see 6.13).

The reservoir(s) of auxiliary equipment shall be isolated. The load-sensing device(s)/function(s), if installed, shall be in a position/status corresponding to the laden vehicle.

9.2 Test procedure

9.2.1 Shut the supply line without venting it (to avoid automatic application of the braking system).

Pressurize the service braking system of the trailer with a pressure of [0,75] MPa (= 7,5 bar) via the control line. During this application, measure and record the pressure p_{res} in the trailer braking system reservoir(s).

9.2.2 Release and repeat a further eight full applications and releases. Allow at least 10 s to elapse between the start of each application and measure the finial pressure in the reservoir(s). Check that, on release, no automatic or parking brake actuation has occurred and the wheels turn freely.

In the event of the trailer also having an electric control line, ensure that a digital demand value corresponding to [0,75] MPa (= 7,5 bar) is present at each brake application.

9.3 Test requirement

The pressure in the reservoir(s) when the control device is fully applied for the 9th time (1 + 8 times), p'_{res}, shall be greater than or equal to [0.5] p_{res}.

9.4 Presentation of results

The following details shall be recorded:

a) the pressure in the reservoir(s) when the control device is fully applied for the first application, (p_{res});

b) the pressure in the reservoir(s) when the control device is fully applied for the ninth time, (p'_{res}).

10 Service braking system — Response time measurement

10.1 General

The response time of a motor vehicle and trailer combination is the time that elapses between the initiation of brake pedal application in the towing vehicle to the moment when the pressure p_A in the least favourably placed brake actuator of the trailer reaches [75] % of its asymptotic value.

As the vehicles forming any typical combination are tested separately, a simulator shall be used to represent a standard towing vehicle when the trailer is being tested:

— in case of a trailer having a pneumatic control line, a simulator corresponding to 10.2.2 shall be used;

— in case of a trailer having an electrical control line, the response time of the digital demand value according to ISO 11992 (all parts) shall also be measured by using a simulator as documented in UN-ECE Regulation No. 13, Annex 6, paragraph 3.4 (see Figure C.4).

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10.2 Towing vehicle simulator

10.2.1 In the case of a pneumatic control line, the simulator shall have the pneumatic characteristics specified in paragraphs 10.2.2 and 10.2.3.

In the case of an electrical control line, the simulator shall have the characteristics specified in UN-ECE Regulation No. 13, Annex 6, paragraph 3.4 (see 8.1.6).

10.2.2 The simulator shall have a reservoir with a capacity of [30] litres which shall be charged to a pressure of 0,65 MPa (= 6,5 bar) before each test; it shall not be recharged during the test. At the outlet of its braking control device, the simulator shall have fitted an orifice with a diameter of between [4] mm and [4,3] mm inclusive or an equivalent adjustable throttle device.

The volume of pipe measured from the orifice up to and including the coupling head shall be [385 ± 5] cm^3 (which is deemed to be equivalent to the volume of a pipe [2,5] m long with an internal diameter of 13 mm and under a pressure of [0,65] MPa (= 6,5 bar). The control line pressure p_m referred to in 10.2.3 shall be measured immediately downstream of the orifice or the adjustable throttle if one is used.

10.2.3 The simulator shall be set, for example through the choice of orifice in accordance with 10.2.2, in such a way that if a reservoir of [385 ± 5] cm^3 is joined to its control line coupling head, the time taken for the pressure pm to increase from [0,065] MPa (= 0,65 bar) to [0,49] MPa (= 4,9 bar) (10 % and 75 % respectively of the normal pressure of [0,65] MPa (= 6,5 bar)) shall be [0,2 ± 0,01] s. If a reservoir of [1155 ± 15] cm^3 is substituted for the first reservoir, the time taken for the pressure p_A to increase from [0,065] MPa (= 0,65 bar) to [0,49] MPa (= 0,49 bar) without further adjustment shall be [0,38 ± 0,02] s. Between these two pressure values, the pressure shall increase approximately linearly. These reservoirs shall be connected to the coupling head without using flexible pipes and the connection shall have an internal diameter of not less than [10] mm.

NOTE Figure C.3 gives an example of the correct configuration and use of the simulator for a pneumatic control line and Figure C.4 gives an example of the configuration for an electrical control line.

10.3 Test conditions

10.3.1 The pressure p_s in the supply line shall be [0,65] MPa (= 6,5 bar).The pressure p_s in the supply line shall be [0,65] MPa (= 6,5 bar).

10.3.2 The response time of the service braking system shall be measured at the pipe connection of the brake actuator, which has the least favourable response time.

10.3.3 Load-sensing devices/functions, if installed, shall be in the position/status corresponding to the laden vehicle.

10.4 Test procedure

10.4.1 Connect the simulator to the trailer and pressurize the supply line p_s to [0,65] MPa (= 6,5 bar).

10.4.2 Determine the asymptotic values of the pressure p_A in the brake actuators.

10.4.3 Measure the time elapsing between the moment when the pressure p_m, or its digital equivalent, produced in the control line by the simulator, reaches [0,65] MPa (= 6,5 bar) and the moment when the pressure p_A in the brake actuator of the trailer reaches [75] % of its asymptotic value.

The time, rounded to the nearest tenth of a second, shall not exceed [0,4] s. If the figure representing the hundredth of a second is five or more, the value shall be rounded up to the next higher tenth.

NOTE 1 The maximum allowable measured value is 0,4499 s.

NOTE 2 In the case of a trailer equipped with both a pneumatic and an electric control line, the response time is determined independently for each control line.

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10.5 Presentation of results

Record the time measured in 10.4.3.

11 Automatic braking

Simulate a failure in the supply line flexible connection between towing vehicle and trailer by reducing the pressure p_s in the supply line from [0,65] MPa (= 6,5 bar) at a rate of at least [0,1] MPa (= 1 bar) per second, and check that there is an initial pressure rise in the brake actuators before p_s falls to [0,2] MPa (= 2 bar). The pressure attained in the brake actuators shall be such as to generate a braking rate of z_{aR} at least equal to [0,135] for the laden trailer at a speed of 40 km/h.

If the trailer has both pneumatic and electric control lines, automatic braking may be suppressed even if the pressure p_s is reduced provided the pressure in the trailer reservoir(s) is sufficient to ensure a braking rate of z_{aR} at least equal to [0,135] for the laden vehicle with the electric control line being electrically connected. When the automatic braking function is suppressed, check that trailer service braking system achieves a braking rate of z_{aR} at least equal to [0,135] for the laden vehicle when supplying a full control signal via the electric control line of [33280d = 0,65 MPa (= 6,5 bar)].

12 Brake defect and failure warning signals

12.1 Antilock braking system warning signal

12.1.1 Verify that the antilock braking system includes provisions to activate an optical warning in towing vehicles via pin 5 of the ISO 7638-1 and ISO 7638-2 and the electrical connector.

Check that the warning signal will become active:

— when there is an electrical break in the supply of electricity to the antilock system, in the wiring external to the antilock system controller(s) or modulator(s), or a sensor malfunction;

— when the trailer antilock braking system is energised and that it is extinguished after a verification phase, only if none of the above-mentioned defects are present.

In addition, check during the verification phase (before the warning signal goes out) that all electrically controlled modulator valve(s) cycle at least once.

NOTE With no defect present the warning signal may become active again, provided that it is extinguished before the trailer reaches a speed of 15 km/h.

12.2 EBS warning signal check

The fulfilment of the requirements for EBS warning signals is shown by the conformity to UN-ECE Regulation No. 13, Annex 17 (see paragraph 8.1.6).

13 Tests on trailers equipped with spring brake actuators

13.1 Initial conditions

The brakes are adjusted as closely as possible.

The wheels are chocked to ensure that the trailer does not roll when the spring brake actuators are released.

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13.2 Energy depletion test

13.2.1 Pressurize the trailer supply line to [0,75] MPa (= 7,5 bar) and disconnect the supply line. Use the appropriate control device mounted on the trailer (e.g. shunt valve) to apply pressure (to, for example, the relay emergency valve) so as to release the automatic application of the brake (emergency brake).

Use the appropriate control device mounted on the trailer (parking brake control valve), to fully apply and release the spring brake actuators [3] times. Allow at least 10 s to elapse between the start of each application and the start of the following release.

13.2.2 After the third spring brake actuator release cycle, the wheels to which spring brake actuators are fitted shall still be free to rotate.

13.3 Spring brake actuation test

Pressurize the trailer supply line so as to have [0,7] MPa (= 7 bar) in the spring brake actuator spring hold-off chamber and then shut off the supply line without venting it (to avoid automatic brake application).

Fully apply and release the service braking system of the trailer via the control line [4] times, allowing at least 10 s to elapse between the start of each application and the start of each following release. For these applications, the load-sensing device(s)/function(s), if installed, shall be in the position/status corresponding to the laden vehicle.

After the fourth brake release, measure the pressure in the spring hold-off chamber and verify that the wheels are free to rotate. Reduce the pressure by creating a leak condition, and record the value at which the spring brake actuators begin to cause the generation of a braking torque making the wheel difficult to rotate.

This pressure shall be less than the pressure in the spring hold-off chamber after the fourth release of the service braking system.

13.4 Auxiliary release system check

Check that it is possible, by mechanical or pneumatic means, to release the spring brake actuators from the brakes applied condition when the normal release system is no longer functional.

14 Dynamometer tests (alternative to vehicle tests)

14.1 General

The tests in 14.2 and 14.3 represent the reference axle tests referred to in Clause 15. If such reference axle tests have already been passed, check under the conditions of paragraph 15.2.3 if the results of the reference axle tests are transferable to the test trailer. In this case, no new type I or type III tests need be carried out.

14.2 Alternative type I tests (fade test for trailers of categories O_2 and O_3)

If, instead of a road test as in 20.4, an alternative type I test is chosen, this shall be carried out on a complete brake, wheel and tyre on a high speed rolling road dynamometer or on an inertia dynamometer.

The test comprises a cold effectiveness test followed by a heating phase and a hot brake test, finishing with a free running test.

14.2.1 High speed rolling road dynamometer test

This dynamometer shall have sufficient motor drive power to drive the wheel against the braking action to accomplish the following tests.

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14.2.1.1 The wheel shall be loaded as defined by the manufacturer.

14.2.1.2 The braking time for the cold effectiveness test in accordance with 14.2.3.1 and for the following test with hot brakes in accordance with paragraph 14.2.3.3 shall be [1] s after an allowed build-up period not exceeding 0,6 s.

NOTE This limitation of the braking time is necessary because with the usual test machines, this test is made against the driving power of the machine motor.

14.2.2 Inertia dynamometer test

14.2.2.1 To conduct the basic inertia dynamometer test in accordance with 14.2.3.1 and the following hot brake test in accordance with 14.2.3.3, the test machine shall have a rotary inertia simulating a set part of the vehicle mass inertia. This part shall be that mass which creates the wheel load acting on the test wheel as defined by the manufacturer.

14.2.2.2 The inertia mass may be connected to the brake either directly, or via the tyre and wheel.

14.2.2.3 Where the tyre does not carry the braking forces, the torque applied to the brake shall be modified by subtracting a torque equivalent to a rolling resistance braking rate z_r of [0,01].

14.2.3 Test procedure

14.2.3.1 Cold effectiveness test

A cold effectiveness test for the purposes of comparison with the hot brake test shall be carried out before starting the heating phase.

Apply the brake three times from an initial speed corresponding to a road speed of [40] km/h, each for a period of approximately [2] s. Each stop shall be made at the same brake actuator pressure p_A as would produce, by calculation, that output which would generate a laden braking rate z_{pW} of at least 0,5. Pressure p_A shall not exceed [0,65] MPa (= 6,5 bar) and the initial brake temperature on each stop shall be approximately equal and not more than [100] °C.

The average braking rate of these three stops shall be recorded as the braking rate of the test.

14.2.3.2 Heating phase

The required energy input to the brake is made, from the motor of the dynamometer, at a constant speed equivalent to [40] km/h for a distance of [1700] m with a constant braking rate of [0,07]. For those cases where during the test there is no tyre rolling resistance, the braking rate shall be reduced to [0,06].

Cooling air at a velocity and in a direction to simulate the actual on-vehicle conditions may be provided. The speed of air flow, v_{air}, used shall be no faster than [13,2] km/h and the cooling air shall be at the ambient temperature.

14.2.3.3 Braking efficiency test with hot brake

This test shall be carried out under the same conditions as for the cold effectiveness test in accordance with paragraph 14.2.3.1 and particularly with the same pressure p_A in the brake actuator as recorded for that test.

Wheel speed build-up for this test shall commence within [60] s after the end of the heating phase of 14.2.3.2 and braking shall start as soon as a speed equivalent to [40] km/h is reached.

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This test shall give a braking rate which fulfils the two following conditions:

a) it reaches at least [60] % of the braking rate of the cold effectiveness test of 14.2.3.1, and;

b) the braking rate z_{paW} obtained from this test shall be equal to or greater than [0,36].

14.2.4 Free running test — Automatic brake adjustment device

If an automatic brake adjustment device is fitted, e.g. an automatic slack adjuster, check that one of the following conditions is fulfilled:

a) it is possible to rotate the wheel by hand when the brake is cold at a temperature of $\leqslant$ [100] °C;

b) at a constant speed equivalent to v = [60] km/h with the brake released the asymptotic temperature does not exceed a drum/disc increase of [80] °C.

14.2.5 Presentation of results

The following details shall be recorded:

a) measured braking force produced by the brake in both the cold effectiveness and the hot brake tests;

b) calculated braking rate produced by the brake in the cold effectiveness and hot brake tests;

c) test machine type (see 14.2.1 and 14.2.2);

d) brake actuator pressure p_A used in the cold effectiveness and hot brake tests;

e) time elapsed between the end of the heating phase and the start of braking with the hot brake.

Further results should be recorded as required for the Annex B test report.

14.3 Alternative type III tests (fade test for category O_4 trailers)

14.3.1 General

If, instead of a road test as in 20.5, an alternative type III test is chosen, this shall be carried out on a complete brake, wheel and tyre on a high speed rolling road dynamometer or on an inertia dynamometer.

The test comprises a cold effectiveness test followed by a heating phase and a hot brake test, finishing with a free running test.

14.3.2 High speed rolling road dynamometer test

14.3.2.1 This dynamometer shall have sufficient motor drive power to drive the wheel against the braking action to accomplish the following tests.

14.3.2.2 The wheel shall be loaded as defined by the manufacturer.

14.3.2.3 Braking time for the cold effectiveness test in accordance with 14.3.4.1 and for the following test with hot brakes in accordance with 14.3.4.3 shall be [1] s after an allowed build-up period not exceeding [0,6] s.

NOTE This limitation of the braking time is necessary because with the usual test machines, this test is made against the driving power of the machine motor.

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14.3.3 Inertia dynamometer test

14.3.3.1 To conduct the cold effectiveness inertia dynamometer test in accordance with 14.3.4.1 and the following hot brake test in accordance with paragraph 14.3.4.3, the test machine shall have a rotary inertia simulating a set part of the vehicle mass inertia. This part shall be that mass which creates the wheel load acting on the test wheel as defined by the manufacturer.

14.3.3.2 The inertia mass may be connected to the brake either directly, or via the tyre and wheel.

14.3.3.3 Where the tyre does not carry the braking forces, the torque applied to the brake shall be modified by subtracting a torque equivalent to a rolling resistance braking rate z_r [0,01].

14.3.4 Test procedure

14.3.4.1 Cold effectiveness test

A cold effectiveness test shall be carried out prior to the heating phase. This shall follow the procedure of 14.2.3.1 except that the initial speed shall be set at the equivalent of [60] km/h. The average test braking rate and corresponding actuator pressure p_A shall be noted.

14.3.4.2 Heating phase

14.3.4.2.1 High speed rolling road dynamometer test

The whole test consists of [20] brake applications each on a brake cycle of [60] s (braking time [25] s and recovery time [35] s). The required energy input to the brake is made at a constant speed equivalent to a vehicle speed of [30] km/h.

The braking rate is constant at [0,06], except that where, during the test, there is no tyre rolling resistance this rate shall be reduced to [0,05]. During the test, cooling air may be used with a velocity and a direction of flow to simulate vehicle conditions. The speed of air flow should be no greater than [10] km/h and cooling air shall be at ambient temperature.

14.3.4.2.2 Inertia dynamometer test

The whole test consists of [20] brake applications on a time cycle (time elapsing between the initiation of one brake application and the initiation of the next) of [60] s. The required actuation pressure at the test brake shall generate the equivalent braking rate, on the first brake application, of [0,3] and the following brake applications are to be made with the same actuator pressure. The initial speed at the beginning of each brake application shall be equivalent to [60] km/h and the brake shall remain applied down to a speed of [30] km/h.

During the test, cooling air may be used with a velocity and a direction of flow to simulate vehicle conditions. The speed of air flow shall not be faster than [20] km/h with cooling air at ambient temperature.

14.3.4.3 Braking efficiency test with hot brake

This test shall be carried out under the same conditions as for the cold effectiveness test in 14.3.4.1, and shall particularly be at the same pressure p_A in the brake actuator as recorded for the cold effectiveness test.

Wheel speed build-up for this test shall commence within [60] s after the end of the heating phase and braking shall start as soon as a speed equivalent to [60] km/h is reached.

This test shall give a braking rate which fulfils the two following conditions:

a) it reaches at least [60] % of the braking rate of the cold effectiveness test of 14.3.4.1, and;

b) the braking rate z_{paW} obtained from this test shall be equal to or greater than [0,4].

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14.3.5 Free running test — Automatic brake adjustment device

If an automatic brake adjustment device is fitted, e.g. an automatic slack adjuster, check that one of the following conditions is fulfilled:

a) it is possible to rotate the wheel by hand when the brake is cold at a temperature of $\leqslant$ [100] °C;

b) at a constant speed equivalent to v = [60] km/h with the brake released the asymptotic temperature does not exceed a drum/disc increase of [80] °C.

14.3.6 Presentation of results

The following details shall be recorded:

a) measured braking force produced by the brake in both the cold effectiveness and hot brake tests;

b) calculated braking rate produced by the brake in both the cold effectiveness and hot brake tests;

c) test machine type (see 14.3.2 and 14.3.3);

d) pressure p_A in the brake actuator in the cold effectiveness and hot brake tests;

e) time elapsed between the end of the heating phase and the start of braking with the hot brake.

Further results shall be recorded as required for the Annex B test report.

15 Transfer of results of type I or type III tests to other vehicles

15.1 General

At the choice of the manufacturer, type I or type III tests need not be performed on a vehicle submitted for approval in any of the following cases:

a) a vehicle which, as regards tyres, braking energy absorbed per axle, specification of wheel and brake assembly, is, with respect to braking, identical[1)] to, or less demanding than, a vehicle which has passed the type I or type III tests, and has been approved, for a mass per axle not lower than that of each axle of the trailer being submitted for approval.

b) a vehicle whose axle(s), as regards tyres, braking energy absorbed per axle, and specification of wheel and brake assembly are, with respect to braking, identical[1)] to, or less demanding than, an axle or axles which have individually passed the type I or type III tests at a mass per axle which is not lower than that of each axle of the trailer being submitted for approval, provided that the braking energy absorbed per axle does not exceed the energy absorbed per axle in the reference test or tests carried out on the individual axle(s);

c) a vehicle equipped with brakes of the same type as on the reference axle(s) which satisfy the verification requirements of 15.2.3 in terms of the characteristics for comparison with a reference axle. The static mass for which the reference axle(s) passed the type I or type III reference test must not be lower than the static mass of each axle of the trailer being submitted for approval. Also, the braking energy absorbed per axle of the trailer must not exceed the energy absorbed per axle in that test or those tests carried out on the reference axle(s).

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1) The term “identical” means the geometric dimensions and the mechanical characteristics including the materials used for manufacture of the components of the vehicle to which reference is being made.

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15.2 Presentation of results

When the conditions in 15.1 are applied, the details listed in 15.2.1 to 15.2.3 shall be provided.

15.2.1 Trailer as in 15.1a)

The approval number of the reference vehicle shall be provided.

15.2.2 Axle(s) as in 15.1b)

The number(s) of reference axle test report(s) and Table 7 shall be completed.

15.2.3 Trailer as in 15.1c)

The calculations in 15.2.3.1 to 15.2.3.5 shall be made, using the values for the reference axle(s) as listed in the completed Annex B. The results of these calculations shall be entered into Table 8.

NOTE For each axle i, the corresponding reference axle is denoted by the suffix ei (as in Table 1).

15.2.3.1 The stroke s_A, of the actuator at a hot performance test is calculated for each axle of the trailer separately and for the type I test or the type III test, using the following formula:

$$s_{Ai} = \frac{(l_i)(s_{Aei})}{l_{ei}}$$

The values of l shall be taken from the braking calculation and the s_{Ae} and l_e values from the corresponding reference axle test report.

The calculated stroke values s_A shall not exceed the relevant s_{Ap} values at which the force falls off by 10 %.

For wheel brake designs having no interpretable lever length, the s_{Ae} values shall be compared to the relevant s_{Ap} values without any further calculation.

15.2.3.2 The average output thrust, F_A at pressure p_A in the actuator resulting from a control line pressure of p_m = 0,65 MPa (= 6,5 bar), is determined for each axle of the trailer separately. This is based on the values of pressure p_A in the actuators of each axle at p_m = 0,65 MPa (= 6,5 bar) taken from the braking calculation. The average output thrust of each actuator for these pressures p_A shall be provided by the actuator manufacturer.

15.2.3.3 The camshaft input torques C, are calculated for each axle brake of the trailer separately at pressure p_A as used in 15.2.3.2, using the following formula:

$$C_i = (F_{Ai}) \times (l_i)$$

where

F_A is as determined in 15.2.3.2.

The calculated C values shall not exceed the relevant C_{adm} values set by the brake manufacturer.

The calculations are made for a value of p_m = 0,65 MPa (= 6,5 bar).

NOTE It is good practice to use a higher value of p_m than 0,65 MPa (= 6,5 bar) and values up to the cut-out pressure may be used.

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The comparison of the calculated C values shall not be made against the C_{max} value, but to a somewhat lower value C_{adm} which takes into account the difference between the maximum p_m and p_m = 0,65 MPa (= 6,5 bar).

Both values of C_{max} and C_{adm} are given by the brake manufacturer.

For wheel brake designs having no interpretable lever length, the F_A values shall not exclude the appropriate F_{Aadm} values. F_{Aadm} can be determined using F_{Amax}.

15.2.3.4 The hot performance axle braking forces F_{Bai} are calculated separately for each axle of the trailer (for the type I or type III test) using the following formula:

$$F_{Bai} = (F_{Baei} - 0{,}01 \times F_{ei}) \times \frac{C'_i - C_O}{C_{ei} - C_{oei}} \times \frac{R_{ei}}{R_i} + 0{,}01 \times F_i$$

The C_e and C_{oe}, and the R_e values are taken from the corresponding reference axle test report, whereas F_i, R_i, and C'_i refer to the axle for which the calculation is being made.

When the pressures p_{Ae} which are used to determine the C_e values of the reference axles are not identical to the p_A values used in 15.2.3.2, then the C values as calculated in 15.2.3.3 shall each be converted to the corresponding p_{Ae} value. The designation of each value so converted is C'.

The C_o values are given by the brake manufacturer. The R values shall not be less than 0,8 R_e, and may even be greater than R_e, provided that the requirements of 15.2.3.5 are fulfilled.

In the case of wheel brake designs having no interpretable lever length the appropriate brake actuator output thrust (F_A) values shall be used instead of the camshaft input torques (C).

15.2.3.5 The hot braking performance rate z_{BaR} is calculated for the trailer, for the type I or type III test, using the following formula:

$$z_{BaR} = \frac{\sum F_{Ba}}{F_R} = \frac{F_{BaR}}{F_R}$$

i.e. summing up the individual F_{Ba} values as determined in 15.2.3.4.

For the type I test, the calculated z_{BaRI} braking rate shall not be less than 0,36 nor less than 60 % of z_{aR} where z_{aR} is taken from the trailer braking calculation.

For the type III test, the calculated z_{BaRIII} braking rate shall not be less than 0,4 nor less than 60 % of z_{aR}, where z_{aR} is taken from the trailer braking calculation.

16 Control failure of load-sensing device/function — Stationary test

As an alternative to the road test (see 20.3), a stationary test (and a comparison with the performance obtained without a control failure) may be specified by the manufacturer (see 6.12) if the trailer is either a semi-trailer, a centre-axle trailer or a full trailer where a single load-sensing device/function controls the braking on all axles.

With the load-sensing device/function control in the failed condition, record the maximum pressure p_A, which can be attained in the brake actuators at a full brake application.

On the basis that p_m is equal to p_A in the laden condition (without a load-sensing device/function control failure), use a graph of z_{aR} against p_m as referred to in 18.1.1, but for the laden condition, to determine if the recorded maximum pressure p_A will give a laden vehicle braking rate, z_{aR}, at least equal to:

— 0,135 for semi-trailers, or

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— 0,150 for centre-axle trailers, or

— 0,150 for full trailers,

which is [30] % of the type O test requirement for the fully laden trailer.

NOTE In the case of a mechanically operated load-sensing device, the control failure is the failure of the linkage between the operating arm of the load-sensing device and the vehicle axle. In the case of an air operated load-sensing device/function, the control failure is the total loss of the control signal(s) from the air suspension system (for the test it is recommended to retain air in the air suspension system to prevent the possibility of the air suspension bags/bellows being damaged).

If the relationship of p_{m} to p_{A} in the laden condition (without a load-sensing device/function control failure) is not 1:1, then the relationship of p_{m} to z_{aR} should be similarly modified to determine if the recorded maximum pressure p_{A} value will achieve the z_{aR} requirement.

17 Auxiliary equipment failure

Pressurize the trailer supply line to [0,75] MPa (= 7,5 bar) and then shut off the supply line without venting it (to avoid automatic application of the braking system).

Simulate a mechanical and/or an electrical failure in the auxiliary equipment that will result in a loss of air pressure and after allowing the pressures in the reservoirs to stabilize make a [0,65] MPa (= 6,5 bar) service brake application via the control line.

In the case where the failure has not resulted in a failure of the load-sensing device(s)/function control, the pressure in the service braking system shall give a braking rate of not less than [80] % of the type O test requirement for that particular trailer type ([0,5] for full trailers and centre-axle trailers, [0,45] for semi-trailers).

NOTE 1 If a value of 0,52 MPa (= 0,52 bar) is obtained in the service brake reservoir(s), the braking rate requirement is deemed to be met. If the pressure is less, it is possible that the required braking rate can be achieved as a result of the system components being used. In this case it may be shown by calculation, or a road test conducted to confirm, that the requirement is met.

In the case where the failure results in a failure of the load-sensing device(s)/function control (e.g. loss of the air suspension system), the pressure in the service braking system shall give a braking rate of not less than [30] % of the type O test requirement for that particular trailer type ([0,5] for full trailers and centre-axle trailers, 0,45 for semi-trailers).

NOTE 2 If a value of 0,2 MPa (= 2 bar) is obtained in the service brake reservoir(s), the braking rate requirement is deemed to be met. If the pressure is less, it is possible that the required braking rate can be achieved as a result of the system components being used. In this case it may be shown by calculation, or a road test conducted to confirm, that the requirement is met.

18 Basic performance tests — Unladen

18.1 Type O test (Service braking system cold brake effectiveness)

18.1.1 Test procedure

The service braking system performance of the trailer z_{aR} may be calculated either from the achieved braking rate z_{aC} of the motor vehicle and trailer combination with only the trailer being braked (see 18.1.1.1) or from the achieved braking rate z_{aC} of the motor vehicle and trailer combination with all the wheels being braked (towing vehicle plus trailer) and the force F_{L} measured on the coupling (see 18.1.1.2).

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

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

In case of a pneumatic control line, the values of z_{aR} shall be plotted in relation to control line pressure p_m. With p_s not greater than [0,7] MPa (= 7 bar) and p_m not exceeding [0,65] MPa (= 6,5 bar), at least one value of z_{aR} shall be greater than or equal to the prescribed braking rate.

In case of an electrical control line, the values of z_{aR} shall be plotted in relation to the digital data messages not exceeding [33280d (0,65 MPa (= 6,5 bar))] as defined in ISO 11992-2.

z_{aR} = [0,5] for full trailers and centre-axle trailers;

or

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

18.1.1.1 When only the trailer is braked

This test consists of a maximum of five service braking system applications from v_s = [60] km/h. The speed at which the brakes are released shall be calculated from the following formula:

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

Determine the maximum braking rate z_{aC} of the motor vehicle and trailer combination, with the towing vehicle unbraked, without locking of the trailer wheels. For this purpose, various pressures p_m are supplied to the trailer control line using the equipment referred to in 8.6.

The braking rate which would be achieved for the trailer alone is calculated as follows:

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

18.1.1.2 When both motor vehicle and trailer are braked

The following procedure may be applied when both vehicles, the motor vehicle and trailer as a combination are braked.

Measure the braking rate of the combination and the force F_L on the mechanical coupling with various pressures p_m.

The achieved braking rate of the trailer is calculated as follows:

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

where

F_L is negative if the coupling is in compression.

18.1.2 Presentation of results

18.1.2.1 During each braking test, the data below shall be recorded:

a) actual speed of the motor vehicle and trailer combination at the initiation of braking;

b) supply line pressure p_s;

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c) control line pressure p_m;

d) brake actuator pressures p_A;

e) braking rate z_{aC};

f) longitudinal force on mechanical coupling F_L (in the case of tests according to 18.1.1.2);

g) any wheel locking, deviation of the vehicle from its intended course or abnormal vibration.

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

a) ambient conditions;

b) vehicle identification;

c) vehicle loading condition (including individual axle loads);

d) tyre size(s).

18.1.2.3 The results obtained in 18.1.2.1 and 18.1.2.2 may conveniently be presented in a table, but the calculated values of z_{aR} should be presented in a graph against p_m.

19 Antilock braking system/electronically controlled braking system (ABS/EBS) tests — Unladen

19.1 Determination of adhesion utilization on high adhesion surface

19.1.1 This measurement is made with all axles of the trailer being braked but with the service braking system of the towing vehicle disabled. From an initial vehicle speed of [50] km/h measure the braking rate z, which the trailer with the antilock braking system operating, can achieve on the high adhesion surface on which the coefficient of adhesion will be measured as the next phase of this procedure.

Perform this test with sufficient pedal force/control line pressure to ensure that full cycling of the antilock braking system function is invoked. Full cycling is where the antilock braking system is repeatedly modulating the brake force and will be assured when the control line pressure is at least 1 bar above the surface skid pressure.

The resulting braking rate is calculated from the time t, in seconds, taken for the speed to reduce from [40] km/h to [20] km/h, using the following formula:

$$z \frac{0{,}566}{t}$$

19.1.2 Repeat this test twice more on the same part of the surface, and calculate the average t_m of the three t values obtained to find the z_{CAL} figure to be used in the adhesion utilization calculation, using the following formula:

motor vehicle and trailer combination braking rate (only trailer braked) with antilock braking system operative

$$z_{CAL} \frac{0{,}566}{t_m}$$

19.1.3 This value z_{CAL} will be used to derive z_{RAL} for the trailer only, which in turn provides the adhesion utilization ε, once the adhesion coefficient for the surface k_R has been measured.

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However, z_{RAL} is influenced by forces from the towing vehicle pulling on the trailer and the derivation shall be considered separately for each type of trailer, after completion of the actual adhesion coefficient measurement and calculation.

Adhesion utilization will finally be given by:

$$\varepsilon = \frac{z_{RAL}}{k_R}$$

19.2 Determination of the peak coefficient of adhesion on the high adhesion surface

This test shall be carried out immediately following the adhesion utilization measurement (see 19.1) and it is important that if the surface was damp for that test, the same level of moisture is employed for this measurement. However, a dry road surface shall be used whenever possible.

The method employed depends upon the type of trailer being tested and because of the different forces involved, different calculations need to be made for full trailers and semi-trailers/centre-axle trailers as follows.

19.2.1 Full trailers

19.2.1.1 Front axle

19.2.1.1.2 For front axle evaluation, disable the trailer rear axle braking system and disable or otherwise ensure that the antilock braking system will not operate between [40] km/h and [20] km/h during the test.

With the towing vehicle contributing no braking effort as in 19.1, determine the peak coefficient of adhesion for the front axle as in the procedure below.

The result obtained is then used in the calculation of the mean surface adhesion value which is required for the trailer adhesion utilization assessment.

19.2.1.1.3 Carry out a number of brake applications from an initial motor vehicle and trailer combination speed of [50] km/h, on the test surface.

During each application the control line pressure shall be held constant but increased for each subsequent run until the maximum combination deceleration result is achieved (probably where slight skidding occurs towards the end of the stop). To ensure that the highest deceleration result is included, the series of increments shall be extended to the point where the wheels are about to lock during the stop.

The braking rate z_C is calculated by reference to the time t in seconds, taken for the speed to reduce from 40 km/h to 20 km/h, i.e.:

$$z_C = \frac{0{,}566}{t}$$

During this procedure, care should be taken (and cooling periods allowed) to prevent a rise in brake temperature greater than 100 °C, as this may affect braking performance and distort the results.

From the minimum recorded value of t, (t_{min}) select [3] values of t which lie within t_{min} and 1,05 t_{min} and calculate the arithmetical mean value t_m, and then the optimum braking rate is give as:

$$z_{C\max} = \frac{0{,}566}{t_m}$$

If it is demonstrated that practical reasons prevent the three values defined above being obtained, the minimum time t_{min} may be used in place of t_m.

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NOTE This procedure is most accurately performed using an adjustable control line pressure regulator. In order to obtain a valid result, both wheels on the axle being measured shall reach the lock point simultaneously. To achieve this, the use of a line pressure regulator for each wheel may be necessary to allow individual pressure adjustments to be made.

19.2.1.1.4 Calculate the value of k_f for a full trailer with the front axle only being braked, from z_{Cmaxf} using the following formulae:

$$F_{bRmaxf} = z_{Cmaxf}(F_M + F_R) - 0{,}01\,F_{Cnd} - 0{,}015F_{Cd}$$

This takes account of the extra mass of the towing vehicle and allows for the rolling resistance contribution coming from all un-braked axles on the towing vehicle and trailer.

To allow for the weight transfer of the trailer mass under deceleration and the pull of the towing vehicle (both increasing the trailer front axle load), the dynamic axle load is calculated as follows:

$$F_{fdyn} = F_f \, \frac{z_{Cmaxf}\,(F_M \times h_D + g \times P_R \times h_R) - F_{WM} \times h_D}{E}$$

and:

$$k_f = \frac{F_{bRmaxf}}{F_{fdyn}}$$

(k_f values shall be rounded to a third decimal place).

For trailers with more than two axles, remove the wheels on the middle axle(s) and measure as a two-axle trailer.

19.2.1.2 Rear axle

Repeat the procedure of 19.2.1.1 using trailer rear axle braking only with the antilock braking system function inoperative. A second mean deceleration figure z_{Cmaxr} for the rear axle is obtained and used in the following formulae to give k_r:

$$F_{bRmaxr} = z_{Cmaxr}(F_M + F_R) - 0{,}01F_{Cnd} - 0{,}015\,F_{Cd}$$

Then calculate the dynamic rear axle load allowing for weight transfer and towing vehicle pull to reduce the rear axle loading:

$$F_{rdyn} = F_r - \frac{z_{Cmaxr}\,(F_M \times h_D + g \times P_R \times h_R) - F_{WM} \times h_D}{E}$$

and:

$$k_{r} = \frac{F_{bRmaxr}}{F_{Rdyn}}$$

k_r values shall be rounded to a third decimal place.

For trailers with more than two axles, remove the wheels on the middle axle(s) and measure as a two-axle trailer.

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19.2.1.3 Total trailer

19.2.1.3.1 The two coefficients obtained are then combined into a single value k_R for the trailer as a whole, by taking into account the dynamic axle loadings under antilock braking system deceleration levels.

$$k_R = \frac{k_f \times F_{fdyn} + k_r \times F_{rdyn}}{g \times P_R}$$

where

F_{fdyn} and F_{rdyn} determined as above except that the deceleration used is z_{RAL} in place of z_{Cmaxf} and z_{Cmaxr}

z_{RAL} is calculated from the test in 19.1.2 which gave z_{CAL}:

$$z_{RAL} = \frac{z_{CAL}\,(F_M + F_R) - F_{WM}}{F_R}$$

which takes into account the mass and the rolling resistance of the towing vehicle.

19.2.1.3.2 The value for the surface coefficient of adhesion k_R having been calculated is used to determine the adhesion utilization ε from:

$$\varepsilon = \frac{z_{RAL}}{k_R}$$

rounded to two decimal places.

This shall have a value $\geqslant$ [0,75] but not $>$ [1,00].

If ε is $>$ [1,00], the measurements of k shall be repeated. A tolerance of [10] %, however, is accepted.

19.2.2 Semi-trailers (and centre-axle trailers)

19.2.2.1 For semi-trailers and centre-axle trailers, the k measurement is made with the antilock braking system disabled (or inoperative between 40 km/h and 20 km/h) and with no braking being applied on the towing vehicle.

In the case of multi-axle trailers, the tests are carried out with wheels fitted only to one axle, which will be used to determine k. This axle shall normally have wheels directly controlled by the antilock braking system.

A figure for z_{Cmax} shall be found by repeated stops with increasing brake pressure until the highest deceleration without wheel locking is achieved using the process described in 19.2.1.1.3.

The trailer braking force is:

$$F_{bRmax} = z_{Cmax}\,(F_M + F_R) - F_{WM}$$

while the dynamic trailer axle load is:

$$F_{Rdyn} = F_R - \frac{F_{bRmax} \times h_K + z_{Cmax} \times g \times P_R\,(h_R - h_K)}{E_R}$$

This takes into account the pull of the towing vehicle and the transfer of weight off the trailer axle being braked.

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As there is only a single k value generated, due to there only being one axle, k_R is given by:

$$k_R = \frac{F_{bRmax}}{F_{Rdyn}}$$

19.2.2.2 The derivation of a figure for z_{RAL} uses the measured value of z_{CAL} as determined in 19.1 with all wheels on the trailer and the antilock braking system fully operating. The formulae used are as follows:

$$F_{bRAL} = z_{CAL} \left(F_M + F_R \right) - F_{WM}$$

which takes into account the mass of the towing vehicle and its rolling resistance.

The dynamic trailer axle loads are derived as follows:

$$F_{Rdyn} = F_R - \frac{F_{bRAL} \times h_K + z_{CAL} \times g \times P_R \left(h_R - h_K \right)}{E_R}$$

then:

$$z_{RAL} = \frac{F_{bRAL}}{F_{Rdyn}}$$

and, adhesion utilized:

$$\varepsilon = \frac{z_{RAL}}{k_R}$$

This shall be $\geqslant$ [0,75].

If ε is $>$ [1,00] with either type of trailer, the measurements of k shall be repeated. A tolerance of [10] %, however, is accepted.

NOTE This figure for ε, determined on a surface with a high coefficient of adhesion, may be used as ε_H in 19.4.1 but, since split-adhesion tests lead to the high adhesion surface being wet, it is preferable to measure ε_H specially.

19.3 Wheel behaviour

19.3.1 In the tests in 19.3.2 momentary locking (less than 0,5 s) of directly controlled wheels (e.g. when braking is suddenly and fully applied) is permitted and it is also permitted for directly controlled wheels to lock when the trailer speed is less than [15] km/h. Indirectly controlled wheels may lock at any speed but stability shall not be noticeably affected.

19.3.2 With all trailer brakes operating and with the antilock braking function enabled, carry out stops to confirm that the directly controlled wheels do not lock (other than momentarily) when brakes are suddenly and fully applied.

These tests are performed on the high adhesion surface, from initial speeds of [40] km/h and [80] km/h.

19.4 Split adhesion tests

19.4.1 For trailers having antilock braking systems of category A, check that the directly controlled wheels do not lock, other than momentarily, when the right and left wheels are on surfaces having different coefficients of adhesion k_H and k_L, and the brakes are suddenly and fully applied at a motor vehicle and trailer combination speed of [50] km/h.

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The motor vehicle and trailer combination shall be positioned centrally over the division between the two surfaces.

While not specifically required by UN-ECE Regulation No. 13, Annex 13, it is advised that the trailer tyres should not cross the division between the two surfaces during the tests to demonstrate vehicle stability.

19.4.2 The maximum braking rates z_{RALH} and z_{RALL} shall be obtained on the two surfaces used for the split-adhesion testing, by employing the procedure of 19.1 and the associated calculations of 19.2.1.3 for full trailers or 19.2.2.2 for semi-trailers and centre-axle trailers.

NOTE z_{RALH} may be less than z_{RALL} measured previously on the high adhesion surface since, in split-adhesion tests, both surfaces are likely to be wet.

The adhesion levels k_H and k_L shall be such that the maximum braking rates z_{RALH} and z_{RALL}, have the following relationship:

$$z_{RALH} = \geqslant 0{,}5\ \varepsilon_H$$

and

$$z_{RALH} = \geqslant 2\ z_{RALL}$$

19.4.3 On this split-adhesion surface, the motor vehicle and trailer combination shall be brought to a halt from 50 km/h with only the trailer braking applied and with the antilock function operating.

The motor vehicle and trailer combination deceleration shall be measured between 40 km/h and 20 km/h as in 19.1.1 and 19.1.2 to generate a z_{CALS} figure.

For full trailers, z_{RALS} is given from the formula in 19.2.1.3.

For semi-trailers and centre-axle trailers, F_{bRALS} and F_{dyn} are calculated using z_{CALS} as in 19.2.2.2 to give:

$$z_{RALS} = \frac{F_{bRALS}}{F_{dyn}}$$

where z_{RALS} shall be:

$$z_{RALS} \geqslant \frac{0{,}75}{\varepsilon_H} \times \frac{4\ z_{RALL} + z_{RALH}}{5}$$

and:

$$z_{RALS} > \frac{z_{RALL}}{\varepsilon_H}$$

If $\varepsilon_H > [0{,}95]$, use the value [0,95].

19.5 Energy consumption of the antilock braking system (on a high adhesion surface)

19.5.1 This test checks the capacity of the energy storage reservoirs in relation to the consumption of energy whilst the antilock braking system is operating. The test comprises a braking run with the trailer only braking, in which the antilock braking system has to operate to control the braking pressures for a period of [15] s.

For this test, it is recommended that the trailer axle(s) are loaded so that the axle load is 2 500 kg or 25 % of the permissible axle load, whichever is the lower.

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19.5.2 The manufacturer may closely adjust the brakes prior to this energy consumption test.

19.5.3 The load-sensing valve(s), if fitted, shall be held in the fully laden position.

19.5.4 With the ABS function operating and with full pressure held in the trailer reservoir(s), check that the wheels normally controlled by the antilock braking system are fully cycling during full braking. (If this is not the case a lower adhesion surface, such as would be achieved by wetting, should be used).

19.5.5 The initial energy level in the trailer reservoir(s) shall be at the maximum value achievable with a pressure of [0,80] MPa (= 8 bar) at the supply line coupling head.

19.5.6 Practical considerations mean that the braking time cannot be achieved in a single [15] s stop unless the trailer being braked is towed under full power of the towing vehicle. Even then, it may not be possible to prevent the motor vehicle and trailer combination losing speed during the test.

If this is the case, the initial motor vehicle and trailer combination speed may be increased substantially but the final speed at the end of [15] s shall be above [15] km/h.

The use of two towing vehicles is not ruled out to achieve a single braking period, but it is also permitted to use the more complicated alternative of performing the test in several phases up to a maximum of 4.

This procedure requires accurate measurement, display and recording of pressure levels in the trailer reservoir(s) and care shall be taken in the setting of pressures as explained in 19.5.7.

19.5.7 If a multi-phase test is selected, it is necessary to determine the number of phases and the initial motor vehicle and trailer combination speed on each phase, (which shall exceed [30] km/h), so as to meet the required overall total braking time, taking into account the following factors:

— towing vehicle power level and thus the expected deceleration under antilock braking system control;

— cut-off speed below which the antilock braking system operation may cease and at which each brake application shall be released;

— length of the test surface available.

As an example, consider a motor vehicle and trailer combination with the following values:

— initial speed: 70 km/h;

— cut-off speed: 15 km/h;

— adhesion coefficient: 0,85;

— expected braking rate z_{CAL}: 0,2;

— a deceleration of 2 m/s^2 is assumed to be constant, meaning a speed decrease rate of approximately 7 km/h/s;

— braking time (70-15)/7 = 7,86 s.

— Check: try 2 stops: 7,86 s each.

Now estimate the stopping distance:

— mean speed during the stop: 15 + (70-15)/2 = 42,5 km/h (11,7 m/s);

— stop time: 7,86 s;

— distance: 11,7 m/s × 7,86 s = 92 m.

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Two phases are a practical test over some 120 m of test surface. (A total test time of > 15 s should be planned to allow for some time lost in phase 2 of the test to correct the starting pressure.)

For each stop in this example, the motor vehicle and trailer combination shall be powered to achieve a deceleration of 2 m/s² with the antilock braking system fully cycling down to the brake release speed of 15 km/h. The brake pedal shall be released at this point and the motor vehicle and trailer combination turned round for the second phase without the use of the brakes so as not to affect the stored energy level.

The energy storage reservoir(s) shall not be charged during each “braking phase” but in-between phases shall be charged so that after the single full brake application which shall be made at the commencement of the second phase, the reservoir pressure shall, ideally, be equal to the value at the end of the first phase.

This equality condition is not easily achieved, so a higher pressure is allowed provided that the second phase timing commences only at that point where the reservoir(s) pressure falls to become equal to that recorded at the end of the first phase. This is the reason for the lost time mentioned above and requires that initial speed to be increased to make a suitable allowance.

19.5.8 If a single phase test is possible, at the end of the braking time bring the motor vehicle and trailer combination to rest without further operation of the antilock braking system and without further recharging the trailer reservoir(s).

19.5.9 After the energy consumption run(s), it is required to make [4] full service brake applications, again without any further charging of the trailer reservoir(s) and then on the [5th] such application the pressure in the trailer actuators shall be sufficient to provide a total braking force of not less than [22,5] % of the maximum stationary wheel load. During this test there shall be no automatic application of any braking system (service braking or spring brake braking) which is not under antilock braking system control.

The braking capability may be verified from the braking calculation which determines the pressure required to meet the [22,5] % braking rate demand at the end of the test. This is the minimum pressure level which shall remain available to the trailer service braking system.

19.6 Antilock braking system failure

With the antilock braking system function disabled, as would be the case in the failed condition, a check shall be made that on a high adhesion surface it is possible to achieve at least [80] % of the prescribed laden braking performance via the service braking system. This can be shown from the braking calculation and pressure measurements.

19.7 Additional tests on trailers equipped with EBS

19.7.1 System operation

19.7.1.1 Check that in the event of a failure in one of the control lines, the trailer shall automatically use the control line not affected by the failure and achieve the type O braking performance requirement.

19.7.1.2 Each specific failure mode within the electric control transmission shall be considered and the braking performance shall be checked for the worst case failure (see 8.1.4) to ensure that at least [30] % of the prescribed type O braking performance is achieved.

19.7.1.3 Check that when both control lines provide their respective signals simultaneously, the trailer uses the electrical control line signal.

NOTE This may be done by first applying a low pressure pneumatic signal followed by a digital signal equivalent to a higher pressure. The pneumatic pressure is then increased to a value significantly higher than the digital signal. The pressure in the service brake actuator must increase with the application of the digital signal, but remain constant with the subsequent increase in pneumatic pressure.

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19.7.1.4 Check that a signal is generated to activate an optical warning in a towing vehicle via pin 5 of the ISO 7638-1 and ISO 7638-2 electrical connector when the electrical control line signal has exceeded the equivalent of [0,1] MPa (= 1 bar) for more than [1] s and there is no pneumatic signal present.

19.7.2 Braking force compensation

The fulfilment of the requirements for braking force compensation is shown through conformity to UN-ECE Regulation No. 13, Annex 18 (see paragraph 8.1.4).

20 Basic performance tests — Laden

20.1 Parking braking system tests

20.1.1 Test conditions

The test vehicle shall be laden to the maximum technical mass. In the case of semi-trailers and centre-axle trailers, the vehicle loading shall include the load on the fifth-wheel coupling or the mechanical coupling (note the special conditions given in 20.1.2.2 if the hill holding procedure is chosen). The brake linings which are effective during parking shall be adequately bedded, according to manufacturer's recommendations. After bedding-in prior to the parking braking system test, brakes may be adjusted manually even if they have automatic adjustment. Verify that the parking braking system can be safely applied and released by a person standing on the ground using a device mounted on the trailer in both of the following two cases:

— when the trailer is standing alone;

— when it is connected to a towing vehicle.

20.1.2 Test procedure

20.1.2.1 General

It shall be confirmed that sufficient braking force can be generated by the parking braking system to hold a laden trailer stationary on an 18 % up or down gradient. This may be done in the form of a calculation. If the calculation method is to be used, an additional calculation shall be carried out to clearly show that the required tyre to road adhesion coefficient is not higher than 0,8.

In the calculation method, the minimum required braking force is given by:

— F_{BR} = [0,18] F_R in the case of full trailers;

— F_{BR} = [0,18] (F_R + F_K) in the case of semi-trailers and centre-axle trailers.

If the calculations clearly show that adequate F_{BR} is provided and the road adhesion coefficient is not higher than 0,8, a parking braking system test may not be necessary.

The sequence of actions to be used to apply the parking braking system comprises a full application of the service braking system (or automatic braking system in the case of a disconnected trailer), followed by an application of the parking braking system with a control force not exceeding [600] N, and finally a release of the service braking system or automatic braking system.

To check the parking braking system effectiveness, one of the following procedures may be chosen by the manufacturer:

— a hill holding test (see 20.1.2.2);

— a level road drag test (see 20.1.2.3);

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- a low speed rolling road dynamometer test (see 20.1.2.4);
- an inertia dynamometer test for spring brake actuators (see 20.1.2.5).

If spring brake actuators are used in the parking braking system, further tests as set out in Clause 13 will need to be carried out in addition to the above.

20.1.2.2 Hill holding test

The hill holding test shall be carried out on a dry, high adhesion road surface having a gradient of at least [18] %. For semi-trailers and centre-axle trailers, safety and practicability mean that the test shall be done with the complete motor vehicle and trailer combination (towing vehicle plus trailer). For this test, the actual mass of the motor vehicle and trailer combination shall exceed the maximum mass of the laden trailer by as little as possible. To meet this requirement, the load on the fifth wheel coupling or on the mechanical coupling may be suitably reduced. Furthermore, during such a test, the landing legs shall not touch the ground.

Tests shall be made in both directions, unless the worse condition is known, in which case only this one needs be tested.

Apply the parking braking system as described in 20.1.2.1.

The time period allowed for evaluating the capability of the parking braking system to hold the vehicle stationary shall not be less than 1 minute.

20.1.2.3 Level road drag test

The level road test shall be carried out on a flat, dry, high adhesion road surface following the procedure in 20.1.2.1 for applying the parking brake.

On the level road, the attempt to tow away the laden trailer shall be made whilst measurements of the towing force on the mechanical coupling are made and recorded.

The trailer shall resist movement at towing forces less than or equal to the total required parking braking force of:

- [0,18] F_R in the case of full trailers, and
- [0,18] ($F_R + F_K$) in the case of semi-trailers and centre-axle trailers.

Repeat this test procedure by attempting to move the test vehicle in the opposite direction, unless the design properties of the brakes are such that the braking efficiency is absolutely independent of the direction of rotation.

20.1.2.4 Low speed rolling road dynamometer test

Dynamometers are not suited to conducting standstill testing but it is possible to measure the dynamic braking forces developed, in the knowledge that static breakaway forces will be greater than these dynamic forces.

Thus, to perform this test, it shall be possible to apply the parking brake once the dynamometer is running and then measure the total braking force developed by each axle.

The speed of the rolling road dynamometer in this test shall not exceed 12 km/h and could even be lower.

Measure successively the braking forces on each axle braked by the parking braking system.

At each measurement, the control force shall not exceed [600] N. The sum of the braking forces, F_{BR} shall be at least [0,18] F_R in the case of full trailers and [0,18] ($F_R + F_K$) in the case of semi-trailers and centre-axle trailers.

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Repeat this procedure with the dynamometer rotating in the opposite direction, unless the design properties of the brakes are such that the braking efficiency is absolutely independent of the direction of rotation.

20.1.2.5 Inertia dynamometer test for spring brake actuators

The static breakaway test for spring brake actuator operated brakes is unsuited to measurement using an inertia dynamometer, since these are run up to speed and then loaded. However, this can be accomplished as a dynamic measurement by releasing the spring hold-off pressure and measuring and recording the braking force developed when the spring is fully released. This can be done from a low speed only sufficiently high as will allow the measurement of the generated force to be made before the brake (identical to those on the trailer) comes to a standstill.

The sum of the total braking forces F_{BR}, developed by all the trailer brakes which are used for parking shall be at least:

$$0{,}18\ F_R \times \frac{R_s}{r_{BD}}$$ for full trailers, or

$$0{,}18\ (F_R + F_K) \times \frac{R_S}{r_{BD}}$$ for semi-trailers and centre-axle trailers

where

R_s = the static radius of the largest tyre used.

Repeat the above test procedure measuring the static breakaway forces in the opposite direction, unless the design properties of the brakes are such that the braking efficiency is absolutely independent of the direction of rotation.

20.1.3 Presentation of results

For all tests the following information shall be reported:

a) general information for all tests:

   1) calculated necessary level of tyre/road adhesion coefficient;

   2) calculated total braking force generated at the wheel peripheries by the parking braking system;

b) for the hill holding test:

   1) gradient and vehicle direction;

   2) parking brake control force;

   3) actual mass of the motor vehicle and trailer combination;

   4) test vehicle stationary for $\geqslant$ 1 min: yes/no;

c) for the level road drag test:

   1) towing force and direction of towing;

   2) parking brake control force;

d) for the low speed rolling dynamometer test:

   1) speed of dynamometer;

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2) parking brake control force;

3) braking force (per axle and total) and direction of rotation;

e) for the spring brake actuator inertia dynamometer test:

1) spring force applied to the brake lever, and the brake lever length;

2) static breakaway force (per brake and total) and direction of static breakaway force;

3) maximum tyre static radius.

20.2 Type O test (Service braking system cold brake effectiveness)

The test shall be carried out as detailed in Clause 18.

20.3 Control failure of load-sensing device/function — Road test

If a road test is specified by the manufacturer (see 6.12), a type O test shall be carried out in accordance with either 18.1.1.1 or 18.1.1.2 (but in the laden condition) with the load-sensing device/function control in the failed condition.

With the vehicle laden, the braking rate z_{aR} shall be higher or equal to [0,135] for semi-trailers and shall be higher or equal to [0,150] for full trailers and centre-axle trailers.

If the vehicle is equipped with more than one load-sensing device/function, the test shall be repeated for the failure of the control of each device/function in turn.

NOTE In the case of a mechanically operated load-sensing device, the control failure is the failure of the linkage between the operating arm of the load-sensing device and the vehicle axle. In the case of an air operated load-sensing device/function, the control failure is the total loss of the control signal(s) from the air suspension system (for the test it is recommended to retain air in the air suspension system to prevent the possibility of the air suspension bags/bellows being damaged).

20.4 Type I test (fade test for trailers of categories O_2 and O_3)

20.4.1 General

This test applies to:

— an O_2 or O_3 trailer and/or;

— an axle or axles intended to serve as trailer reference axle(s).

The complete type I test may alternatively be carried out on a dynamometer (see 14.1).

Under certain conditions, the road test specified below may not be required (see Clause 15).

20.4.2 Cold effectiveness test

A cold effectiveness test for the purposes of the type I test shall be carried out prior to the heating phase in order to provide a performance comparison between hot and cold brakes.

20.4.2.1 If the type I test is to be conducted with all axles of the trailer being braked, a cold effectiveness test similar to that described in Clause 18, but with v_s = [40] km/h and under laden conditions shall be carried out, constituting the basic test.

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20.4.2.2 However, if the type I test is to be limited to one or more axles of the trailer (see 20.4.2.2), this basic test shall be conducted in accordance with 20.4.1.1, with the exception that the appropriate axle(s) of the trailer is (are) braked. For the evaluation of the results of this basic test, note the remarks in 20.4.3.2.

20.4.2.3 The highest value of the achieved trailer braking rate z_{aR} which results after calculation made using the measurements obtained in 20.4.1.1 or 20.4.1.2, is the braking rate of the cold effectiveness test. This serves as the cold reference value for the braking efficiency test with hot brakes, as set out in 20.4.3.4.

The measured brake actuator pressure p_A used to obtain this reference value should be recorded for use in 20.4.3.4.

20.4.3 Adjustment of the brakes — Automatic brake adjustment device

For vehicles fitted with automatic brake adjustment devices, e.g. automatic slack adjusters, the following procedure is carried out prior to the heating.

De-adjust the automatic brake adjustment device so that the actuator stroke $S_A \geqslant 1{,}1\ S_{re\text{-}adjust}$ and with an actuator pressure of [0,2] MPa (= 2 bar) apply and release the brakes [50] times in succession. Following the 50th application make a further brake application with an actuator pressure of $\geqslant$ [0,65] MPa (= 6,5 bar).

The upper limit of $S_A \geqslant 1{,}1\ S_{re\text{-}adjust}$ shall not exceed a value recommended by the manufacturer of the automatic brake adjustment device.

Where it is impractical to measure the actuator stroke, the automatic brake adjustment device shall be released so as to create sufficient clearance in the brake that allows the automatic brake adjustment device to function.

20.4.4 Test procedure

20.4.4.1

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

NOTE The alternative method allowed in UN-ECE Regulation No. 13, Annex 4, paragraph 1.5.2.1 (type I 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 practical difficulty of maintaining the correct test conditions.

20.4.4.2 This drag test shall be carried out with a towing vehicle as set out in 8.5 and, if necessary to increase the tractive effort, with an additional towing vehicle as in 8.9.

20.4.4.3 If it is required to apply the results of this test to other trailers as in Clause 15, it is preferable to carry out the test on a single axle only. However, this test may alternatively be carried out by braking several or all axles of the test vehicle if single axle results are not specifically required.

If required, the conditions of 18.1.1.1, but with v_s = [40] km/h may be adapted as follows to give the single axle braking rate z_{aA} with the trailer alone providing braking:

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

When both vehicles in the motor vehicle and trailer combination are braked and F_L (coupling thrust) is measured, the conditions of 18.1.1.2 may be adapted as follows to give the single axle braking rate z_{aA}:

$$z_{aA} = \frac{1}{F_{Rb}} \left(z_{aC} \left(F_R - F_L\right) - z_r \times F_{Ru}\right)$$

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20.4.4.4 Heating phase

The required energy input to the brakes of the test axle(s) shall be made at a constant speed of v = [40] km/h for a distance of [1 700] m with a mean tractive force F_L on the coupling, such that the resulting braking rate z_{aA} as given by the formula in 20.4.4.3 is [0,07].

If the tractive power of the towing vehicle is insufficient, the test may be conducted at a lower speed, but over a longer distance, as shown in Table 6. In order to adapt to optimum gearbox conditions, intermediate values, may be chosen by linear interpolation between the two nearest values.

Table 6 — Speed and distance

Speed, v km/h	**Distance** m
40	1 700
30	1 950
20	2 500
15	3 100

20.4.4.5 Braking efficiency test with hot brakes

This test shall be carried out from [40] km/h under the same conditions as for the cold effectiveness test in accordance with 20.4.2, except for the high brake temperature. It is imperative to use the same pressure p_A in the brake actuators as was recorded for the cold effectiveness test. Vehicle movement for this test shall commence within [60] s after the end of the heating phase (as 20.4.4) with maximum acceleration being used to gain speed and with braking commencing as soon as 40 km/h is reached.

The calculated value of the braking rate from the measurements made shall reach:

a) [60] % of the braking rate of the basic test calculated in 20.4.2.3, and;

b) the value of z_{aR} or the value of z_{aA} (depending upon whether all axles or only one is braked) $>$ [0,36].

20.4.4.6 Free running test — Automatic brake adjustment device

For vehicles fitted with automatic brake adjustment devices, e.g. automatic slack adjusters, check that following the hot test (20.4.4.5) one of the following conditions is fulfilled:

— all wheels are running freely at a temperature below 100°C, and may be rotated by hand; or

— when the trailer is driven at a constant speed of v = 60 km/h with the brakes released the asymptotic temperatures do not exceed a drum/disc temperature increase of 80 °C.

20.4.4.7 Presentation of results

The following results shall be recorded:

a) achieved braking rate of motor vehicle and trailer combination, z_{aC} in the cold effectiveness test and in the test with hot brakes;

b) calculated braking rate of test axle z_{aA}, or trailer z_{aR}, in the cold effectiveness test and in the test with hot brakes;

c) speed and test distance (see 20.4.4.4);

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d) pressure p_A in the brake actuators in the cold effectiveness test and in the test with hot brakes;

e) control line pressure p_m and the corresponding digital values in the case of an electric control line in the cold effectiveness test and in the test with hot brakes;

f) longitudinal force on mechanical coupling F_L (if appropriate);

g) time elapsed between the end of the heating phase and commencement of braking with hot brakes.

If the axle(s) tested is (are) intended to serve as reference axle(s), complete the test report given in Annex B.

20.5 Type III test (fade test for vehicles of category O_4)

20.5.1 General

This test applies to:

— an O_4 trailer, and/or;

— an axle or axles intended to serve as reference axle(s).

The complete type III test may alternatively be carried out on a dynamometer (see 14.2).

Under certain conditions, the road test specified below may not be required (see Clause 15).

20.5.2 Cold effectiveness test

The cold effectiveness test according to Clause 18 (but in the laden condition) shall be carried out prior to the heating phase.

20.5.3 Adjustment of the brakes — Automatic brake adjustment device

For vehicles fitted with automatic brake adjustment devices, e.g. automatic slack adjusters, the following procedure is carried out prior to the heating.

De-adjust the automatic brake adjustment device so that the actuator stroke $S_A \geqslant 1{,}1\ S_{re\text{-}adjust}$ and with an actuator pressure of [0,2] MPa (= 2 bar) apply and release the brakes [50] times in succession. Following the 50th application, make a further brake application with an actuator pressure of ⩾ [0,65] MPa (= 6,5 bar).

The upper limit of $S_A \geqslant 1{,}1\ S_{re\text{-}adjust}$ shall not exceed a value recommended by the manufacturer of the automatic brake adjustment device.

Where it is impractical to measure the actuator stroke, the automatic brake adjustment device shall be released so as to create sufficient clearance in the brake that allows the automatic brake adjustment device to function.

20.5.4 Test procedure

20.5.4.1 General

20.5.4.1.1 The heating of the brakes is carried out by a drag test on a level road (see 20.4.3).

20.5.4.1.2 This test shall be carried out with a towing vehicle in accordance with paragraph 8.5 and, if necessary to increase the tractive effort, with an additional towing vehicle as in paragraph 8.9.

20.5.4.1.3 This test is carried out by braking all of the axles of the motor vehicle and trailer combination or only the trailer axles.

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To derive a single axle braking rate, the conditions of 18.1.1.1 should be adapted as follows:

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

with the trailer only being braked, or with the whole combination being braked and F_L (coupling thrust) measured, the conditions of 18.1.1.2 are adapted as follows:

$$z_{aA} = \frac{z_{aC} \times \left(F_r - F_L\right)}{F_{Rb}} - z_r \times \frac{F_{Ru}}{F_{Rb}}$$

20.5.4.2 Heating phase

The whole test consists of [20] brake applications and the time for one brake cycle (time between the initiation of one brake application and the initiation of the next) is [60] s. The required pressure input to the brakes of the test axle(s) shall generate a deceleration of [3] m/s^2 on the first brake application and this input level shall be maintained on subsequent applications.

The speed v_s at the beginning of each brake application is [60] km/h with the braking being continued until a speed v_f is reached, where v_f is calculated from:

$$v_f = v_s \sqrt{\frac{F_M + F_{Ru} + \frac{F_{Rb}}{4}}{F_M + F_{Ru} + F_{Rb}}}$$

20.5.4.3 Braking efficiency test with hot brakes

This test shall be carried out under the same conditions as for the basic test as in 20.5.1, with p_m at the same pressure as in that cold effectiveness test.

Vehicle movement for this test shall commence within [60] s after the end of the heating phase in accordance with 20.5.2, and with maximum acceleration to [60] km/h so that braking commences within the shortest possible time.

The value of the braking rate calculated from the measurements made shall reach:

— [60] % of the braking rate achieved in the type O test as calculated in 18.1.1.1 (but for the laden condition); and

— depending upon whether all axles or just one axle is braked, a value of z_{aR} or of z_{aA} respectively, at least equal to [0,4].

20.5.4.4 Free running test — Automatic brake adjustment device

For vehicles fitted with automatic brake adjustment devices, e.g. automatic slack adjusters, check that following the hot test (20.5.4.3) one of the following conditions is fulfilled:

a) all wheels are running freely at a temperature below 100°C, and may be rotated by hand;

b) when the trailer is driven at a constant speed of v = 60 km/h with the brakes released, the asymptotic temperatures do not exceed a drum/disc temperature increase of 80 °C.

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20.5.5 Presentation of results

The following results shall be recorded:

a) achieved braking rate of motor vehicle and trailer combination, z_{aC} in the cold effectiveness test and in the test with hot brakes;

b) calculated braking rate of test axle z_{aA}, or trailer z_{aR} in the cold effectiveness test and in the test with hot brakes;

c) pressure p_A in the brake actuators in the cold effectiveness test and in the test with hot brakes;

d) control line pressure p_m, and the corresponding digital values in the case of an electric control line, in the cold effectiveness test and in the test with hot brakes;

e) longitudinal force on mechanical coupling F_L (if appropriate);

f) time elapsed between the end of the heating and commencement of braking with hot brakes.

If the axle(s) tested is (are) intended to serve as reference axle(s), complete the test report given in Annex B.

Table 7 — (see 15.2.2)

Axle	Axles of the Trailer			Reference Axles		
	Technically admissible maximum mass per axle kg	Required braking force at the wheels (type I or type III tests) N	Speed of trailer (heating phase) km/h	Axle mass as tested kg	Braking force developed per axle at the wheels (type I or type III tests) N	Speed of wheel (heating phase) km/h
Type I Test						
No. 1						
No. 2						
No. 3						
Type III Test						
No. 1						
No. 2						
No. 3						

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Table 8 — (see 15.2.3)

Actuator stroke, calculated values from 15.2.3.1			
	Type I test s_A mm	s_{Ap} mm	**Type III test** s_A mm
Axle No. 1	⩽	⩾	
Axle No. 2	⩽	⩾	
Axle No. 3	⩽	⩾	
Average output thrust, determined values from 15.2.3.2			
	F_A N	At pressure p_A bar	
Axle No. 1			
Axle No. 2			
Axle No. 3			
Camshaft input torque, calculated values from 15.2.3.3 [a]			
	C Nm	C_{adm} Nm	
Axle No. 1			
Axle No. 2			
Axle No. 3			
[a] Brake actuator output thrust (F_A and $F_{Aadm,}$ N) if appropriate			
Braking forces, calculated values from 15.2.3.4			
	Type I test F_{Ba} N	Type III test F_{Ba} N	
Axle No. 1			
Axle No. 2			
Axle No. 3			
Sum of braking forces	$F_{BaR} = \Sigma F_{Ba}$ = N	$F_{BaR} = \Sigma F_{Ba}$ = N	
Hot braking rate, calculated values from 15.2.3.5			
with z_{aR} =	Type I test Z_{BaR} =	Type III test Z_{BaR} =	

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Annex A
(normative)

Description of test vehicle, axle or brake

A.1 Test vehicle

Trade name or mark: ....

Category: ....

Type and identification number: ....

Manufacturer's name and address: ....

Total maximum calculated mass (ISO 1176, code: ISO-M07): ....

Distribution of maximum mass on each axle: ....

Tyre size: ....

Maximum design speed: ....

Number and arrangement of axles: ....

Brief description of braking equipment: ....

Brief description of antilock braking system/electronically controlled braking system (including reference number of test report(s)): ....

Table A.1 — Mass of vehicle at the time of testing

	Unladen mass kg	**Laden mass** kg
Axle No. 1		
Axle No. 2		
Axle No. 3		
Axle No. 4		
Total		
NOTE For a semi-trailer indicate in the line "Axle No. 1" the mass on the fifth-wheel coupling and for a centre-axle trailer indicate in the line "Axle No. 1" the static mass supported by the towing vehicle.		

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A.2 Test axle

Trade name or mark: ....

Type: ....

Manufacturer's name and address: ....

Technically permissible mass per axle: ....

A.3 Test brake

Trade name or mark: ....

Type and design: ....

Manufacturer's name and address: ....

Automatic brake adjustment device .... integrated/not integrated

A.3.1 Drum

Internal diameter: ....

External width: ....

Mass: ....

Material: ....

A.3.2 Disc

Nominal effective radius: ....

Thickness: ....

Mass: ....

Material: ....

A.3.3 Brake lining/pad

Trade name or mark and identification (which shall remain visible when lining is mounted): ....

Manufacturer's name and address: ....

Width: ....

Nominal thickness*: ....

Surface area (of all linings/pads per brake): ....

Method of attachment: ....

* In the case of tapered drum brake linings, the nominal thickness is taken as the thickness dimension 19,2 mm from the thick end.

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A.3.4 Wheel

Single or twin (delete as applicable)

Rim size: ....

Axial distance from rim flange to open end of drum or to disc: ....

Tyre size: ....

Rolling radius (dynamic): ....

Technically permissible maximum mass per wheel: ....

A.3.5 Actuation

Manufacturer of actuator: ....

Type of actuator and stroke: ....

Lever length*: ....

Type and make of slack adjuster*: ....

* In the case of disc brakes, may not be necessary.

A.3.6 Automatic brake adjustment device (not applicable in the case of an integrated automatic brake adjustment device)

Manufacturer (name and address): ....

Make: ....

Type: ....

Version: ....

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Annex B
(normative)

Test report

Test report no. ………....of reference axle no. ……………

Applicant: ....

Test date: ....

Axle

Manufacturer: ....

Make: ....

Type: ....

Model: ....

Technically permissible mass per axle: ....

Brake

Manufacturer: ....

Make: ....

Type: ....

Model: ....

Technically admissible camshaft input torque; C_{adme}: ....

Maximum technically admissible camshaft input torque; C_{maxe}: ....

Automatic brake adjustment device: integrated/not integrated

Brake Drum

Manufacturer: ....

Internal diameter: ....

External width: ....

Mass: ....

Material: ....

Brake Disc

Manufacturer: ....

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Nominal effective radius: ....

Thickness: ....

Mass: ....

Material: ....

Brake lining/pad

Manufacturer: ....

Type: ....

Identification (which remains visible when the lining is mounted): ....

Width: ....

Nominal thickness*: ....

Surface area (of all linings/pads per brake): ....

Method of attachment: ....

* In the case of tapered drum brake linings, the nominal thickness is taken as the thickness dimension 19,2 mm from the thick end.

Wheel

Single or twin (delete as applicable)

Rim size: ....

Tyre

Dynamic rolling radius: ....

Brake actuator

Manufacturer: ....

Type and Model: ....

Lever length*: ....

* In the case of disc brakes, may not be necessary.

Automatic brake adjustment device (not applicable in the case of an integrated automatic brake adjustment device)

Manufacturer (name and address): ....

Make: ....

Type: ....

Version: ....

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Table B.1 — Tests carried out

Tests	Road	High speed rolling road dynamometer	Inertia dynamometer
Type O			
Cold effectiveness			
Type I			
Type III			

Table B.2 — Test results

Characteristics	Unit	Type I test			Type III test		
		Cold effective-ness test	Heating phase	Hot brake test	Cold effective-ness test	Heating phase	Hot brake test
Initial speed v_s	km/h	40	40	40	60		60
Final speed v_f	km/h	—	—				
Constant speed v	km/h	—		—	—		—
Pressure in brake actuator	bar						
Number of brake applications	—	—	—	—	—	20	—
Duration of each braking cycle	s	—	—	—	—	60	—
Duration of braking	min.	—	2,55	—	—	—	—
Braking F_{Be}	N		—	—		—	—
Braking F_{Bhe}	N	—		—	—		—
Braking F_{Bae}	N	—	—		—	—	
Braking rate z_e	—						
Heating phase braking rate z_{he}	—	—		—	—		—
Hot brake braking rate z_{hae}	—	—	—		—	—	
Brake actuator stroke s_{Ae}	mm						
Camshaft input torque C_e Actuator output thrust F_{Ae} *	Nm N		— —			— —	
Threshold input torque C_{oe} Threshold actuator thrust F_{Aoe} *	Nm N		— —			— —	
NOTE Choice of appropriate one depends on the design of the wheel (foundation) brake.							

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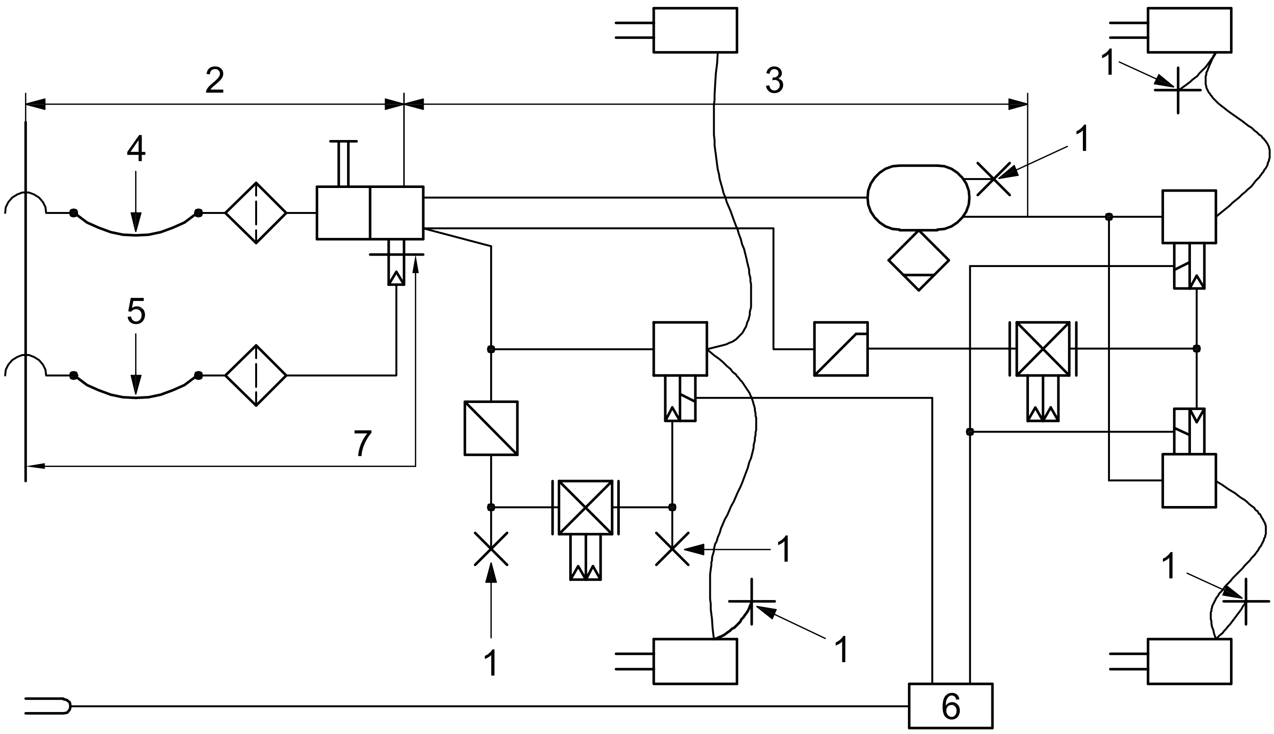
Annex C
(informative)

Figures



Key

1 test connection
2 energy supplying device
3 transmission device
4 supply, red
5 brake, yellow
6 ABS electronic control
7 control device

Figure C.1 — Typical trailer service and automatic air braking system with pressure test connections

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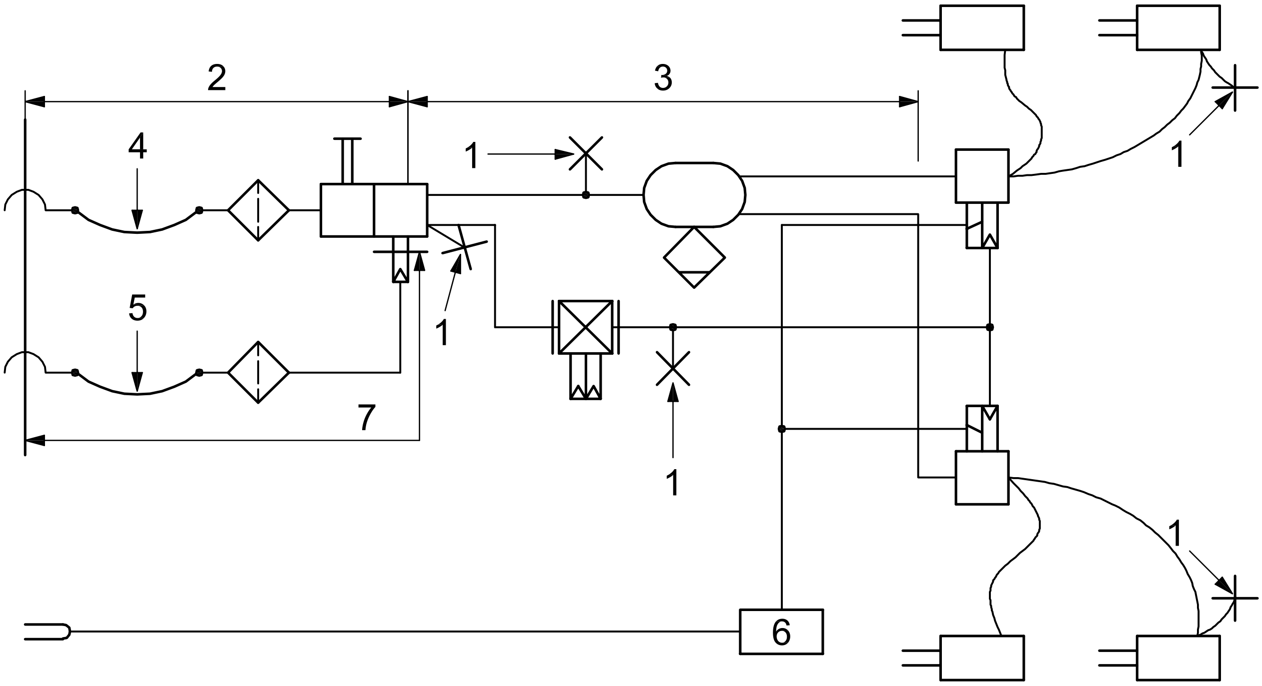

Key

1 test connection
2 energy supplying device
3 transmission device
4 supply, red
5 brake, yellow
6 ABS electronic control
7 control device

Figure C.2 — Typical semi-trailer service and automatic air braking system with pressure test connections

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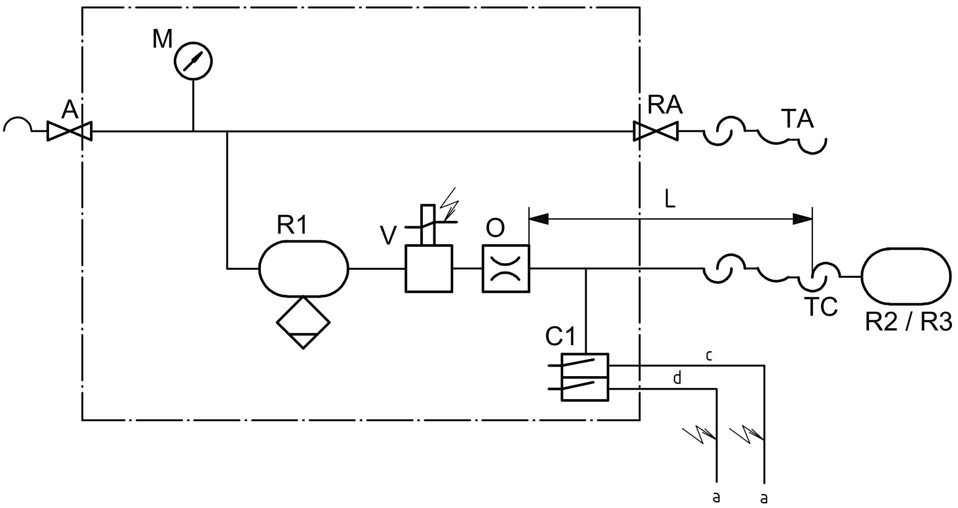
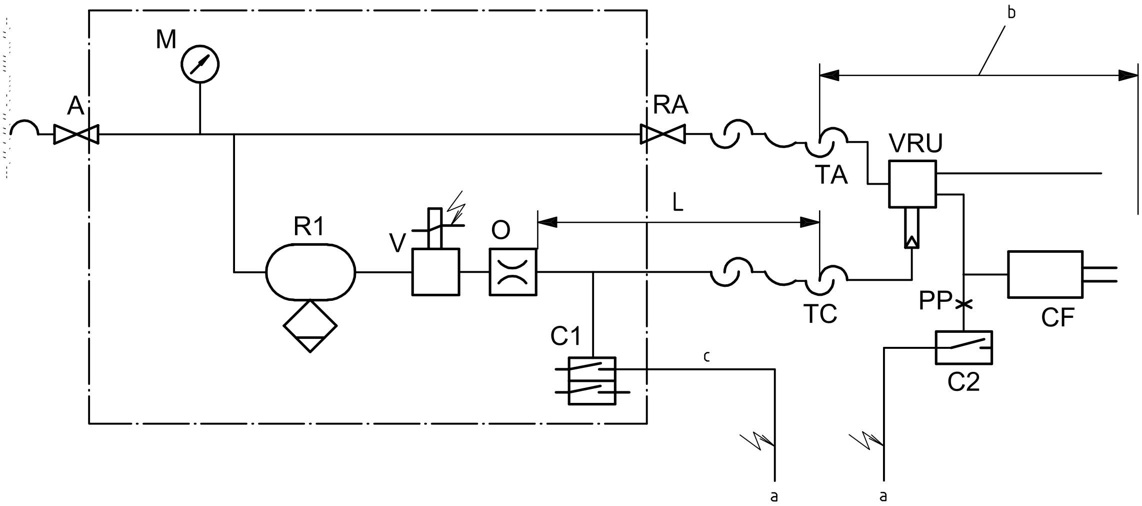


a) **Setting simulator**



b) **Trailer test**

Components

A supply connection with shut-off valve
C1 pressure switch in the simulator, set at 0,65 bar and 4,9 bar
C2 pressure switch to be connected to the brake actuator of the trailer, to operate at 75 % of the asymptotic pressure in the brake actuator, CF
CF brake actuator
L line from orifice O up to and including its coupling head TC, having an inner volume of (385 ± 5) cm^3 under a pressure of 6,5 bar
M pressure gauge
O orifice with diameter of not less than 4 mm and not more than 4,3 mm
PP pressure test connection
R1 30 l air reservoir with drain valve
R2 calibrating reservoir, including its coupling head TC, (385 ± 5) cm^3
R3 calibrating reservoir, including its coupling head TC, (1 155 ± 15) cm^3
RA shut-off valve
TA coupling head, supply line
TC coupling head, control line
V braking control device
VRU relay emergency valve
[a] To electronic chronometer.
[b] Braking equipment of trailer to be tested.
[c] 0,65 bar (= 0,065 MPa).
[d] 4,9 bar (= 0,49 MPa).

Figure C.3 — Example of pneumatic simulator (see 10.2)

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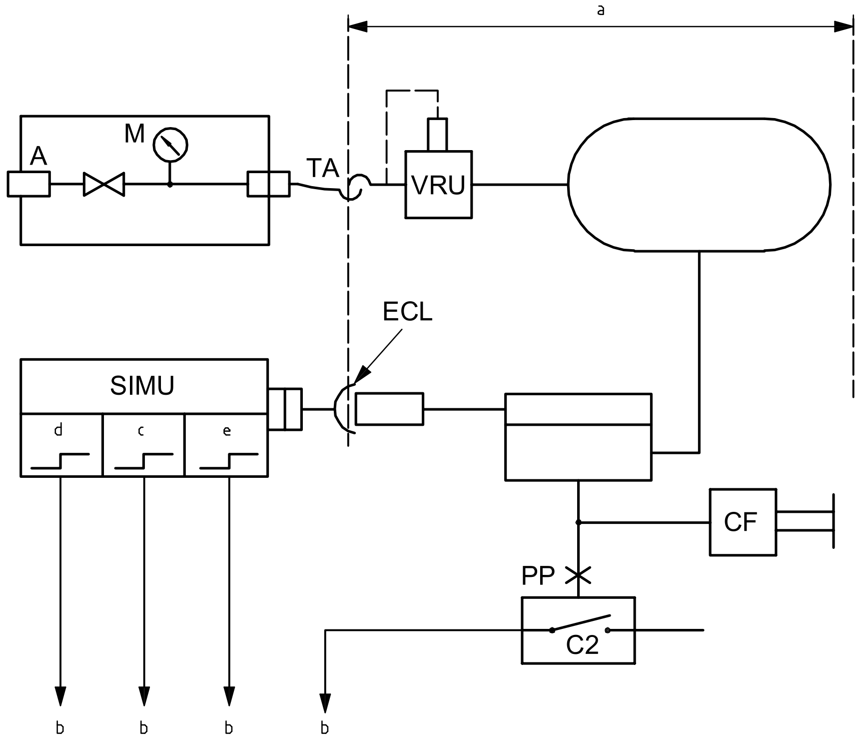

Components

ECL electric control line corresponding to ISO 7638-1 and ISO 7638-2

SIMU simulator of Byte 3,4 of EBS 11 according to ISO 11992 with output signals at start, 0,65 bar and 6,5 bar

A supply connection with shut-off valve

C2 pressure switch to be connected to the brake actuator of the trailer, to operate at 75 % of the asymptotic pressure in the brake actuator CF

CF brake cylinder

M pressure gauge

PP pressure test connection

TA coupling head, supply line

VRU relay emergency valve

[a] Braking equipment of trailer to be tested.

[b] To electronic chronometer.

[c] 0,65 bar (= 0,065 MPa).

[d] Start.

[e] 6,5 bar (= 0,65 MPa).

Figure C.4 — Example of a simulator for electric control lines (reference paragraph 10.2)

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