II

(Acts whose publication is not obligatory)

COMMISSION

COMMISSION DIRECTIVE

of 23 December 1985

adapting to technical progress Council Directive 71/320/EEC on the approximation of the laws of the Member States relating to the braking devices of certain categories of motor vehicles and their trailers

(85/647/EEC)

THE COMMISSION OF THE EUROPEAN COMMUNITIES,

Having regard to the Treaty establishing the European Economic Community,

Having regard to Council Directive 70/156/EEC of 6 February 1970 on the approximation of the laws of the Member States relating to the type-approval of motor vehicles and their trailers (1), as last amended by Directive 78/547/EEC (2), and in particular Articles 11, 12 and 13 thereof,

Having regard to Council Directive 71/320/EEC of 26 July 1971 on the approximation of the laws of the Member States relating to the braking devices of certain categories of motor vehicles and their trailers (3), as last amended by Commission Directive 79/489/EEC (4),

Whereas, in view of experience gained and of the state of the art, it is now possible to make requirements more stringent and to match them more closely to actual test conditions;

Whereas it is now also possible to adopt provisions relating to braking systems with anti-lock devices; where such devices are fitted compliance with the corresponding provisions of this Directive is required;

Whereas the provisions of this Directive are in accordance with the opinion of the Committee on the Adaptation to Technical Progress of the Directives Aimed at the Removal of Technical Barriers to Trade in the Motor Vehicle Sector;

Whereas the Commission in its two communications to the Council on Road Safety Year 1986 (5) has included in its programme for legislative actions 'Improvements to the existing braking Directive' and whereas the provisions of this new Directive will contribute to the improvement of road safety,

HAS ADOPTED THIS DIRECTIVE

Article 1

Directive 71/320/EEC is amended as follows:

1. Article 2 is replaced by the following:

'*Article 2*

No Member State may refuse to grant EEC type-approval or national type-approval of a vehicle on grounds relating to its braking device if that vehicle is fitted with the devices specified in Annexes I to VIII and X to XII and if these devices satisfy the requirements set out therein.

(1) OJ No L 42, 23. 2. 1970, p. 1.
(2) OJ No L 168, 26. 6. 1978, p. 39.
(3) OJ No L 202, 6. 9. 1971, p. 37.
(4) OJ No L 128, 26. 5. 1979, p. 12.
(5) COM(84) 704 final, 13. 12. 1984; COM(85) 239 final, 22. 5. 1985.

2. Annexes I, II, III, IV, V, VII, VIII and IX to Directive 71/320/EEC are hereby amended and new Annexes X, XI and XII are added in accordance with the Annex to this Directive.'

Article 2

1. As from 1 October 1986 no Member State may, on grounds relating to braking devices:

— refuse, in respect of a type of vehicle, to grant EEC type-approval, or to issue the copy of the certificate provided for in the last indent of Article 10 (1) of Directive 70/156/EEC, or to grant national type-approval, or

— prohibit the entry into service of vehicles

where the braking devices of such type of vehicle or of such vehicles comply with the provisions of Directive 71/320/EEC, as last amended by this Directive.

2. As from 1 April 1987, Member States:

— shall no longer issue the copy of the certificate provided for in the last indent of Article 10 (1) of Directive 70/156/EEC in respect of a type of vehicle of which the braking devices do not comply with the provisions of Directive 71/320/EEC, as last amended by this Directive,

— may refuse to grant national type-approval of a type of vehicle of which the braking devices do not comply with the provisions of Directive 71/320/EEC, as last amended by this Directive.

3. As from 1 October 1988 Member States may prohibit the entry into service of vehicles of which the braking devices do not comply with the provisions of Directive 71/320/EEC, as last amended by this Directive.

Article 3

Before 1 October 1986, Member Stares shall bring into force the provisions necessary in order to comply with this Directive, and shall forthwith inform the Commission thereof.

Article 4

This Directive is addressed to the Member States.

Done at Brussels, 23 December 1985.

For the Commission

COCKFIELD

Vice-President

ANNEX

Amendments to the Annexes to Directive 71/320/EEC, as amended by Directives 74/132/EEC, 75/524/EEC and 79/489/EEC

ANNEX I: DEFINITIONS, REQUIREMENTS, CONSTRUCTION AND FITTING

Item 1 shall read:

'1. DEFINITIONS

For the purpose of this Directive:'

After item 1.14 the following new items 1.15, 1.16 and 1.17 shall be added:

'1.15. **Hydraulic braking device with stored energy**

"Hydraulic braking device with stored energy" means a braking system where energy is supplied by a hydraulic fluid under pressure, stored in one or more accumulators fed from one or more pressure pumps each fitted with a means of limiting the pressure to a maximum value. This value shall be specified by the manufacturer.

1.16. **Category O_3 and O_4 trailer types**

1.16.1. *Semi-trailer*

"Semi-trailer" means a towed vehicle in which the axle(s) is (are) positioned behind the centre of gravity of the vehicle (when uniformly loaded) and which is equipped with a connecting device permitting horizontal and vertical forces to be transmitted to the drawing vehicle.

1.16.2. *Full trailer*

"Full trailer" means a towed vehicle having at least two axles, and equipped with a towing device which can move vertically (in relation to the trailer) and controls the direction of the front axle(s), but which transmits no significant static load to the drawing vehicle.

1.16.3. *Centre-axle trailer*

"Centre-axle trailer" means a towed vehicle equipped with a towing device which cannot move vertically (in relation to the trailer), and in which the axle(s) is (are) positioned close to the centre of gravity of the vehicle (when uniformly loaded) such that only a small static vertical load, not exceeding 10 % of the maximum mass of the trailer or 1 000 kg (whichever is the lesser) is transmitted to the drawing vehicle.

The maximum mass to be taken into consideration when classifying a centre-axle trailer shall be the mass transmitted to the ground by the axle(s) of the centre-axle trailer when coupled to the drawing vehicle and laden with a maximum load.

1.17. **Retarder** (1)

"Retarder" means an additional braking system having the capability to provide and to maintain a braking effect over a long period of time without a significant reduction in performance. The term "retarder" covers the complete system including the control device.

1.17.1. *Independent retarder*

"Independent retarder" means a retarder whose control device is separate from that of the service and other braking systems.

1.17.2. *Integrated retarder* (2)

"Integrated retarder" means a retarder whose control device is integrated with that of the service braking system in such a way that both retarder and service braking systems are applied simultaneously or suitably phased by operation of the combined control device.

1.17.3. *Combined retarder*

"Combined retarder" means an integrated retarder which in addition has a cut-out device, which allows the combined control to apply the service braking system alone.

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(1) Until uniform procedures have been agreed to calculate the effects of retarders on the provisions in the Appendix to item 1.1.4.2 of Annex II, this definition does not cover vehicles fitted with regenerative braking systems.

(2) Until uniform procedures have been agreed to calculate the effects of retarders on the provisions in the Appendix to item 1.1.4.2 of Annex II, vehicles equipped with an integrated retarder must also be equipped with an anti-lock device, acting on at least the service brakes of the axle controlled by the retarder, and on the retarder, and complying with the requirements specified in Annex X.'

After item 2.1.2.3 the following new item 2.1.3 shall be added:

'2.1.3. *Pneumatic connections between motor vehicles and trailers*

2.1.3.1. In the case of a braking device operated by compressed air, the pneumatic link with the trailer must be of the type with two or more lines. However, in all cases, all the requirements of this Directive must be satisfied by the use of only two lines. Shut-off devices which are not automatically actuated shall not be permitted. In the case of articulated vehicle combinations, the flexible hoses shall be a part of the drawing vehicle. In all other cases, the flexible hoses shall be a part of the trailer.'

Item 2.2.1.2.1 shall read:

'2.2.1.2.1. there must be at least two controls, independent of each other and readily accessible to the driver from his normal driving position. For all categories of vehicles, except M_2 and M_3, every brake control (excluding a retarder control) shall be designed such that it returns to the fully-off position when released. This requirement shall not apply to a parking brake control (or that part of a combined control) when it is mechanically locked in an applied position;'.

Item 2.2.1.2.7 shall read:

2.2.1.2.7. certain parts, such as the pedal and its bearing, the master cylinder and its piston(s) (hydraulic systems), the control valve (hydraulic and/or pneumatic systems), the linkage between the pedal and the master cylinder or the control valve, the brake cylinders and their pistons (hydraulic and/or pneumatic systems), and the lever-and-cam assemblies of brakes, shall not be regarded as liable to breakage if they are amply dimensioned, are readily accessible for maintenance, and exhibit safety features at least equal to those prescribed for other essential components (such as the steering linkage) of the vehicle. Where the failure of any such part would make it impossible to brake the vehicle with a performance at least equal to that prescribed for the secondary braking, that part must be made of metal or of a material with equivalent characteristics and must not be subject to significant distortion in the normal operation of the braking devices.'

Item 2.2.1.4.2 shall read:

'2.2.1.4.2. these wheels must be so selected that the residual performance of the service braking device satisfies the requirements laid down in item 2.1.4 of Annex II;'.

Item 2.2.1.5 shall read:

'2.2.1.5. Where use is made of energy other than the muscular energy of the driver, there need not be more than one source of such other energy (hydraulic pump, air compressor, etc.), but the means by which the device constituting that source is driven must be as safe as practicable.'

After item 2.2.1.5 the following new items 2.2.1.5.1, 2.2.1.5.2 and 2.2.1.5.3 shall be added:

'2.2.1.5.1. In the event of failure in any part of the transmission of a vehicle's braking devices, the supply to the part not affected by the failure must continue to be ensured where this is required for the purpose of

halting the vehicle with the degree of effectiveness prescribed for residual and/or for secondary braking. This condition must be met by means of devices which can be easily actuated when the vehicle is stationary, or by automatic means.

2.2.1.5.2. In addition, storage devices located down-circuit of this device must be such that in the event of a failure in the energy supply, after four full-stroke actuations of the service brake control under the conditions prescribed in item 1.2 of Annex IV it is still possible to halt the vehicle at the fifth application with the degree of effectiveness prescribed for secondary braking.

2.2.1.5.3. However, for hydraulic braking devices with stored energy, these provisions can be considered to be met, provided that the requirements of item 1.2.2 of Annex IV, section C, are satisfied.'

Item 2.2.1.11 shall read:

'2.2.1.11. Wear on the brakes must be easily compensated by means of a system of manual or automatic adjustment. In addition, the control and the components of the transmission and of the brakes must possess a reserve of travel and, if necessary, suitable means of compensation such that, when the brakes become heated or when the brake linings have reached a certain degree of wear, effective braking is ensured without immediate adjustment being necessary.'

Item 2.2.1.12.2 shall read:

'2.2.1.12.2. the failure of a part of a hydraulic transmission system shall be signalled to the driver by a device comprising a red tell-tale lamp lighting up not later than on actuation of the control and remaining lit as long as the failure persists and the ignition (start) switch is in the "on" (run) position. However a device comprising a red tell-tale lamp lighting up when the level of the fluid in its reservoirs falls below the value specified by the manufacturer is admissible. The tell-tale lamp shall be visible even by daylight; the satisfactory condition of the lamp must be easily verifiable by the driver from the driver's seat. The failure of a component of the device shall not entail total loss of effectiveness of the braking device in question.'

After item 2.2.1.13 the following new items 2.2.1.13.1 and 2.2.1.13.2 shall be added:

'2.2.1.13.1. However, in the case of vehicles which are only considered to comply with the requirements of item 2.2.1.5.1 by virtue of meeting the requirements of item 1.2.2 of Annex IV, section C, the alarm device shall consist of an acoustic signal in addition to an optical signal. These devices need not operate simultaneously, provided that each of them meets the above requirements and the acoustic signal is not actuated before the optical signal.

2.2.1.13.2. This acoustic device may be rendered inoperative while the handbrake is applied and/or, at the choice of the manufacturer, in the case of automatic transmission the selector is in the "park" position.'

Item 2.2.1.14 shall read:

'2.2.1.14. Without prejudice to the requirements of item 2.1.2.3, where the use of an auxiliary energy source is essential for the operation of a braking device, the energy reserve must be such as to ensure that, should the engine stop, or in the event of a failure of the means by which the energy source is driven, the braking performance remains sufficient to bring the vehicle to a halt in the prescribed conditions. In addition, if the muscular energy applied by the driver to the parking brake device is reinforced by some aid, the actuation of the parking braking must be ensured in the event of failure of that aid, if necessary a reserve of energy independent of that normally supplying such aid. This reserve of energy may be that indended for the service braking. The expression "actuation" also covers the action of releasing.'

The former item 2.2.1.17 shall be deleted and the subsequent paragraphs shall be renumbered.

After item 2.2.1.18.3 (new numbering) the following new item 2.2.1.18.4 shall be added:

'2.2.1.18.4. in the case of a two-line air supply system, the requirement in item 2.2.1.18.3 above shall be considered to be met if the following conditions are fulfilled:

2.2.1.18.4.1. when the service brake control of the drawing vehicle is fully actuated, the pressure in the supply line must fall to 1,5 bar within the following two seconds;

2.2.1.18.2. when the supply line is evacuated at the rate of at least 1 bars the automatic braking of the trailer must operate when the pressure in the supply line falls to 2 bar.'

After item 2.2.1.19 (new numbering) the following new item 2.2.1.20 **shall be** added:

'2.2.1.20. In the case of a motor vehicle equipped to draw a trailer with electric service brakes, the following requirements shall be met:

2.2.1.20.1. the power supply (generator and battery) of the motor vehicle shall have a sufficient capacity to provide the current for an electric braking system. **With** the engine running at the idling speed recommended by the manufacturer and all electric devices supplied by the manufacturer as standard equipment of the vehicle switched on, the voltage in the electrical lines shall at maximum current consumption of the electric braking system (15 A) not fall below the value of 9,6 V measured at the connection. The electrical lines shall not be capable of short-circuiting even when overloaded;

2.2.1.20.2. in the event of a failure of the drawing vehicle's service braking device, where that device consists of at least two independent units, the unit or units not affected by the failure shall be capable of partially or fully actuating the brakes of the trailer;

2.2.1.20.3. the use of the stop-light switch and circuit for actuating the electric braking system is permissible only if the actuating line is connected in parallel with the stop-light and the existing stop-light switch and circuit are capable of taking the extra load.'

After item 2.2.1.20 (new numbering) the following new item 2.2.1.21 **shall be** added:

2.2.1.21. In the case of a pneumatic service braking device comprising two or more independent sections, any leakage between those sections at or downstream of the control shall be continuously vented to atmosphere.'

Item 2.2.2.2 shall read:

2.2.2.2. Every trailer of category O_2 must be fitted with a service braking device either of the continuous or semi-continuous type or of the inertia (overrun) type. The latter type shall be authorized only for trailers other than semi-trailers. However, electric service brakes conforming to the requirements of Annex XI shall be permitted.'

Item 2.2.2.8 shall read:

2.2.2.8. Wear on the brakes must be easily compensated by a system of manual or automatic adjustment. In addition, the control and the components of the transmission and of the brakes must possess a reserve of travel and if necessary, suitable means **of compensation such** that, when the brakes become heated or when the brake linings have reached a certain degree of wear, effective braking is ensured without immediate adjustment being necessary.'

After item 2.2.2.11 the following new item 2.2.2.12 shall be added:

'2.2.2.12. Trailers of categories O_3 and O_4 fitted with a two-line air supply system shall satisfy the conditions specified in item 2.2.1.18.4 above.'

ANNEX II: **BRAKING TESTS AND PERFORMANCE OF BRAKING DEVICES**

Item 1.2.1.2.1, add at the end:

'in the case of tractive units for semi-trailers, the load may be re-positioned approximately half-way between the kingpin position resulting from the above loading conditions and the centreline of the rear axle(s);'.

Item 1.2.1.2.2 shall read:

'1.2.1.2.2. every test must be repeated on the unladen vehicle. In the case of a motor vehicle there may be, in addition to the driver, a second person on the front seat who is responsible for noting the results of the test. In the case of a motor vehicle designed to draw a semi-trailer, the unladen tests will be

conducted with the vehicle in its solo condition, including a mass representing the fifth wheel. It will also include a mass representing a spare wheel, if this is included in the standard specification of the vehicle. In the case of a vehicle presented as a bare chassis-cab, a supplementary load may be added to simulate the mass of the body, not exceeding the minimum mass declared by the manufacturer in Annex IX;'.

Item 1.2.3.1 shall read:

'1.2.3.1. Apart from the test prescribed in item 1.2.2, additional tests shall be carried out at various speeds with the engine connected, the lowest being equal to 30 % of the maximum speed of the vehicle and the highest being equal to 80 % of that speed. The maximum practical performance figures shall be measured and the behaviour of the vehicle shall be recorded in the test report. Tractive units for semi-trailers, artificially loaded to simulate the effects of a lade semi-trailer, shall not be tested beyond 80 km/h.'

After item 1.2.3.1 the following new item 1.2.4 shall be added:

'1.2.4. *Type O test for vehicles of category O equipped with compressed air brakes*

1.2.4.1. The braking performance of the trailer can be calculated either from the braking rate of the drawing vehicle plus the trailer and the measured thrust on the coupling or, in certain cases, from the braking rate of the drawing vehicle plus the trailer with only the trailer being braked. The engine of the drawing vehicle must be disconnected during the braking test. In the case where only the trailer is braked, to take account of the extra mass being retarded, the performance will be taken to be the mean fully developed deceleration.

1.2.4.2. With the exception of cases according to items 1.2.4.3 and 1.2.4.4, it is necessary for the determination of the braking rate of the trailer to measure the braking rate of the drawing vehicle plus the trailer and the thrust on the coupling. The drawing vehicle must meet the requirements laid down in the Appendix to item 1.1.4.2 of Annex II with regard to the relation between the ratio $\frac{T_m}{P_m}$ and the pressure p_m. The braking rate of the trailer is calculated according to the following formula:

$$z_R = z_{R+M} + \frac{D}{PR}$$

where:

z_R = braking rate of the trailer,

z_{R+M} = braking rate of the drawing vehicle plus the trailer,

D = thrust on the coupling
(tractice force D = > 0)
(compressive force D = < 0).

1.2.4.3. If a trailer has a continuous or semi-continuous braking device where the pressure in the brake actuators does not change during braking despite the dynamic axle load shifting, and in the case of semi-trailers, the trailer alone may be braked. The braking rate of the trailer is calculated according to the following formula:

$$z_R = (z_{R+M} - R) \cdot \frac{PM + PR}{PR} + R$$

where:

R = rolling resistance value = 0,01.

1.2.4.4. Alternatively, the evaluation of the braking rate of the trailer may be done by braking the trailer alone. In this case the pressure used shall be the same as that measured in the brake actuators during the braking of the combination.'

Item 1.3.3.1 shall read:

'1.3.3.1. At the end of the Type I test (test described in item 1.3.1 or test described in item 1.3.2 of this Annex) the residual performance of the service braking device shall be measured under the same conditions (and in particular at a constant control force no greater than the mean force actually used) as for the Type O test with the engine disconnected (the temperature conditions may be different). For motor vehicles, this residual performance must not be less than 80 % of that prescribed for the category in question nor less than 60 % of the figure recorded in the Type O test with the engine disconnected. However in the case of trailers, the residual brake force at the

periphery of the wheels when tested at 40 km/h must not be less than 36 % of the force corresponding to the maximum mass borne by the wheels when the vehicle is stationary, nor less than 60 % of the figure recorded in the Type O test at the same speed.

After item 1.3.3.1 the following new item 1.3.3.2 shall be added:

'1.3.3.2. In the case of a motor vehicle which cannot comply with the requirements of item 1.3.3.1 above, a further hot performance test may be carried out using a control force not exceeding that specified in item 2.1.1.1 of this Annex. The results of both tests shall be entered in the report.'

Item 1.4.3 shall read:

'1.4.3. At the end of the test, the residual performance of the service braking device shall be measured in the same conditions as for the Type O test with the engine disconnected (the temperature conditions, of course, are different). For motor vehicles, this residual performance must give a stopping distance not exceeding the following values, using a control force not exceeding 700 N:

category M_3 $0{,}15\ V + \frac{1{,}33\ V^2}{130}$ (the second term corresponding to a mean braking deceleration of 3,75 m/s²);

category N_3 $0{,}15\ V + \frac{1{,}33\ V^2}{115}$ (the second term corresponding to a mean braking deceleration of 3,3 m/s²).

However, in the case of trailers the residual brake force at the periphery of the wheels when tested at 40 km/h must not be less than 33 % of the force corresponding to the maximum mass borne by the wheels when the vehicle is stationary.'

Item 1.5.1, add at the end:

'An integrated retarder may be used, provided that it is suitably phased such that the service brakes are not applied; this may be verified by checking that these brakes remain cold, as defined in item 1.2.1.1 of this Annex.'

Item 2.1.1.1.1 — amend the table as follows:

	'M₁	M₂	M₃	N₁	N₂	N₃
Type of test	O – I	O – I	O – I – II	O – I	O – I	O – I – II
V	80 km/h	60 km/h	60 km/h	80 km/h	60 km/h	60 km/h
$s \leqslant$	$0{,}1V + \frac{V^2}{150}$			$0{,}15V + \frac{V^2}{130}$		
$d_m \geqslant$	5,8 m/s²			5 m/s²		
$f \leqslant$	500 N			700 N'		

Item 2.1.2.1 shall read:

'2.1.2.1. The secondary braking, even if the device which actuates it is also used or other braking functions, must give a stopping distance not exceeding the following values:

category M_1 $0{,}1\ V + \frac{2\ V^2}{150}$ (the second term corresponding to a mean braking deceleration of 2,9 m/s²);

category M_2, M_3 $0{,}15\ V + \frac{2\ V^2}{130}$ (the second term corresponding to a mean braking deceleration of 2,5 m/s²);

category N $0{,}15\ V + \frac{2\ V^2}{115}$ (the second term corresponding to a mean braking deceleration of 2,2 m/s²).'

Item 2.1.2.4 shall read:

'2.1.2.4. The performance of the secondary braking device shall be checked by the Type O test with the engine disconnected from the following initial speeds:

M_1 = 80 km/h M_2 = 60 km/h M_3 = 60 km/h;

N_1 = 70 km/h N_2 = 50 km/h N_3 = 40 km/h.'

Item 2.1.3.6 shall read (remainder unchanged):

'2.1.3.6. To check compliance with the requirements of Annex I, item 2.2.1.2.4, a Type O test must be carried out with the engine disconnected at the initial speed specified in item 2.1.2.4 for the relevant vehicle category. The mean fully developed . . .'.

After item 2.1.3.6 the following new item 2.1.4 shall be added:

'2.1.4. *Residual service braking after transmission failure:*

2.1.4.1. The residual performance of the service braking device, in the event of failure in a part of its transmission, must not be greater than the following stopping distances (or less than the corresponding mean deceleration) using a force applied to the control not exceeding 700 N, when checked by the Type O test with the engine disconnected from the following initial speeds for the relevent vehicle category:

Stopping distance (m) and mean deceleration (m/s^2)

	(km/h)	Laden		Unladen	
M_1	80	$0{,}1\ V + \frac{100}{30}\frac{V^2}{150}$	(1,7)	$0{,}1\ V + \frac{100}{25}\frac{V^2}{150}$	(1,5)
M_2	60	$0{,}15V + \frac{100}{30}\frac{V^2}{130}$	(1,5)	$0{,}15V + \frac{100}{25}\frac{V^2}{130}$	(1,3)
M_3	60	$0{,}15V + \frac{100}{30}\frac{V^2}{130}$	(1,5)	$0{,}15V + \frac{100}{30}\frac{V^2}{130}$	(1,5)
N_1	70	$0{,}15V + \frac{100}{30}\frac{V^2}{115}$	(1,3)	$0{,}15V + \frac{100}{25}\frac{V^2}{115}$	(1,1)
N_2	50	$0{,}15V + \frac{100}{30}\frac{V^2}{115}$	(1,3)	$0{,}15V + \frac{100}{25}\frac{V^2}{115}$	(1,1)
N_3	40	$0{,}15V + \frac{100}{30}\frac{V^2}{115}$	(1,3)	$0{,}15V + \frac{100}{30}\frac{V^2}{115}$	(1,3)'.

Item 2.2.1.2.1 shall read:

'2.2.1.2.1. Where the trailer is fitted with compressed-air brakes, the pressure in the control line and in the forces exerted at the periphery of the braked wheels must be equal to not less than X % of the force corresponding to the maximum mass borne by the wheels when the vehicle is stationary, X having the following values:

full trailer, laden and unladen 50,
semi-trailer, laden and unladen 45,
centre-axle trailer, laden and unladen 50.

Where the trailer is fitted with compressed-air brakes, the pressure in the control line and in the supply line must not exceed 6,5 bar (1) during the brake test. The test speed is 60 km/h. A supplementary test at 40 km/h must be carried out with the laden vehicle for comparison with the Type I test result.'

After item 2.3.2 the following new item 2.3.3 shall be added:

'2.3.3. in the case of vehicles fitted with hydraulic braking devices, the requirements of item 2.3.1 are considered to be satisfied if, in an emergency manœuvre, the deceleration of the vehicle, or the pressure at the least favourable brake cylinder, reaches a level corresponding to the prescribed performance within 0,6 seconds.'

APPENDIX TO ANNEX II: **DISTRIBUTION OF BRAKING EFFORT AMONG VEHICLE AXLES (75/524/EEC)**

Item 1 shall read:

'1. GENERAL REQUIREMENTS

Vehicles of categories M, N, O_3 and O_4 which are not equipped with an anti-lock device as defined in Annex X shall meet all the requirements of this Appendix. If a special device is used, this must operate automatically.'

Item 2 shall read (remainder unchanged):

'h = height of centre of gravity specified by the manufacturer and agreed by the Technical Services conducting the approval test

h_R = height above ground of centre of gravity of semi-trailer specified by the manufacturer and agreed by the Technical Services conducting the approval test'.

Item 3.1.1 shall read:

'3.1.1. (2) For all categories of vehicles for k values between 0,2 and 0,8:

$$z \geqslant 0{,}1 + 0{,}85\ (k - 0{,}2)$$

For all states of load of the vehicle, the adhesion utilization curve of the front axle shall be situated above that for the rear axle:

— for all braking rates of between 0,15 and 0,8 in the case of vehicles of category M_1.

However, for vehicles of this category over the range of z values between 0,3 and 0,45, an inversion of the adhesion utilization curves is permitted provided that the adhesion utilization curve of the rear axle does not exceed by more than 0,05 the line defined by the formula k = z (line of ideal adhesion utilization — see diagram 1 A),

— for all braking rates of between 0,15 and 0,5 in the case of vehicles of category N_1 (3).

This condition is also considered satisfied if, for braking rates between 0,15 and 0,30, the adhesion utilization curves for each axle are situated between two parallels to the line of ideal adhesion utilization given by the equations k = z + 0,08 and k = z − 0,08 as shown in diagram 1 C, where the adhesion utilization curve for the rear axle may cross the line k = z — 0,08 and, for braking rates between 0,3 and 0,5, complies with the relation $z \geqslant k - 0{,}08$, and between 0,5 and 0,61 with the relation $z \geqslant 0{,}5\ k + 0{,}21$,

— for all braking rates of between 0,15 and 0,30, in the case of other categories.

This condition is also considered satisfied if, for braking rates between 0,15 and 0,30, the adhesion utilization curves for each axle are situated between two parallels to the line of ideal adhesion utilization given by the equations k = z + 0,08 and k = z − 0,08, as shown in diagram 1 B, and the adhesion utilization curve for the rear axle, for braking rates $z \geqslant 0{,}3$ complies with the relation

$$z \geqslant 0{,}3 + 0{,}74\ (k - 0{,}38).$$

(3) Vehicles of category N_1 with a laden/unladen rear axle loading ratio not exceeding 1,5 or having a maximum mass of less than 2 tonnes will have comply with the requirements for category M_1 vehicles of this item from 1 October 1990.'

Item 3.1.2 shall read:

'3.1.2. In the case of a vehicle authorized to draw trailers of category O_3 or O_4 fitted with compressed air brakes, when tested with the energy source stopped, the supply line blocked off and a reservoir of 0,5-litre capacity connected to the control line, the pressure at full application of the braking control must be between 6,5 and 8 bar at the coupling head of the supply line and between 6 and 7,5 bar at the coupling head of the control line, irrespective of the load condition of the vehicle.'

Item 3.1.3 shall read:

'3.1.3. In order to verifiy the requirement of item 3.1.1, the manufacturer shall provide the adhesion utilization curves for the front and rear axles calculated by the formulae:

$$f_1 = \frac{T_1}{N_1} = \frac{T_1}{P_1 + z\frac{h}{E}P}; \qquad f_2 = \frac{T_2}{N_2} = \frac{T_2}{P_2 - z\frac{h}{E}P}.$$

The graphs shall be plotted for both the following load conditions:

— unladen, in running order with the driver on board.

In the case of a vehicle presented as a bare chassis-cab, a supplementary load may be added to simulate the mass of the body, not exceeding the minimum mass declared by the manufacturer in Annex IX,

— laden.

Where provision is made for several possibilities of load distribution, the one whereby the front axle is the most heavily laden shall be the one to be taken into consideration.'

Item 3.1.4.1 shall read:

'3.1.4.1. In the case of a vehicle fitted with compressed-air brakes, whether it is a trailer or a motor vehicle authorized to draw a trailer, the permissible relationship between the braking rate $\frac{TR}{PR}$ or $\frac{TM}{PM}$ and the pressure p_m shall be within the areas shown in diagram 2.'

Item 3.1.5.1 shall read:

'3.1.5.1. Tractive units with unladen semi-trailer.

An unladen articulated combination is considered to be a tractive unit in running order with the driver on board, coupled to an unladen semi-trailer. The dynamic load of the semi-trailer on the tractive unit shall be represented by a static mass applied at the coupling king-pin equal to 15 % of the maximum mass on the coupling. The braking forces must continue to be regulated between the state of the tractive unit with semi-trailer (unladen) and that of the solo tractive unit; the braking forces relating to the solo tractive unit shall be verified.'

Item 4 shall read:

'4. REQUIREMENT FOR SEMI-TRAILERS

4.1. For semi-trailers fitted with compressed-air braking systems

The permissible relationship between the braking rate $\frac{TR}{PR}$ and the pressure p_m shall lie within two areas derived from diagrams 4 A and 4 B for the laden and unladen states of load. This requirement shall be met for all permissible load conditions of the semi-trailer axles.

4.2. If the requirements of item 4.1 cannot be satisfied in conjunction with the requirements of item 2.2.1.2.1 of Annex II for semi-trailers with a K_c factor less than 0,8 then the semi-trailer must meet the minimum braking performance specified in item 2.2.1.2.1 of Annex II and be fitted with an anti-lock device complying with Annex X, except the compatibility requirement in item 1 of that Annex.'

Item 5 shall read:

'5. REQUIREMENTS FOR FULL AND CENTRE-AXLE TRAILERS

5.1. For full trailers fitted with compressed-air braking systems

5.1.1. The requirements set out in item 3.1 shall apply to twin-axle trailers (except where the axle spread is less than 2 metres).

5.1.2. Full trailers with more than two axles shall be subject to the requirements contained in item 3.2.

5.2. For centre-axle trailers fitted with compressed-air braking systems

5.2.1. The permissible relationship between the braking rate $\frac{TR}{PR}$ and the pressure p_m shall lie within two areas derived from diagram 2, by multiplying the vertical scale by 0,95, for the laden and unladen states of load.

5.2.2. If the requirements of item 2.2.1.2.1 of Annex II cannot be satisfied due to lack of adhesion, then the centre-axle trailer must be fitted with an anti-lock device complying with Annex X.'

Item 8 shall read:

'8. PRESSURE TEST CONNECTIONS

8.1. Braking systems incorporating the devices referred to in item 7.2 shall be fitted with pressure test connections in the pressure line upstream and downstream of the device, at the closest readily accessible positions. The downstream connection shall not be required, if the pressure at that point can be checked at the connection required by item 4.1 of Annex III.

8.2. The pressure test connections shall comply with clause 3 of ISO Standard 3583/1982.'

DIAGRAM 1 A: The title shall read:

'**Vehicles of category M_1, and certain vehicles of category N_1 from 1 October 1990 (see item 3.1.1).**'

DIAGRAM 1 B: The title shall read:

'**Vehicles other than vehicles of category M_1 and N_1**'

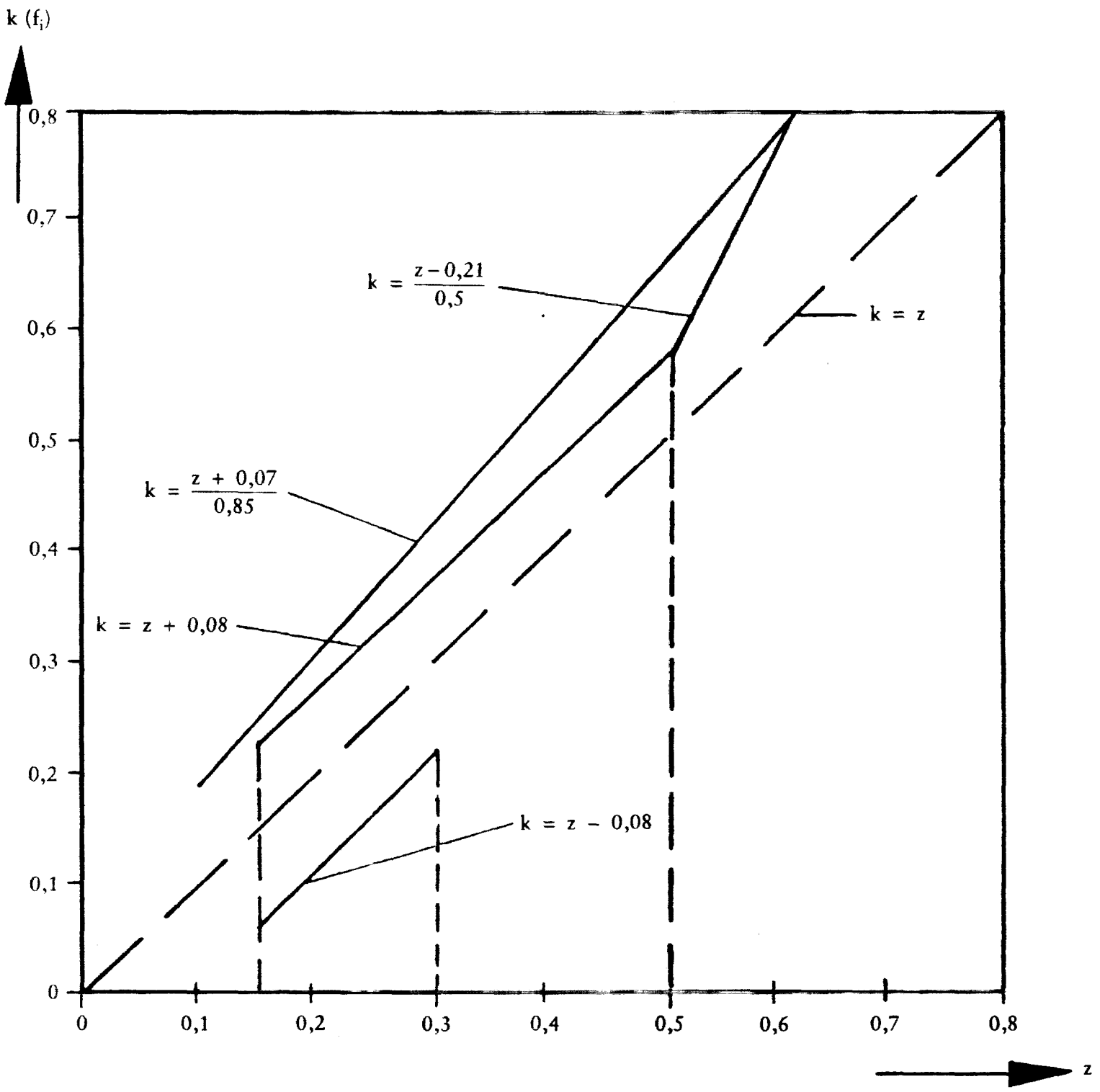
DIAGRAM 1 B: Add the following Note:

'*Note:* The lower limit of the corridor is not applicable for the adhesion utilization of the rear axle.'

DIAGRAM 1 C: Add the following new diagram:

'DIAGRAM 1 C

Vehicles of category N_1 (with certain exceptions from 1 October 1990) (see item 3.1.1)



Note: The lower limit of the corridor is not applicable for the adhesion utilization of the rear axle.'

DIAGRAM 2: Add a new Note (2) corresponding to Note (2) to Diagram 3 and number the existing Note as (1).

ANNEX III: METHOD OF MEASURING THE REACTION TIME FOR VEHICLES FITTED WITH COMPRESSED-AIR BRAKING DEVICES

Item 1.1 shall read:

'1.1. The reaction time for the braking device shall be determined with the vehicle stationary, the pressure being measured at the opening of the least favourable brake cylinder. In the case of vehicles fitted with combined compressed-air/hydraulic braking systems, the pressure may be measured at the opening of the least favourable pneumatic unit.'

Item 4.1 shall read:

'4.1. On each independant circuit of the braking system a pressure test connection shall be fitted at the closest readily accessible position to the brake cylinder which is the least favourably placed as far as reaction time is concerned.'

Item 4.2 shall read:

'4.2. The pressure test connections shall comply with clause 3 of ISO Standard 3583/1982.'

ANNEX IV: ENERGY RESERVOIRS AND SOURCES OF ENERGY

After the amended Annex IV title (above) add the following:

'A. *COMPRESSED-AIR BRAKING SYSTEMS*'

Item 1.3.2.3 shall read:

'1.3.2.3. The reservoir shall not be replenished during the test.'

After item 2.5.1 the following new items 2.6 and 2.6.1 shall be added:

'2.6. **Drawing vehicles**

2.6.1. Vehicles to which the coupling of a category O vehicle is authorized shall also comply with the above requirements for vehicles not so authorized. In that case, the tests in items 2.4.1, 2.4.2 (and 2.5.1) will be conducted without the reservoir mentioned in item 2.3.3 of this Annex.'

Item 3.1 shall read:

'3.1. A pressure test connection must be fitted at the closest readily accessible position to the least favourably placed reservoir within the meaning of item 2.4 of this Annex.'

Item 3.2 shall read:

'3.2. The pressure test connections must comply with clause 3 of ISO Standard 3583/1982.'

After item 3.2 the following new sections B and C shall be added:

'B. *VACUUM BRAKING SYSTEMS*

1. CAPACITY OF RESERVOIRS

1.1. **General**

1.1.1. Vehicles on which operation of the braking device requires the use of a vacuum shall be equipped with reservoirs of a capacity meeting the requirements of items 1.2 and 1.3 below.

1.1.2. However, the reservoirs shall not be required to be of a prescribed capacity if the braking system is such that in the absence of any energy reserve it is possible to achieve a braking performance at least equal to that prescribed for the secondary braking system.

1.1.3. In verifying compliance with the requirements of items 1.2 and 1.3 below, the brakes shall be adjusted as closely as possible.

1.2. **Motor vehicles**

1.2.1. The reservoirs of motor vehicles shall be such that it is still possible to achieve the performance prescribed for the secondary brake:

1.2.1.1. after eight full-stroke actuations of the service-brake control where the energy source is a vacuum pump; and

1.2.1.2. after four full-stroke actuations of the service-brake control where the energy source is the engine.

1.2.2. Testing shall be performed in conformity with the following requirements:

1.2.2.1. the initial energy level in the reservoir(s) shall be that specified by the manufacturer. It shall be such as to enable the prescribed service-braking performance to be achieved and shall correspond to a vacuum not exceeding 90 % of the maximum vacuum furnished by the energy source (1);

1.2.2.2. the reservoir(s) shall not be fed. During the test the auxiliary-service reservoir(s) shall be isolated;

1.2.2.3. on a motor vehicle to which the coupling of a trailer is authorized, the supply line shall be stopped and a reservoir of 0,5-litre capacity shall be connected to the control line. After the test referred to in item 1.2.1, the vacuum level provided at the control line shall not have fallen below a level equivalent to one-half of the figure obtained at the first brake application.

1.3. **Trailers (category O_1 and O_2 only)**

1.3.1. The reservoir(s) with which trailers are equipped shall be such that the vacuum level provided at the user points shall not have fallen below a level equivalent to one-half of the value obtained at the first brake application after a test comprising four full-stroke actuations of the trailer's service brake.

1.3.2. Testing shall be performed in conformity with the following requirements:

1.3.2.1. The initial energy level in the reservoir(s) shall be that specified by the manufacturer. It shall be such as to enable the prescribed service braking performance to be achieved (1).

1.3.2.2. The reservoir(s) shall not be fed. During the test the auxiliary service reservoir(s) shall be isolated.

2. CAPACITY OF ENERGY SOURCES

2.1. **General**

2.1.1. Starting from the ambient atmospheric pressure, the energy source shall be capable of achieving in the reservoir(s) in three minutes, the initial level specified in item 1.2.2.1. In the case of a motor vehicle to which the coupling of a trailer is authorized the time taken to achieve that level in the conditions specified in item 2.2 below shall not exceed six minutes.

2.2. **Conditions of measurement**

2.2.1. The speed of the vacuum source shall be:

2.2.1.1. where the vacuum source is the vehicle engine, the engine speed obtained with the vehicle stationary, the neutral gear engaged and the engine idling;

2.2.1.2. where the vacuum source is a pump, the speed obtained with the engine running at 65 % of the speed corresponding to its maximum power output; and

2.2.1.3. where the vacuum source is a pump and the engine is equipped with a governor, the speed obtained with the engine running at 65 % of the maximum speed allowed by the governor.

2.2.2. Where it is intended to couple to the motor vehicle a trailer whose service braking system is vacuum-operated, the trailer shall be represented by an energy storage device having a capacity V in litres determined by the formula $V = 15\ R$, where R is the maximum permissible mass, in tonnes, on the axles of the trailer.

(1) The initial energy level shall be stated in the approval document.

C. HYDRAULIC BRAKING SYSTEMS WITH STORED ENERGY

1. CAPACITY OF STORAGE DEVICES (ENERGY ACCUMULATORS)

1.1. **General**

1.1.1. Vehicles on which the braking device requires the use of stored energy provided by hydraulic fluid under pressure shall be equipped with energy storage devices (energy accumulators) of a capacity meeting the requirements of item 1.2 below.

1.1.2. However, the energy storage devices shall not be required to be of a prescribed capacity if the braking system is such that in the absence of any energy reserve it is possible with the service brake control to achieve a braking performance at least equal to that prescribed for the secondary braking system.

1.1.3. In verifying compliance with the requirements of items 1.2.1, 1.2.2 and 2.1 below, the brakes shall be adjusted as closely as possible and, for item 1.2.1, the rate of full-stroke actuations must be such as to provide an interval of at least one minute between each actuation.

1.2. **Motor vehicles**

1.2.1. Motor vehicles equipped with a hydraulic braking system with stored energy shall meet the following requirements:

1.2.1.1. after eight full-stroke acutations of the service braking control, it shall still be possible to achieve, on the ninth application, the performance prescribed for the secondary braking system.

1.2.1.2. Testing shall be performed in conformity with the following requirements:

1.2.1.2.1. testing shall commence at a pressure that may be specified by the manufacturer but is not higher than the cut-in pressure;

1.2.1.2.2. the accumulator(s) shall not be fed; in addition, the auxiliary equipment and its accumulators, if any, shall be isolated.

1.2.2. Motor vehicles equipped with a hydraulic braking system with stored energy which cannot meet the requirements of item 2.2.1.5.1 of Annex I shall be deemed to satisfy that item if the following requirements are met:

1.2.2.1. After any single transmission failure it shall still be possible after eight full-stroke actuations of the service braking control, to achieve, at the ninth application, at least the performance prescribed for the secondary braking system or, where secondary performance requiring the use of stored energy is achieved by a separate control, it shall still be possible after eight full-stroke actuations to achieve, at the ninth application, the residual performance prescribed in item 2.2.1.4 of Annex I.

1.2.2.2. Testing shall be performed in conformity with the following requirements:

1.2.2.2.1. with the energy source stationary or operating at a speed corresponding to the engine idling speed, any transmission failure may be induced. Before inducing such a failure the energy storage device(s) shall be at a pressure that may be specified by the manufacturer but not exceeding the cut-in pressure;

1.2.2.2.2. the auxiliary equipment and its accumulators, if any, shall be isolated.

2. CAPACITY OF HYDRAULIC FLUID ENERGY SOURCES

2.1. **The energy sources shall meet the requirements set out in the following paragraphs:**

2.1.1. *Definitions*

2.1.1.1. "p_1" represents the maximum system operational pressure (cut-out pressure) in the accumulator(s) specified by the manufacturer.

2.1.1.2. "p_2" represents the pressure after four full-stroke actuations with the service brake control, starting at p_1, without having fed the accumulator(s).

2.1.1.3 "t" represents the time required for the pressure to rise from p_2 to p_1 in the accumulator(s) without application of the brake control.

2.1.2. *Conditions of measurement*

2.1.2.1. During the test to determine the time t, the feed rate of the energy source shall be that obtained when the engine is running at the speed corresponding to its maximum power or at the speed allowed by the over-speed governor.

2.1.2.2. During the test to determine the time t, accumulator(s) for auxiliary equipment shall not be isolated other than automatically.

2.1.3. *Interpretation of results*

2.1.3.1. In the case of all vehicles except those of categories M_3, N_2 and N_3, the time t shall not exceed 20 seconds.

2.1.3.2. In the case of vehicles of categories M_3, N_2 and N_3, the time t shall not exceed 30 seconds.

3. CHARACTERISTICS OF ALARM DEVICES

With the engine stationary and commencing at a pressure that may be specified by the manufacturer but does not exceed the cut-in pressure, the alarm device shall not operate following two full-stroke actuations of the service brake control.'

ANNEX V: **SPRING BRAKES**

Item 1 shall read:

'1. DEFINITIONS

1.1. "Spring brakes" are braking devices for which the energy required for braking is supplied by one or more springs acting as an energy accumulator.

1.2. "Spring compression chamber" means the chamber where the pressure variation that induces the compression of the spring is actually produced.

1.3. If the compression of the springs is obtained by means of a vacuum device, "pressure" shall mean negative pressure everywhere in this Annex.'

Item 2.1 shall read:

'2.1. A spring brake shall not be used as a service brake. However, in the event of a failure in a part of the transmission of the service brake, a spring brake may be used to achieve the residual performance prescribed in item 2.2.1.4 of Annex I, provided that the driver can graduate this action. In the case of motor vehicles, with the exception of drawing vehicles for semi-trailers meeting the requirements specified in item 2.2.1.4.3 of Annex I, the spring brake shall not be the sole source of residual braking.

Vacuum spring brakes shall not be used for trailers.'

Item 2.2 shall read:

'2.2. A small variation in any of the pressure limits which may occur in the spring compression chamber feed circuit must not cause a significant variation in the braking force.'

Item 2.3 shall read:

'2.3. The feed circuit to the spring compression chamber must either include an own energy reserve or must be fed from at least two independent energy reserves. The trailer supply line may be branched from this feed line under the condition that a pressure drop in the trailer supply line must not be able to apply the spring brake actuators. Auxiliary equipment may only draw its energy from the feed line for the spring brake actuators under the condition that its operation, even in the event of damage to the energy source, cannot cause the energy reserve for the spring brake actuators to fall below a level from which one release of the spring brake actuators is possible.

This item does not apply to trailers.'

Item 2.5 shall read:

'2.5. In the case of motor vehicles, the pressure in the spring compression chamber beyond which the springs begin to actuate the brakes, the latter being adjusted as closely as possible, must not be greater than 80 % of the minimum level of the normal available pressure. In the case of trailers, the

pressure in the spring compression chamber beyond which the springs begin to actuate the brakes must not be greater than that obtained after four full-stroke actuations of the service brake in accordance with Annex IV, item 1.3. The initial pressure is fixed at 6,5 bar.'

Item 2.6 shall read:

'2.6. When the pressure in the line feeding energy to the spring compression chamber — excluding lines of an auxiliary release device using a fluid under pressure — falls to the level at which the brake parts begin to move, an optical or audible warning device must be actuated. Provided this requirement is met, the warning device may be that specified in item 2.2.1.13 of Annex I. This provision does not apply to trailers.'

Item 3.1 shall read:

'3.1. A spring braking system must be so designed that, in the event of a failure in that system, it is still possible to release the brakes. This may be achieved by the use of an auxiliary release device (pneumatic, mechanical, etc.). Auxiliary release devices using an energy reserve for releasing, must draw their energy from an energy reserve which is independent from the energy reserve normally used for the spring braking system.

The pneumatic or hydraulic fluid in such an auxiliary release device may act on the same piston surface in the spring compression chamber, which is used for the normal spring braking system, under the condition that the auxiliary release device uses a separate line. The junction of this line with the normal line connecting the control device with the spring brake actuators, shall be at each spring brake actuator immediately before the port to the spring compression chamber, if not integrated in the body of the actuator. This junction shall include a device which prevents an influence of one line on the other. The requirements of item 2.2.1.6 of Annex I also apply to this device.'

ANNEX VII: **CASES IN WHICH TYPE I AND/OR II (OR IIA) TESTS DO NOT HAVE TO BE CARRIED OUT ON A VEHICLE SUBMITTED FOR TYPE APPROVAL**

Item 1 shall read:

'1. Type I and/or II (or IIA) tests do not have to be carried out on a vehicle submitted for type approval in the following cases:'.

After item 1.3.2 the following new item 1.4 shall be added:

'1.4. The vehicle concerned is a trailer equipped with S-cam air operated brakes (1) which satisfies the verification requirements of Appendix 1 to this Annex relating to a report of a reference axle test as shown in Appendix 2 to this Annex.

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(1) Other brake designs may be approved upon presentation of equivalent information.'

After item 3.3 the following new item 3.4 shall be added:

'3.4. Where item 1.4 is applicable, the table in item 14.7.4 of the model of the communication in Annex IX must be completed.'

After item 4 the following new Appendices 1 and 2 shall be added:

'Appendix 1

ALTERNATIVE PROCEDURES FOR TYPE I AND TYPE II TESTS FOR TRAILER BRAKES

1. GENERAL

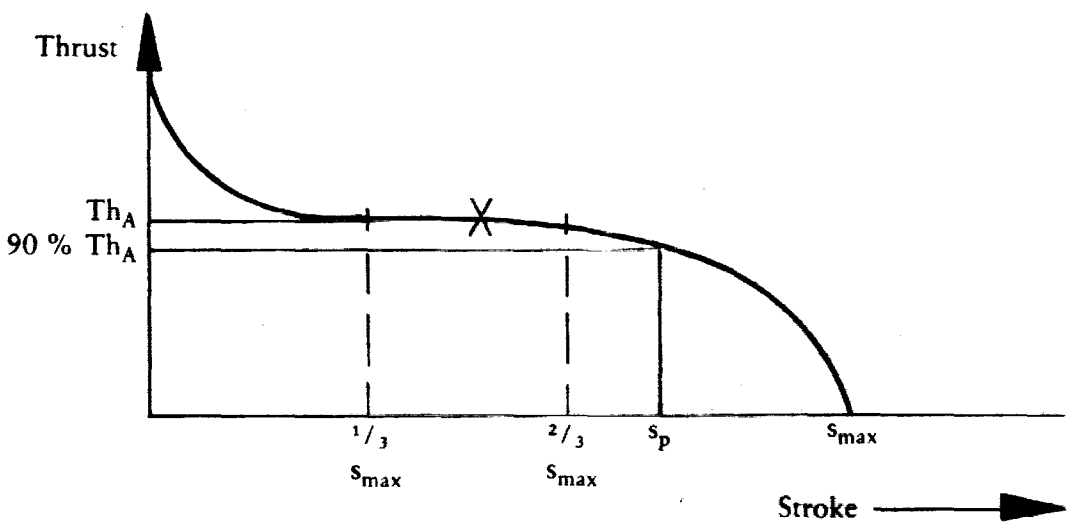
1.1. In accordance with item 1.4 of this Annex, the Type I and II fade tests may be waived at the time of type approval of the vehicle provided that the braking system components comply with the

requirements of this Appendix and that the resulting predicted brake performance meets the prescriptions of this Directive for the appropriate vehicle category.

1.2. Tests carried out in accordance with the methods detailed in this Appendix shall be deemed to meet the above requirements.

2. SYMBOLS AND DEFINITIONS (The reference brake symbols shall have the suffix "e")

P = normal reaction of road surface on the axle under static conditions
C = camshaft input torque
C_{max} = maximum technically permissible camshaft input torque
C_0 = threshold camshaft input torque, i.e. minimum camshaft torque necessary to produce a measurable brake torque
R = tyre rolling radius (dynamic)
T = brake force at tyre/road interface
M = brake torque = $T \cdot R$
z = braking rate $\frac{T}{P} = \frac{M}{RP}$
s = actuator stroke (working stroke plus free stroke)
S_p = effective stroke — the stroke at which the output thrust is 90 % of the average thrust (Th_A)
Th_A = average thrust — the average thrust is determined by integrating the values between one-third and two-thirds of the total stroke (s_{max})



l = lever length
r = radius of brake drum
p = brake actuation pressure

3. TEST METHODS

3.1. Track tests

3.1.1. The brake performance tests should preferably be carried out on a single axle only.

3.1.2. The results of tests on a combination of axles may be used in accordance with item 1.1 provided that each axle contributes equal braking energy input during the drag and residual brake tests.

3.1.2.1. This is ensured if the following are identical for each axle: brake geometry (Figure 2), lining, wheel mounting, tyres, actuation and pressure distribution in the actuators.

3.1.2.2. The result recorded for a combination of axles will be the average value for these axles.

3.1.3. The axle(s) should preferably be loaded with the maximum static axle mass, though this is not essential provided that due allowance is made during the tests for the difference in rolling resistance caused by a different mass on the test axle(s).

3.1.4. Allowance shall be made for the effect of the increased rolling resistance resulting from a combination of vehicles being used to carry out the tests.

3.1.5. The initial speed of the test shall be prescribed. The final speed shall be calculated by the following formula:

$$v_2 = v_1 \sqrt{\frac{P_0 + P_1}{P_0 + P_1 + P_2}}$$

where:

v_1 = initial speed (km/h)

v_2 = final speed (km/h)

P_o = mass of the drawing vehicle (kg) under test conditions

P_1 = mass of the trailer borne by the non-braked axle(s) (kg)

P_2 = mass of the trailer borne by the braked axle (kg)

3.2. **Inertia dynamometer tests**

3.2.1. The test machine shall have a rotary inertia simulating that part of the linear inertia of the vehicle mass acting upon one wheel, necessary for the cold performance and residual performance tests, and capable of being operated at constant speed for the purpose of the test described in items 3.5.2 and 3.5.3 below.

3.2.2. The test shall be carried out with a complete wheel, including the tyre, mounted on the moving part of the brake, as it would be on the vehicle. The inertia mass may be connected to the brake either directly or via the tyres and wheels.

3.2.3. Air cooling at a velocity and air flow direction simulating actual conditions may be used during the heating runs, the speed of air flow being not greater than 10 km/h. The temperature of the cooling air shall be the ambient temperature.

3.2.4. Where the tyre rolling resistance is not automatically compensated for in the test, the torque applied to the brake shall be modified by subtracting a torque equivalent to a rolling resistance coefficient of 0,01.

3.3. **Rolling road dynamometer tests**

3.3.1. The axle should preferably be loaded with the maximum static axle mass, though this is not essential provided that due allowance is made during the tests for the difference in rolling resistance caused by a different mass on the test axle.

3.3.2. Air cooling at a velocity and air flow direction simulating actual conditions, may be used during the heating runs, the speed of air flow being not greater than 10 km/h. The temperature of the cooling air shall be the ambient temperature.

3.3.3. The braking time shall have a duration of 1 s after a maximum build-up time of 0,6 s.

3.4. **Test conditions**

3.4.1. The test brake(s) shall be instrumented so that the following measurements can be taken:

3.4.1.1. a continuous recording to enable the brake torque or force at the periphery of the tyre to be determined;

3.4.1.2. a continuous recording of air pressure in the brake actuator;

3.4.1.3. speed during the test;

3.4.1.4. initial temperature on the outside of the brake drum;

3.4.1.5. brake actuator stroke used during the Type O test and Type I and II residual brake stops.

3.5. **Test procedures**

3.5.1. *Supplementary cold performance test*

3.5.1.1. This test is carried out at an initial speed equivalent to 40 km/h in order to evaluate the residual braking performance at the end of the Type I and Type II tests.

3.5.1.2. Three brake applications are made at the same pressure (p) and at an initial speed equivalent to 40 km/h, with an approximately equal initial brake temperature not exceeding 100 °C, measured at the outside surface of the drum. The applications shall be at the brake actuator pressure required to give a brake torque or force equivalent to a braking rate (z) of at least 0,50. The brake actuator pressure shall not exceed 6,5 bar, and the camshaft input torque (C) shall not exceed the maximum technically permissible camshaft input torque (C_{max}). The average of the three results shall be taken as the cold performance.

3.5.2. *Type I test*

3.5.2.1. This test is carried out at a speed equivalent to 40 km/h with an initial brake temperature not exceeding 100 °C, measured at the outside surface of the drum.

3.5.2.2. A braking rate is maintained at 0,07 including the rolling resistance (see item 3.2.4).

3.5.2.3. The duration of the test is 2 minutes and 33 seconds or 1,7 km at 40 km/h. If the test velocity cannot be achieved then the duration of the test can be lengthened according to item 1.3.2.2 of Annex II.

3.5.2.4. Not later than 60 seconds after the end of the Type I fade test, a residual performance test is carried out in accordance with item 1.3.3 of Annex II at an initial speed equivalent to 40 km/h. The brake actuator pressure shall be that used during the cold performance test.

3.5.3. *Type II test*

3.5.3.1. This test is carried out at a speed equivalent to 30 km/h with an initial brake temperature not exceeding 100 °C, measured at the outside surface of the drum.

3.5.3.2. A braking rate is maintained at 0,06 including the rolling resistance (see item 3.2.4).

3.5.3.3. The duration of the test is 12 minutes or 6 km at 30 km/h.

3.5.3.4. Not later than 60 seconds after the end of the Type II fade test, a residual performance test is carried out in accordance with item 1.4.3 of Annex II at an initial speed equivalent to 40 km/h. The brake actuator pressure used shall be that used during the cold performance test.

3.6. **Test report**

3.6.1. The result of tests carried out in accordance with item 3.5 shall be reported on a form, a model of which is shown in Appendix 2 to this Annex.

3.6.2. The brake and the axle shall be identified. Particulars of the brakes, the axle, the technically permissible mass and the number of the corresponding test report shall be marked on the axle.

4. VERIFICATION

4.1. **Verification of components**

The brake specification of the vehicle to be type approved shall be verified by satisfying each of the following design criteria:

	Item	Criteria
4.1.1.	(a) Brake drum cylindrical section	**No change allowed**
	(b) Brake drum material	**No change allowed**
	(c) Brake drum mass	**May change between** − 0 and + 20 % of the **reference drum mass**
4.1.2.	(a) Proximity of wheel to outside surface of brake drum (dimension E)	**Tolerances to be determined by the technical service conducting the approval tests**
	(b) Part of brake drum not covered by wheel (dimension F)	
4.1.3.	(a) Brake lining material	**No change allowed**
	(b) Brake lining width	
	(c) Brake lining thickness	
	(d) Brake lining actual surface	
	(e) Brake lining method of attachment	
4.1.4.	Brake geometry (figure 2)	**No change allowed**
4.1.5.	Tyre rolling radius (R)	**May change subject** to the requirements of **item** 4.3.5 of this Appendix
4.1.6.	(a) Average thrust (Th_A)	**May change provided that the predicted performance meets the requirements of item 4.3 of this Appendix**
	(b) Actuator stroke (s)	
	(c) Lever length	
	(d) Brake actuation pressure (p)	
4.1.7.	Static mass (P)	**P shall not exceed** P_e

4.2. **Verification of brake forces developed**

4.2.1. The brake forces (T) for each subject brake (for the same control line pressure p_m) necessary to produce the drag force specified for both Type I and Type II test conditions are determined by the method described in item 4.2.3.

4.2.2. For each axle, T shall not exceed $X \cdot P_e$.

4.2.3. $$T_1 = X \cdot PR_{max} \frac{V_1}{V_1 + V_2 + V_3}$$

where:

X = 0,07 for the Type I and 0,06 for the Type II tests,

V = the value of any component that varies the camshaft input torque at each axle for a given control line pressure (p_m) or the value of the actuator pressure at each axle (p) where it is not common for a given control line pressure (p_m).

Example:

Three-axled trailer having a PR_{max} of 200 000 N where all components are identical except the brake lever lengths which are:

axle 1 = 152, axle 2 = 127, axle 3 = 127

$$\text{then (for Type I) } T_1 = 0{,}07 \cdot 200\,000 \cdot \frac{152}{152 + 127 + 127}$$

$$= 14\,000 \cdot 0{,}374 = 5\,236 \text{ N}$$

$$\text{similary } T_2 \text{ and } T_3 = 0{,}07 \cdot 200\,000 \cdot \frac{127}{152 + 127 + 127}$$

$$= 14\,000 \cdot 0{,}313 = 4\,382 \text{ N}$$

4.3. **Verification of residual performance**

4.3.1. The brake force (T) for each subject brake for a specified pressure (p) in the actuators and control line pressure (p_m) used during the Type O test of the subject trailer is determined by the methods described in items 4.3.2 to 4.3.5.

4.3.2. The predicted actuator stroke (s) of the subject brake is **determined from** the following relationship

$$s = l \cdot \frac{s_e}{l_e}$$

s shall not exceed the effective stroke (s_p)

4.3.3. The average thrust output (Th_A) of the actuator fitted to the subject brake at the pressure specified in item 4.3.1. is determined.

4.3.3. The camshaft input torque (C) is then given by

$$C = Th_A \cdot l.$$

C shall not exceed C_{max}.

4.3.5. The predicted brake performance for the subject brake is given by:

$$T = T_e \cdot \frac{(C - C_0)}{(C_e - C_{0_e})} \cdot \frac{R_e}{R}$$

R shall not be less than 0,8 R_e.

4.3.6. The predicted brake performance for the subject trailer is given by:

$$\frac{TR}{PR} = \frac{\Sigma T}{\Sigma P}$$

4.3.7. The residual performances following the Type I and II tests shall **be determined** in accordance with items 4.3.2, 4.3.3, 4.3.4 and 4.3.5. The resulting predictions given by item 4.3.6 must satisfy the requirements of this Directive for the subject trailer. The value used for "the figure recorded in the Type O test", as prescribed in Annex II, item 1.3.3, shall be the figure recorded in the Type O test of the subject trailer.

Appendix 2

MODEL REFERENCE AXLE TEST REPORT FORM AS PRESCRIBED IN APPENDIX 1, ITEM 3.6

TEST REPORT No

1. IDENTIFICATION

1.1. **Axle**

Manufacturer (name and address)
Make
Type
Model
Technically permissible mass (P_e) (kg)

1.2. **Brake**

Manufacturer (name and address)
Make
Type
Model
Technically permissible camshaft input torque C_{max}
Brake drum: Internal diameter
Mass
Material (attach dimensioned drawing as in Figure 1)
Brake lining: Manufacturer
Type
Identification (must be visible when the lining is mounted on the brake shoe)
Width
Thickness
Surface area
Method of attachment

Brake geometry (attach dimensioned drawing as in Figure 2)

1.3. **Wheel(s)**

Single/twin (1)
Rim diameter (D)
(attach dimensioned drawing as in Figure 1)

1.4. **Tyres**

Rolling radius (R) at reference mass (P_e)

1.5. **Actuation**

Manufacturer
Type (cylinder/diaphragm) (1)
Model
Lever length (l)

2. RECORD OF TEST RESULTS (Corrected to take account of rolling resistance)

Test type	Units	O	I	II
Brake force developed (T_e)	N		—	—
Brake efficiency $\left(\frac{T_e}{P_e}\right)$			—	—
Brake actuator pressure (P_e) (performance test)	bar		—	—
Test speed (performance test)	km/h		—	—
Test speed (heating run)	km/h	—	40	30
Braking time (heating run)	min	—	2,55	12
Residual brake force developed (T_e)	N	—		
Residual brake efficiency $\left(\frac{T_e}{P_e}\right)$		—		
Actuator stroks (s_e)	mm			
Camshaft input torque (C_e)	Nm			
Threshold camshaft input torque (C_{0_e})	Nm			

(1) Delete where not applicable.

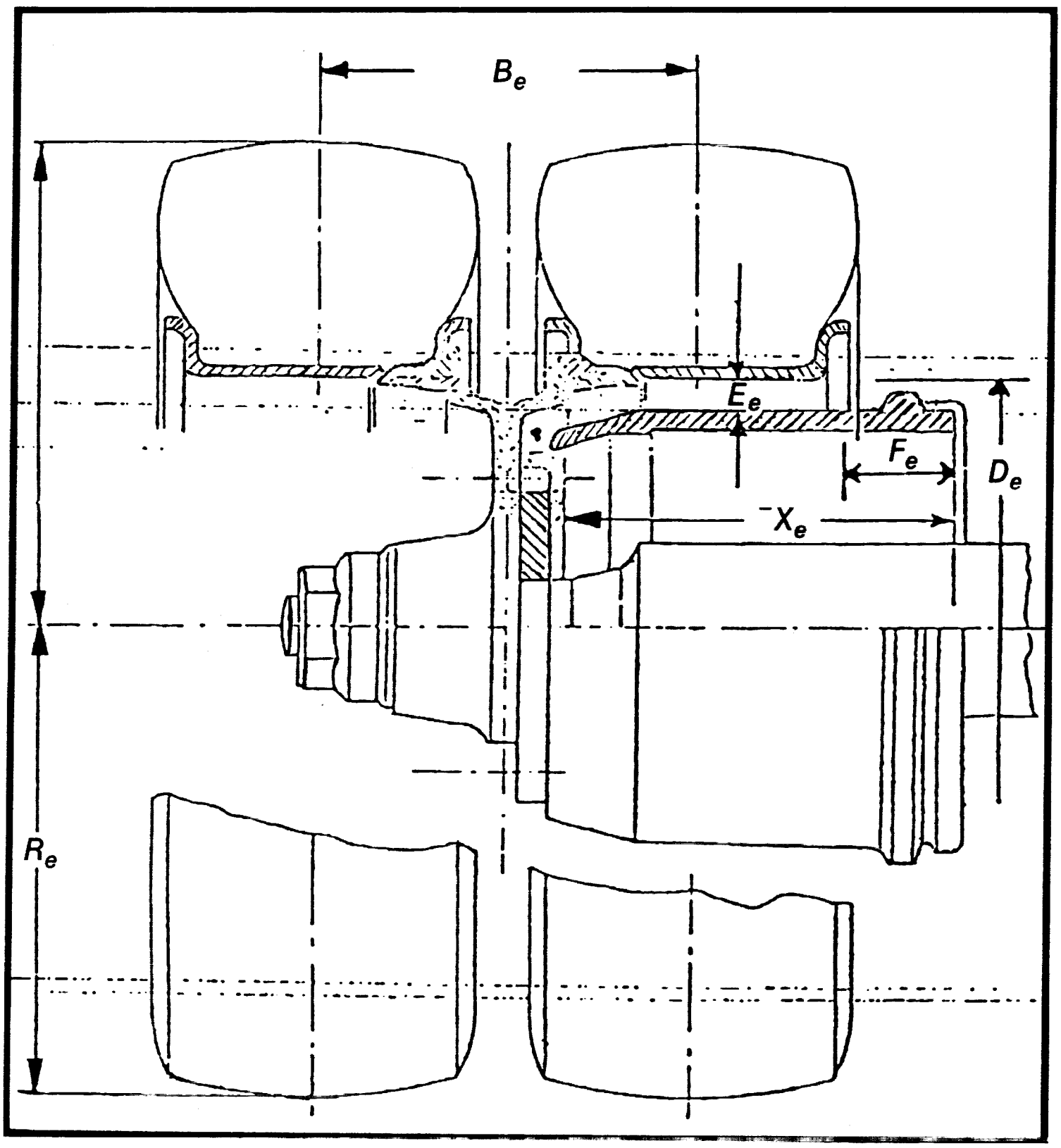
3. Name of technical service conducting the test:

4. Date of test:

5. This test has been carried out and the result reported in accordance with Directive 71/320/EEC, as amended, and Annex VII, Appendix 1.

Signed Date

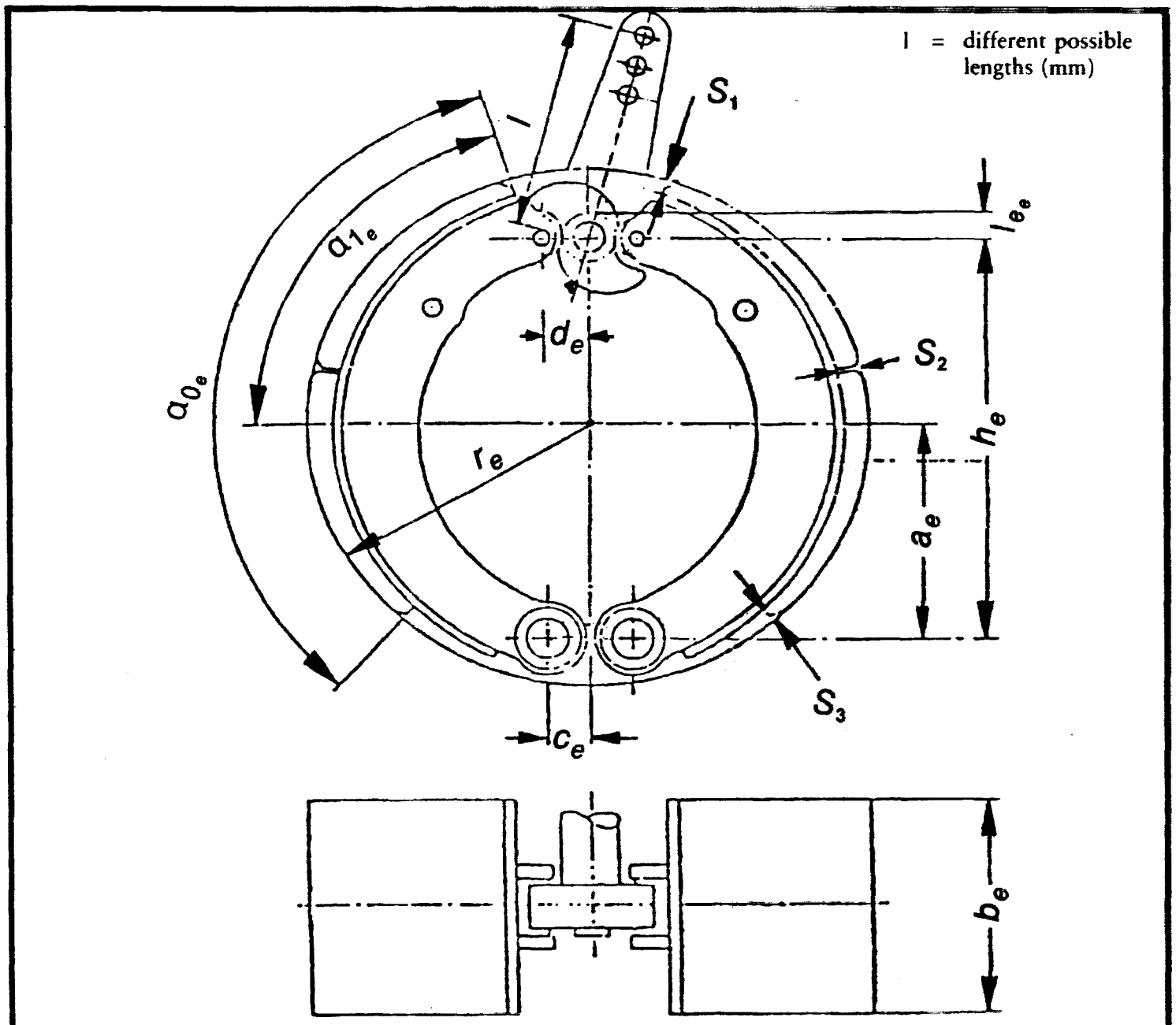
Figure 1



Drum width X_e	Axle load (kg)	Tyre	Rim	B_e	R_e	D_e	E_e	F_e
				← mm →				

Figure 2

BRAKE GEOMETRY



All dimensions except α_0 , α_1 and F in mm. F = braking surface per brake (cm^2).

Type of brake	a_e	h_e	c_e	d_e	e_e	α_{0_e}	α_{1_e}	b_e	r_e	F_e	S_{1_e}	S_{2_e}	S_{3_e}'

ANNEX VIII: CONDITIONS GOVERNING THE TESTING OF VEHICLES EQUIPPED WITH INERTIA (OVERRUN) BRAKES

The former items 3.3 and 3.3.1 shall be deleted.

Item 3.3.2 shall be renumbered 3.3 and amended to read:

'3.3 Inertia braking devices must be arranged in such a way that, in the case where the coupling head travels to its fullest extent, no part of the transmission becomes jammed, or suffers any permanent distortion or fails. This must be checked after uncoupling the first element of the transmission from the brake control levers.'

After item 3.3 the following new item 3.4 shall be added:

'3.4. The inertia braking device must allow the trailer to be reversed with the towing vehicle without imposing a sustained drag force exceeding 8 % of the force corresponding to the maximum mass of the trailer. Devices used for this purpose must act automatically and disengage automatically when the trailer moves forward.'

After item 3.4 the following new item 3.5 shall be added:

'3.5. Any special device incorporated for the purposes of item 3.4 shall be such that the parking performance when facing up a gradient shall not be adversely affected.'

The former item 4.3 shall be deleted and the subsequent items 4.4, 4.5 and 4.6 shall be renumbered 4.3, 4.4 and 4.5.

Item 4.4 (new numbering) shall read:

'4.4 The maximum depression force of D_1 may not exceed 0,10 G'_A in the case of single-axle trailers and 0,067 G'_A in the case of multi-axle trailers.'

The former items 5.5, 6.3, 9.2.4, 9.2.4.1 and 9.2.4.2 shall be deleted and the former item 5.6 shall be renumbered 5.5.

Item 6.2 shall read:

'6.2. The force P or the pressure p required to achieve the braking torque M_{max} indicated by the manufacturer must be at least 1,8 times the force P or at least 1,8 times the pressure p required to give a braking force of 0,50 G_{BO}.'

Item 7.2.3 (second sentence shall read:

'. . .

The speed at which the braking surfaces rotate must correspond to an initial vehicle speed of 60 km/h. The following shall be deducted from the curve obtained from these measurements:'.

Item 9.3.1 shall read:

'9.3.1. The sum of the braking forces exerted on the circumference of the trailer wheels must be at least $B^* = 0,5\ G_A$, including a rolling resistance of 0,01 G_A.

This represents a braking force of $B = 0,49\ G_A$.

In this case, the maximum permitted thrust on the coupling shall be:

$D^* = 0,067\ G_A$ in the case of multi-axle trailers,

$D^* = 0,10\ G_A$ in the case of single-axle trailers.

In order to check whether these conditions are observed, the following inequalities must be applied:

Item 9.4.1 shall read:

'9.4.1. In the case of control devices for multi-axle trailers of which the brake rod system is dependent upon the position of the towing device, the travel of the control s must be greater than the available travel of the control s'; the difference in length must be at least equivalent to the loss of travel s_o. The travel s_o must not exceed 10 % of the effective travel s'.'

Appendix 2

The former items 9.8, 9.8.1, 9.8.2 and 9.9 shall be deleted.

Appendix 3

The former items 9.6 and 9.6a shall be deleted and the subsequent items 9.7a and 9.8a shall be renumbered 9.6a and 9.7a.

Item 11 shall read:

'11. The above brake does/does not (1) conform to the requirements of items 3 and 6 of the testing conditions for vehicles equipped with inertia brakes.

Signature

Appendix 4

Items 4.8, 4.9 and 4.10 shall read:

'4.8.	Permissible force on the coupling	$D^* = 0{,}10 \quad G_A = \ldots$ da N (1) or $D^* = 0{,}067 \quad G_A = \ldots$ da N (1)
4.9.	Required braking force	$B^* = 0{,}5 \quad G_A = \ldots$ da N
4.10.	Braking force	$B = 0{,}49 \quad G_A = \ldots$ da N'

The former items 5.6, 5.6.1, 5.6.1.1 and 5.6.1.2 shall be deleted, and items 5.7 and 5.8 renumbered 5.6 and 5.7 respectively.

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(1) Editorial correction: 'Safe travel' should read 'Spare travel' in items 2.2.19, 5.4.3 and 9.6 (Appendix 2, English version only).

ANNEX IX: **COMMUNICATION CONCERNING THE TYPE APPROVAL OF A VEHICLE WITH REGARD TO BRAKING**

Item 6 shall read:

'6. Mass of vehicle . . .

6.1. Maximum mass of vehicle . . .

6.2. Minimum mass of vehicle . . .'.

Item 9.4 shall read:

'9.4. If applicable (4), maximum mass of trailer which may be coupled

9.4.1. full trailer

9.4.2. semi-trailer

9.4.3. centre-axle trailer: indicate the maximum ratio of the coupling overhang (5) to the wheelbase

9.4.4. maximum mass of the combination . . .

---

(5) "coupling overhang" is the horizontal distance between the coupling for centre-axle trailers and the centreline of the rear axle(s).'

After item 9.4.1 the following new item 9.5 shall be added:

9.5. vehicle is/is not (4) equipped to tow a trailer with electric service brakes.'

After item 14.7.3 the following new item 14.7.4 shall be added:

'14.7.4.

Reference axle ..... Report No ... Date .....
(copy attached)

	Type I	Type II	
Verification of brake forces developed (see item 4.2, Appendix 1 of Annex VII)			
Axle 1	T_1 = ... % P_e	T_1 = ... % P_e	
Axle 2	T_2 = ... % P_e	T_2 = ... % P_e	
Axle 3	T_3 = ... % P_e	T_3 = ... % P_e	
Predicted actuator stroke (mm) (see item 4.3.2, Appendix 1 of Annex VII)			
Axle 1	s_1 = ...	s_1 = ...	
Axle 2	s_2 = ...	s_2 = ...	
Axle 3	s_3 = ...	s_3 = ...	
Average output thrust (N)			
Axle 1	Th_{A_1} = ...	Th_{A_1} = ...	
Axle 2	Th_{A_2} = ...	Th_{A_2} = ...	
Axle 3	Th_{A_3} = ...	Th_{A_3} = ...	
Braking performance (N) (see item 4.3.5, Appendix 1 of Annex VII)			
Axle 1	T_1 = ...	T_1 = ...	
Axle 2	T_2 = ...	T_2 = ...	
Axle 3	T_3 = ...	T_3 = ...	
Braking performance of vehicle (see item 4.3.6, Appendix 1 of Annex VII)	Type O subject trailer test result (E)	Type I (predicted) residual	Type II (predicted) residual
Residual braking requirements (see items 1.3.3 and 1.4.3 of Annex II)		⩾ 0,36 and ⩾ 0,6 E	⩾ 0,33'

Item 17 (a) shall be renumbered as item 18 (new)

After item 18 (new) the following item 19 (new) shall be added:

'19. Vehicles equipped with anti-lock devices ...

19.1. Does the vehicle fulfil the requirements contained in the Annex X: yes/no (4);

19.2. Category of anti-lock device: category 1/2/3 (2) (4).'

Items 18 to 25 shall be renumbered as items 20 to 27.

After Annex IX the following new Annexes X, XI and XII shall be added:

'ANNEX X: **REQUIREMENTS APPLICABLE TO TESTS FOR VEHICLES EQUIPPED WITH ANTI-LOCK DEVICES**

1. GENERAL

1.1. The purpose of this Annex is to define the required performances for braking systems with anti-lock devices fitted to road vehicles. This Annex does not make it compulsory to fit vehicles with anti-lock devices, but if such devices are fitted to a road vehicle they must meet the requirements of this Annex. In addition, motor vehicles which are authorized to draw a trailer, and trailers equipped with compressed-air braking systems, shall, when the vehicles are laden, meet the requirements for compatibility set out in the Appendix to item 1.1.4.2 of Annex II.

1.2. The devices known at present comprise a sensor or sensors, a controller or controllers and a modulator or modulators. Any devices of a different design which may be introduced in the future will be deemed to be anti-lock devices within the meaning of this Annex and the Appendix to item 1.1.4.2 of Annex II, if they provide performances equal to those prescribed by this Annex.

2. DEFINITIONS

2.1. An "anti-lock device" is a component of a service braking system which automatically controls the degree of slip, in the direction of rotation of the wheel(s), on one or more wheels of the vehicle during braking.

2.2. "Sensor" means a component designed to identify and transmit to the controller the conditions of rotation of the wheel(s) or the dynamic conditions of the vehicle.

2.3. "Controller" means a component designed to evaluate the data transmitted by the sensor(s) and to transmit a signal to the modulator.

2.4. "Modulator" means a component designed to vary the braking force(s) in accordance with the signal received from the controller.

2.5. "Directly controlled wheel" means a wheel whose braking force is modulated according to data provided at least by its own sensor (1).

2.6. "Indirectly controlled wheel" means a wheel whose braking force is modulated according to data provided by the sensor(s) of other wheel(s) (1).

---

(1) Anti-lock devices with select-high control are deemed to include both directly and indirectly controlled wheels; in devices with select-low control, all sensed wheels are deemed to be directly controlled wheels.

3. TYPES OF ANTI-LOCK DEVICE

3.1. A motor vehicle is deemed to be equipped with an antilock device within the meaning of paragraph 1 of the Appendix to item 1.1.4.2 of Annex II, if one of the following devices is fitted:

3.1.1. *Category 1 anti-lock device:*

A vehicle equipped with a category 1 anti-lock device shall meet all the relevant requirements of this Annex.

3.1.2. *Category 2 anti-lock device:*

A vehicle equipped with a category 2 anti-lock device shall meet all the relevant requirements of this Annex, except those of item 5.3.5.

3.1.3. *Category 3 anti-lock device:*

A vehicle equipped with a category 3 anti-lock device shall meet all the relevant requirements of this Annex, except those of items 5.3.4 and 5.3.5. On such vehicles, any individual axle (or bogie) which does not include at least one directly controlled wheel must fulfil the conditions of adhesion utilization and the wheel-locking sequence of the Appendix to item 1.1.4.2 of Annex II, instead of the adhesion utilization requirements prescribed in item 5.2 of this Annex. However, if the relative positions of the adhesion utilization curves do not meet the requirements of item 3.1.1 of the

Appendix to item 1.1.4.2 of Annex II, a check shall be made to ensure that the wheels on at least one of the rear axles do not lock before those on the front axle or axles under the conditions prescribed in items 3.1.1 and 3.1.4 of the Appendix to item 1.1.4.2 of Annex II with regard to the braking rate and the load respectively. These requirements may be checked on high- or low-adhesion road surfaces (about 0,8 and 0,3 maximum) by modulating the service brake control force.

3.2. A towed vehicle is deemed to be equipped with an anti-lock device within the meaning of item 1 of the Appendix to item 1.1.4.2 of Annex II, if it meets all the relevant requirements of this Annex.

4. GENERAL REQUIREMENTS

4.1. Any break in the supply of electricity to the device and/or in the wiring external to the elctronic controller(s) shall be signalled to the driver by a specific optical warning signal. This requirement also applies to the anti-lock device(s) of towed vehicles which are designed to be coupled to towing vehicles of categories other than M_1 and N_1. The warning device for the anti-lock device(s) of the towed vehicle must not give a signal when a towed vehicle without an anti-lock device, or when no towed vehicle, is coupled. This requirement must be met automatically.

The warning signal shall light up when the anti-lock device is energised and go off at the latest when the vehicle reaches a speed of 10 km/h and no defect is present. The tell-tale lamps of the warning devices must be visible even in daylight; it must be easy for the driver to check that they are in working order (1).

4.2. Motor vehicles equipped with anti-lock devices and/or designed to tow a trailer equipped with such devices, with the exception of vehicles of categories M_1 and N_1, shall be fitted with a separate warning device for the anti-lock device(s) of the towed vehicle, meeting the requirements of item 4.1 above, or shall be fitted with an optical warning signal which shall light up not later than any application of the brake to warn the driver if the attached trailer is not equipped with an anti-lock device. This warning signal shall be visible even in daylight and its good working order shall be easily checked by the driver. It shall not convey any signal if no trailer is attached. This function shall be automatic (1).

4.3. Except for vehicles of categories M_1 and N_1, the electrical connections used for the anti-lock devices of towed vehicles shall be effected by a special connector conforming to ISO Standard 7638/1985 (1).

4.4. In the event of failure of the anti-lock device, the residual braking performance must be that prescribed for the vehicle in question in the event of failure of a part of the transmission to the service brake (see item 2.2.1.4 of Annex I). This requirement shall not be construed as a departure from the requirements concerning secondary braking.

4.5. The operation of the device must not be adversely affected by magnetic or electrical fields (2).

---

(1) To ensure compatibility of all vehicles until the special ISO connector is in general use, it shall be considered that the requirements of items 4.1, 4.2 and 4.3 concerning towed vehicles are fulfilled only if the vehicles satisfy the following two conditions:

1. the supply of electricity to the anti-lock device(s) of the towed vehicle is provided:
   (a) firstly, via the ISO 3731 (24S) connector (using pins 2 and 6 for failure warning and power supply, respectively) or via the special anti-lock connector conforming to ISO 7638; and
   (b) secondly, via the ISO 1185 (24N) connector (using pin 4 without exceeding the present limits of the stop lamp circuit); if this is not fulfilled, the requirements of the Appendix to item 1.1.4.2 of Annex II shall be satisfied: for example, by the installation of a brake load sensing device on the towed vehicle;
2. the towed vehicle is equipped with an optical device, within the field of view of the driver's rear view mirror and visible even in daylight, to warn him of any break in the supply of electricity and/or in the wiring external to the electronic controller of the anti-lock device of the towed vehicle.

(2) Until uniform test procedures have been agreed, the manufacturers shall provide the Technical Services with their test procedures and results.

5. SPECIAL PROVISIONS CONCERNING MOTOR VEHICLES

5.1. **Energy consumption**

Braking systems equipped with anti-lock devices must maintain their performance when the service brake is fully applied for long periods. Compliance with this requirement shall be verified by means of the following tests:

5.1.1. *Test procedure*

5.1.1.1. The initial energy level in the energy storage device(s) shall be that specified by the manufacturer. This level shall be at least such as to ensure the efficiency prescribed for service braking when the vehicle is laden. The auxiliary service storage device(s) must be isolated.

5.1.1.2. From an initial speed of not less than 50 km/h, on a surface with a coefficient of adhesion of 0,3 (1) or less, the brakes of the laden vehicle shall be fully applied for a time t, and all the wheels equipped with an anti-lock device must remain under control throughout that time.

5.1.1.3. The vehicle's engine shall then be stopped or the supply to the energy storage device(s) cut off.

5.1.1.4. The service brake control shall then be fully actuated four times in succession with the vehicle stationary.

5.1.1.5. When the brakes are applied for the fifth time, it must be possible to brake the vehicle with at least the performance prescribed for secondary braking of the laden vehicle.

5.1.1.6. During the tests, in the case of a motor vehicle authorized to draw a trailer equipped with a compressed air braking system, the supply line shall be stopped and an energy storage device of 0,5-litre capacity shall be connected to the control line (in accordance with Annex IV, item 1.2.2.3). When the brakes are applied for the fith time, as provided in item 5.1.1.5, the energy level supplied to the control line must not be below half the level obtained at a full application starting with the initial energy level.

5.1.2. *Additional requirements*

5.1.2.1. The coefficient of adhesion of the road surface shall be measured with the vehicle in question, by the method described in item 1.1 of Appendix 1 to this Annex.

5.1.2.2. The braking test shall be conducted with the engine disconnected and idling, and with the vehicle laden.

5.1.2.3. The braking time t shall be determined by the formula: $t = \frac{V_{max}}{7}$ (but not less than 15 seconds) where t is expressed in seconds and V_{max} represents the maximum design speed of the vehicle expressed in km/h, with an upper limit of 160 km/h.

5.1.2.4. If the time t cannot be completed in a single braking phase, further phases may be used, up to a maximum of four in all.

5.1.2.5. If the test is conducted in several phases, no fresh energy shall be supplied between the phases of the test.

5.1.2.6. The performance prescribed in item 5.1.1.5 shall be deemed to be satisfied if, at the end of the fourth application, with the vehicle stationary, the energy level in the storage device(s) is at or above that required for secondary braking with the laden vehicle.

5.2. **Utilization of adhesion**

5.2.1. The utilization of adhesion by the anti-lock device takes into account the actual increase in braking distance beyond the theoretical minimum. The anti-lock device shall be deemed to be satisfactory when the condition $\varepsilon \geqslant 0{,}75$ is satisfied, where ε represents the adhesion utilized, as defined in item 1.2 of Appendix 1 to this Annex. This requirement shall not be construed as requiring a braking performance better than that prescribed in Annex II for the vehicle in question.

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

5.2.2. The adhesion utilization ε shall be measured on road surfaces with a coefficient of adhesion of 0,3 (1) or less, and of about 0,8 (dry road), with an initial speed of 50 km/h.

5.2.3. The test procedure to determine the coefficient of adhesion (K) and the formulae for calculation of the adhesion utilization (ε) shall be those laid down in Appendix 1 to this Annex.

5.2.4. The utilization of adhesion by the anti-lock device shall be checked on complete vehicles equipped with anti-lock devices of categories 1 or 2. In the case of vehicles equipped with category 3 anti-lock devices, only the axle(s) with at least one directly controlled wheel must satisfy this requirement.

5.2.5. The condition $\varepsilon \geqslant 0{,}75$ shall be checked with the vehicle laden and unladen.

5.3. **Additional checks**

The following additional checks shall be carried out with the vehicle laden and unladen.

5.3.1. The wheels directly controlled by an anti-lock device must not lock when the full force (2) is suddenly applied on the control device, on the two kinds of road surface specified in item 5.2.2 above, at low initial speeds V = 40 km/h and at high initial speeds $V \approx 0{,}8\ V_{max} \leqslant 120$ km/h.

5.3.2. When an axle passes from a high-adhesion surface (K_1) to a low-adhesion surface (K_2) where $K_1 \geqslant 0{,}5$ and $K_1/K_2 \geqslant 2$ (3), with the full force (2) applied on the control device, the directly controlled wheels must not lock. The running speed and the instant of applying the brake shall be so calculated that, with the anti-lock device fully cycling on the high-adhesion surface, the passage from one surface to the other is made at high and at low speed, under the conditions laid down in item 5.3.1 above.

5.3.3. When a vehicle passes from a low-adhesion surface (K_2) to a high-adhesion surface (K_1) where $K_1 \geqslant 0{,}5$ and $K_1/K_2 \geqslant 2$, with the full force (2) applied on the control device, the deceleration of the vehicle must rise to the appropriate high value within a reasonable time and the vehicle must not deviate from its initial course. The running speed and the instant of applying the brake shall be so calculated that, with the anti-lock device fully cycling on the low-adhesion surface, the passage from one surface to the other occurs at approximately 50 km/h.

5.3.4. The provisions of this paragraph shall only apply to vehicles equipped with anti-lock devices of categories 1 or 2. When the right and left wheels of the vehicle are situated on surfaces with differing coefficients of adhesion (K_1 and K_2), where $K_1 \geqslant 0{,}5$ and $K_1/K_2 \geqslant 2$, the directly controlled wheels must not lock when the full force (2) is suddenly applied on the control device at a speed of 50 km/h.

5.3.5. Furthermore, laden vehicles equipped with anti-lock devices of category 1 shall, under the conditions of item 5.3.4 above, satisfy the prescribed braking rate in Appendix 2 to this Annex.

5.3.6. However, in the tests provided for in items 5.3.1, 5.3.2, 5.3.3, 5.3.4 and 5.3.5 above, brief periods of wheel-locking shall be allowed. Furthermore, wheel-locking is permitted when the vehicle speed is less than 15 km/h; likewise, locking of indirectly controlled wheels is permitted at any speed, but stability and steerability must not be affected.

5.3.7. During the tests provided for in items 5.3.4 and 5.3.5 above, steering correction is permitted if the angular rotation of the steering control is within 120° during the initial 2 seconds and not more than 240° in all. Furthermore, at the beginning of these tests the longitudinal median plane of the vehicle must pass over the boundary between the high- and low-adhesion surfaces and during these tests no part of the (outer) tyres must cross this boundary.

---

(1) See footnote to item 5.1.1.2.

(2) "Full force" means the maximum force prescribed in Annex II for the category of vehicle; a higher force may be used if required to activate the anti-lock device.

(3) K_1 is the high-adhesion surface coefficient.
K_2 is the low-adhesion surface coefficient.
K_1 and K_2 are measured as laid down in Appendix 1 to this Annex.

6. SPECIAL PROVISIONS CONCERNING TOWED VEHICLES

6.1. **Energy consumption**

Braking systems equipped with anti-lock devices shall be so designed that, even after the service braking control has been fully applied for some time, the vehicle retains sufficient energy to bring it to a halt within a reasonable distance.

6.1.1. Compliance with the above requirement shall be checked by the procedure specified below, with the vehicle unladen, on a straight and level road with a surface having a good coefficient of adhesion (1), and with the brakes adjusted as closely as possible and with the proportioning/load-sensing valve (if fitted) held in the "laden" position throughout the test.

6.1.2. The initial energy level in the energy storage device(s) shall be the maximum specified by the vehicle manufacturer; in the case of a standard assembly as referred to in item 3.1.2 of the Appendix to item 1.1.4.2 of Annex II, the initial energy level shall be equivalent to a pressure of 8 bar at the coupling head of the trailer's supply line.

6.1.3. The brakes shall be fully applied for a time t = 15 seconds, during which all wheels equipped with an antilock device must remain under control. During this test, the supply to the energy storage device(s) shall be cut off.

6.1.4. If the axle or axles equipped with an anti-lock device receive energy from an energy storage device or devices shared with another axle or axles not equipped with an anti-lock device, the supply to the axle or axles not so equipped may be cut off during braking. However, the consumption of energy corresponding to the initial application of the brakes on that axle or axles shall be taken into account.

6.1.5. At the end of the braking, with the vehicle stationary, the service braking control shall be fully actuated four times. During the fifth application, the pressure in the operating circuit must be sufficient to provide a total braking force at the periphery of the wheels equal to not less than 22,5 % of the force corresponding to the maximum mass borne by the wheels when the vehicle is stationary.

6.2. **Utilization of adhesion**

6.2.1. Braking systems equipped with an anti-lock device shall be deemed acceptable when the condition $\varepsilon \geqslant 0{,}75$ is satisfied, where ε represents the adhesion utilized, as defined in item 2 of Appendix 1 to this Annex. This condition shall be verified with the vehicle unladen, on a straight and level road with a surface having a good coefficient of adhesion (1)

6.3. **Additional checks**

6.3.1. At speeds exceeding 15 km/h, the wheels directly controlled by an anti-lock device must not lock when the full force is suddenly applied on the control device. This shall be checked, under the conditions prescribed in item 6.2 above, at a low initial speed V = 40 km/h and at a high initial speed V ≈ 80 km/h.

6.3.2. Brief periods of locking of the wheels shall, however, be allowed, but stability must not be affected.

(1) If the coefficient of adhesion of the test track is too high, preventing the anti-lock device from cycling, then the test may be carried out on a surface with a lower coefficient of adhesion.

Appendix 1

UTILIZATION OF ADHESION

1. METHOD OF MEASUREMENT FOR MOTOR VEHICLES

1.1. **Determination of the coefficient of adhesion (K)**

1.1.1. The coefficient of adhesion (K) shall be determined as the quotient of the maximum braking forces without locking the wheels and the corresponding dynamic load on the axle being braked.

1.1.2. The brakes shall be applied on only one axle of the vehicle under test, at an initial speed of 50 km/h. The braking forces shall be equally distributed between the wheels of the axle. The anti-lock device shall be disconnected.

1.1.3. A number of tests at increments of line pressure shall be carried out to determine the maximum braking rate of the vehicle (z_m).

During each test, a constant input force shall be maintained and the braking rate will be determined by reference to the time taken (t) for the speed to reduce from 40 km/h to 20 km/h using the formula:

$$z = \frac{0{,}56}{t}$$

z_m is the maximum value of z; t is in seconds.

1.1.4. The braking forces shall be calculated from the measured braking rate and the rolling resistance of the unbraked axle(s) which is equal to 0,015 and 0,010 of the static axle load for a driven axle and a non-driven axle, respectively.

1.1.5. The dynamic load on the axle shall be that given by the relations in the Appendix to item 1.1.4.2 of Annex II.

1.1.6. The value of K shall be rounded to the second place of decimals.

1.1.7. Example: in the case of a two-axle vehicle, with the front axle (1) being braked, the coefficient of adhesion (K) is given by:

$$K = \frac{z_m \cdot P - 0{,}015 \cdot P_2}{P_1 + \frac{h}{E} \cdot z_m \cdot P}.$$

The other symbols (P, h, E) are defined in the Appendix to item 1.1.4.2 of Annex II.

1.2. **Determination of the adhesion utilized (ε)**

1.2.1. The adhesion utilized (ε) is defined as the quotient of the maximum braking rate with the anti-lock device in operation (z_{max}) and the coefficient of adhesion (K) i.e.

$$\varepsilon = \frac{z_{max}}{K}$$

1.2.2. The maximum braking rate (z_{max}) shall be measured with the anti-lock device in operation and based on the average value of three tests, using the time taken for the speed to reduce from 40 km/h to 20 km/h as in item 1.1.3 above.

1.2.3. The value of ε shall be rounded to the second place of decimals.

1.2.4. In the case of a vehicle equipped with an anti-lock device of categories 1 or 2, the value of z_{max} will be based on the whole vehicle, with the anti-lock device in operation, and the adhesion utilized (ε) is given by the same formula quoted in item 1.2.1 above.

1.2.5. In the case of a vehicle equipped with an anti-lock device of category 3, the value of z_{max} will be measured on each axle which has at least one directly controlled wheel.

Example: for a two-axle vehicle with an anti-lock device acting only on the rear axle (2), the adhesion utilized (ε) is given by:

$$\varepsilon = \frac{z_{max} \cdot P - 0{,}010 \cdot P_1}{K \cdot \left(P_2 - \frac{h}{E} \cdot z_{max} \cdot P\right)}.$$

This calculation shall be made for each axle having at least one directly controlled wheel.

2. METHOD OF MEASUREMENT FOR TOWED VEHICLES

2.1. Where all the axles have at least one directly controlled wheel:

2.1.1. The test shall be conducted by braking one axle at a time; the other axles shall not be braked and the engine of the towing vehicle shall be disconnected.

2.1.2. The mean braking rate (z) shall be determined, taking into account the rolling resistance of the unbraked axles. The test shall be conducted at a speed of 50 km/h and the rolling resistance coefficient may be estimated at 0,01.

2.1.3. The following relation shall be verified for each axle:

$$\varepsilon = \frac{z_1}{z_0} \geqslant 0{,}75$$

where:

ε = the adhesion utilized,

z_0 = the maximum braking rate obtained by braking one axle without locking the wheels, the anti-lock device being disconnected,

z_1 = the braking rate obtained by braking the same axle on the same road surface, with the anti-lock device in operation.

The values to be used for z_1 and z_0 shall be the arithmetic means of three values measured in succession under the same test conditions.

2.2. Where not all axles have at least one directly controlled wheel:

2.2.1. In the case of full trailers, the coefficient of adhesion (K) and the adhesion utilized (ε) shall be determined in accordance with the provisions for motor vehicles in items 1.1 and 1.2 of this Appendix. The forces in the drawbar connection shall be taken into account.

2.2.2. In the case of semi-trailers (and centre-axle trailers), the following procedure shall be used:

2.2.2.1. The adhesion utilized shall be calculated by means of the formula:

$$\varepsilon = \frac{z_{max}}{z_0}$$

where:

z_0 = the maximum braking rate obtained by braking one axle without locking the wheels, the anti-lock device being disconnected and the wheels of the other axles removed,

z_{max} = the braking rate obtained by braking all the axles controlled by the anti-lock device, with the device in operation.

2.2.2.2. The value of z_0 may be calculated by carrying out the procedure described in item 1.1.3 of this Appendix to determine the maximum braking rate (z^*).

$$\text{Then: } z_0 = \frac{TR}{PR_{dyn}};$$

where:

$$TR = \text{braking force} = z^* \cdot (P + P_M) - 0{,}01 \cdot W$$

$$PR_{dyn} = \text{dynamic load} = PR - \frac{TR \cdot h_s + P \cdot z^* (h_R - h_s)}{E_R}.$$

and W is the static mass of the unbraked axles.

The other symbols are defined in the appendix to item 1.1.4.2 of Annex II.

2.2.2.3. The value of z_{max} may be calculated by the same procedure: measure z^{**}, the braking rate with the anti-lock device in operation; calculate TR' and PR'_{dyn} using the formulae in item 2.2.2.2 above, and then

$$z_{max} = \frac{TR'}{PR'_{dyn}}$$

Appendix 2

PERFORMANCE ON DIFFERING-ADHESION SURFACES

1. The prescribed braking rate referred to in item 5.3.5 of this Annex may be calculated by reference to the measured coefficient of adhesion of the two surfaces on which this test is carried out.

These two surfaces must satisfy the conditions prescribed in item 5.3.4 of this Annex.

2. The coefficient of adhesion (K_1 and K_2) of the high- and low-adhesion surfaces, respectively, shall be determined in accordance with the provisions in item 1.1 of Appendix 1 to this Annex.

3. The prescribed braking rate (z_3) for laden motor vehicles shall be:

$$z_3 \geqslant 0{,}75 \cdot \left(\frac{4\,K_2 + K_1}{5}\right) \text{ and } z_3 \geqslant K_2.$$

ANNEX XI: TEST CONDITIONS FOR TRAILERS WITH ELECTRICAL BRAKING SYSTEMS

1. GENERAL

1.1. For the purposes of the following provisions electrical brakes are service braking systems consisting of a control device, an electromechanical transmission device, and friction brakes. The electrical control device regulating the voltage for the trailer must be situated on the trailer.

1.2. The electrical energy required for the electrical braking system is supplied to the trailer by the motor vehicle.

1.3. Electrical braking systems shall be actuated by operating the service braking system of the motor vehicle.

1.4. The nominal voltage rating shall be 12 V.

1.5. The maximum current consumption shall not exceed 15 A.

1.6. The electrical connection of the electrical braking system to the motor vehicle shall be effected by means of a special plug and socket connection corresponding to ... (1), the plug of which shall not be compatible with the sockets of the lighting equipment of the vehicle. The plug together with the cable shall be situated on the trailer.

2. CONDITIONS CONCERNING THE TRAILER

2.1. If there is a battery on the trailer fed by the power supply unit of the motor vehicle, it shall be separated from its supply line during service braking of the trailer.

2.2. With trailers whose unladen mass is less than 75 % of their maximum mass the braking force shall be automatically regulated as a function of the loading condition of the trailer.

2.3. Electrical braking devices shall be such that even if the voltage in the connection lines is reduced to a value of 7 V a braking effect of 20 % of the force corresponding to the maximum mass of the trailer is maintained.

2.4. Control devices for regulating the braking force, which react to the inclination in the direction of travel (pendulum, spring-mass-system, liquid-inertia-switch) shall, if the trailer has more than one axle and a vartically adjustable towing device, be attached to the chassis. In the case of single-axle trailers and trailers with close-coupled axles where the axle spread is less than 1 metre, these control devices shall be equipped with a mechanism indicating its horizontal position (e.g. spirit level) and shall be manually adjustable to allow the mechanism to be set in the horizontal plane in line with the direction of travel of the vehicle.

2.5. The relay for actuating the braking current in accordance with item 2.2.1.20.2 of Annex I, which is connected to the actuating line, shall be situated on the trailer.

2.6. A dummy socket shall be provided for the plug.

2.7. A tell-tale shall be provided at the control device, lighting up at any brake application and indicating the proper functioning of the trailer electric braking system.

3. PERFORMANCE

3.1. Electrical braking systems shall respond at a deceleration of the tractor/trailer combination of not more than 0,4 m/s^2.

3.2. The braking effect may commence with an initial braking force, which shall not be higher than 10 % of the force corresponding to the maximum mass nor higher than 13 % of the force corresponding to the unladen mass of the trailer.

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(1) Under study. Until the characteristics of this special connection have been determined, the type to be used will be indicated by the national authority granting the approval.

3.3. The braking forces may also be increased in steps. At higher levels of the braking forces than those referred to in item 3.2 these steps shall not be higher than 6 % of the force corresponding to the maximum mass, nor higher than 8 % of the force corresponding to the unladen mass of the trailer. However, in the case of single-axle trailers having a maximum mass not exceding 1,5 tonnes, the first step must not exceed 7 % of the force corresponding to the maximum mass of the trailer. An increase of 1 % of this value is permitted for the subsequent steps (example: first step 7 %, second step 8 %, third step 9 %, etc.; any further step should not exceed 10 %). For the purpose of these provisions a two-axle trailer having a wheelbase shorter than 1 metre will be considered as a single-axle trailer.

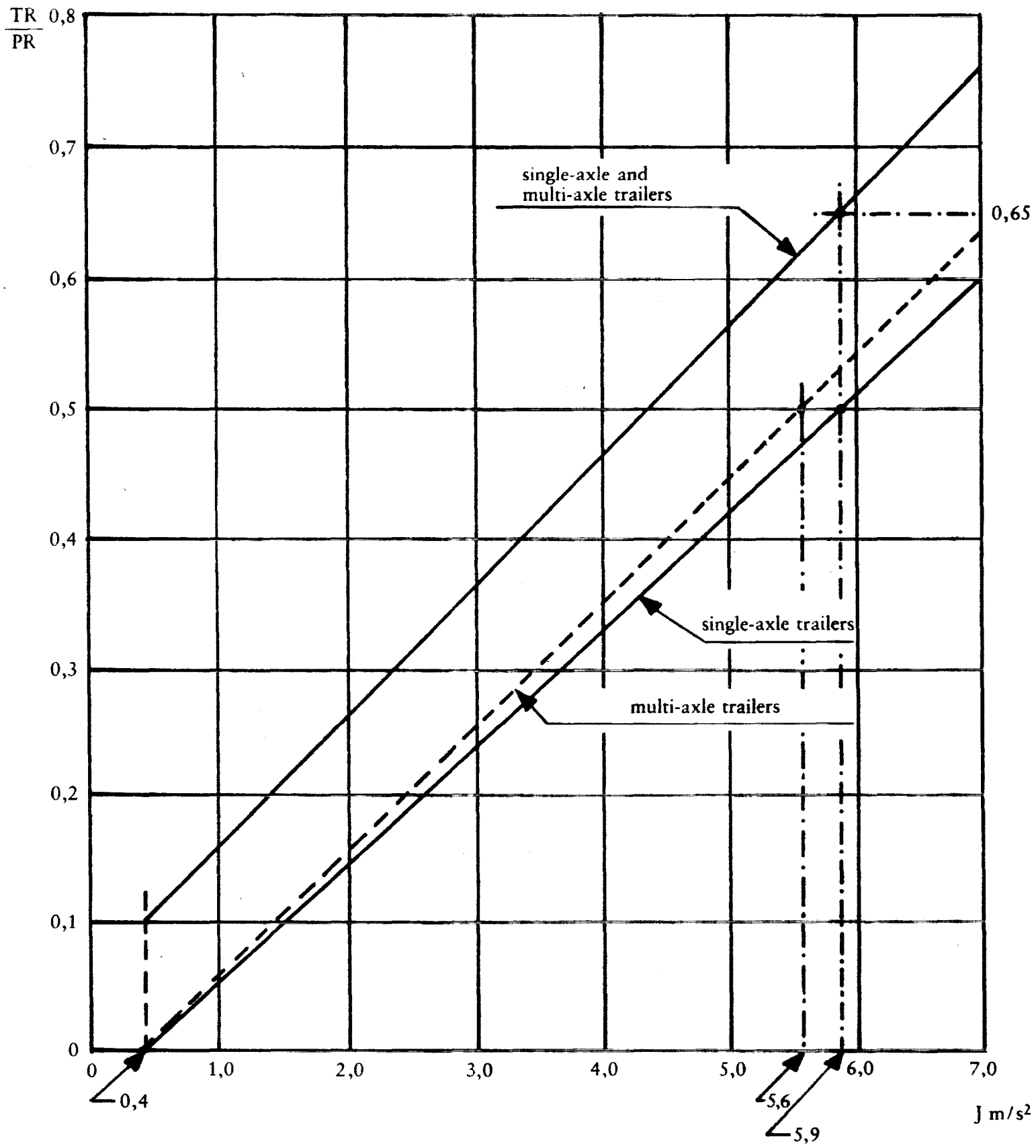
3.4. The prescribed braking force of the trailer of at least 50 % of the force corresponding to its maximum mass shall be attained — with maximum mass — in the case of a mean fully developed deceleration of the tractor/trailer combination of not more than 5,9 m/s^2 with single-axle trailers and of not more than 5,6 m/s^2 with multi-axle trailers. Trailers with close-coupled axles where the axle spread is less than 1 metre are also considered as single-axle trailers within the meaning of this provision. Moreover, the limits as defined in the Appendix to this Annex must be observed. If the braking force is regulated in steps, they shall lie within the range shown in the Appendix to this Annex.

3.5. The test shall be carried out with an initial speed of 60 km/h.

3.6. Automatic braking of the trailer shall be provided in accordance with the conditions of item 2.2.2.9 of Annex I. If this automatic braking action requires electrical energy, a trailer braking force of at least 25 % of the force corresponding to its maximum mass shall be guaranteed for at least 15 minutes to satisfy the abovementioned conditions.

Appendix

Compatibility of the braking rate of the trailer and the mean fully developed deceleration of the tractor/trailer combination (trailer laden and unladen)



Notes:

1. Limits indicated in the diagram refer to laden and unladen trailers. When the trailer unladen mass exceeds 75 % of its maximum mass, limits shall be applied only to "laden" conditions.
2. Limits indicated in the diagram do not affect the provisions of this Annex regarding the minimum braking performances required. However, if braking performances obtained during test — in accordance with provisions indicated in item 3.4 above — are greater than those requested, do not exceed the limits indicated in the above diagram.

TR = sum of braking forces at periphery of all wheels of trailer.

PR = total normal static reaction of road surface on wheels of trailer.

J = mean fully developed deceleration of tractor/trailer combination.

ANNEX XII: INERTIA DYNAMOMETER TEST METHOD FOR BRAKE LININGS

1. GENERAL

1.1. The procedure described in this Annex may be applied in the event of a modification of vehicle-type resulting from the fitting of brake linings of another type to vehicles which have been approved in accordance with this Directive.

1.2. The alternative types of brake linings shall be checked by comparing their performance with that obtained from the brake linings with which the vehicle was equipped at the time of approval and conforming to the components identified in the relevant information document, a model of which is given in Annex IX.

1.3. The technical authority responsible for conducting approval tests may at its discretion require comparison of the performance of the brake linings to be carried out in accordance with the relevant provisions contained in Annex II.

1.4. Application for approval by comparison shall be made by the vehicle manufacturer or by his duly accredited representative.

1.5. In the context of this Annex "vehicle" shall mean the vehicle-type approved according to this Directive and for which it is requested that the comparison shall be considered satisfactory.

2. TEST EQUIPMENT

2.1. A dynamometer having the following characteristics shall be used:

2.1.1. it shall be capable of generating the inertia required by item 3.1 of this Annex, and have the capacity to meet the requirements prescribed by items 1.3 and 1.4 of Annex II with respect to Type I and II fade tests;

2.1.2. the brakes fitted shall be identical with those of the original vehicle-type concerned;

2.1.3. air cooling, if provided, shall be in accordance with item 3.4 of this Annex;

2.1.4. the instrumentation for the test shall be capable of providing at least the following data:

2.1.4.1. a continuous recording of disc or drum rotational speed;

2.1.4.2. number of revolutions completed during a stop, to resolution not greater than one-eighth of a revolution;

2.1.4.3. stop time;

2.1.4.4. a continuous recording of the temperature measured in the centre of the path swept by the lining or at mid-thickness of the disc or drum or lining;

2.1.4.5. a continuous recording of brake application control line pressure or force;

2.1.4.6. a continuous recording of brake output torque.

3. TEST CONDITIONS

3.1. The dynamometer shall be set as close as possible, with ± 5 % tolerance, to the rotary inertia equivalent to that part of the total inertia of the vehicle braked by the appropriate wheel(s) according to the following formula:

$I = MR^2$

Where:

I = rotary inertia (kgm^2)

R = tyre rolling radius (m)

M = that part of the maximum mass of the vehicle braked by the appropriate wheel(s). In the case of a single-ended dynamometer, this mass shall be calculated from the design braking distribution when deceleration corresponds to the appropriate value given in item 2.1.1.1.1 of Annex II, except in the case of category O trailers when the value of M will be equivalent to the mass on the ground for the appropriate wheel when the vehicle is stationary and loaded to its maximum mass.

3.2. The initial rotational speed of the inertia dynamometer shall correspond to the linear speed of the vehicle as prescribed in this Directive and shall be based on the rolling radius of the tyre.

3.3. Brake linings shall be at least 80 % bedded and shall not have exceeded a temperature of 180 °C during the bedding procedure, or alternatively, at the vehicle manufacturer's request, be bedded in accordance with his recommendations.

3.4. Cooling air may be used, flowing over the brake in a direction perpendicular to its axis of rotation. The velocity of the cooling air flowing over the brake shall be not greater than 10 km/h. The temperature of the cooling air shall be the ambient temperature.

4. TEST PROCEDURE

4.1. Five sample sets of the brake lining shall be subjected to the comparison test; they shall be compared with five sets of linings conforming to the original components identified in the information document concerning the first approval of the vehicle-type concerned.

4.2. Brake lining equivalence shall be based on a comparison of the results achieved using the test procedures prescribed in this Annex and in accordance with the following requirements:

4.3. **Type O cold performance test**

4.3.1. Three brake applications shall be made when the initial temperature is below 100 °C. The temperature shall be measured in accordance with the provisions of item 2.1.4.4.

4.3.2. In the case of brake linings intended for use on vehicles of categories M and N, brake applications shall be made from an initial rotational speed equivalent to that given in item 2.1.1.1.1 of Annex II and the brake shall be applied to achieve a mean torque equivalent to the declaration prescribed in that item. In addition, tests shall be carried out at several rotational speeds, the lowest being equivalent to 30 % of the maximum speed of the vehicle and the highest being equivalent to 80 % of that speed.

4.3.3. In the case of brake linings intended for use on vehicles of category O, brake applications shall be made from an initial rotational speed equivalent to 60 km/h, and the brake shall be applied to achieve a mean torque equivalent to that prescribed in item 2.2.1 of Annex II. A supplementary cold performance test from an initial rotational speed equivalent to 40 km/h shall be carried out for comparison with the Type I and II test results as described in item 2.2.1.2.1 of Annex II.

4.3.4. The mean braking torque recorded during the above cold performance tests on the linings being tested for the purpose of comparison shall, for the same input measurement, be within the test limits ± 15 % of the mean braking torque recorded with the brake linings conforming to the component indentified in the relevant application for vehicle type approval.

4.4. **Type I test:**

4.4.1. *With repeated braking*

4.4.1.1. Brake linings for vehicles of category M and N shall be tested according to the procedure given in paragraph 1.3.1 of Annex II.

4.4.2. *With continuous braking*

4.4.2.1. Brake linings for trailers of category O shall be tested in accordance with item 1.3.2 of Annex II.

4.4.3. *Residual performance*

4.4.3.1. On completion of the tests required under item 4.4.1 and 4.4.2 above, the residual braking performance test specified in item 1.3.3 of Annex II shall be carried out.

4.4.3.2. The mean braking torque recorded during the above residual performance tests on the linings being tested for the purpose of comparison shall, for the same input measurement, be within the test limits ± 15 % of the mean braking torque recorded with the brake linings conforming to the component identified in the relevant application for vehicle type approval.

4.5. **Type II test**

4.5.1. This test is required only if, on the vehicle type in question, the friction brakes are used for the Type II test.

4.5.2. Brake linings for motor vehicles of category M_3 (except those required under item 2.2.1.19 of Annex I to undergo a Type II A test) and category N_3, and trailers of category O_4 shall be tested according to the procedure set out in item 1.4.1 of Annex II.

4.5.3. *Residual performance*

4.5.3.1. On completion of the test required under item 4.5.2 above, the residual performance test specified in item 1.4.3 of Annex II shall be carried out.

4.5.3.2. The mean braking torque recorded during the above residual performance tests on the linings being tested for the purpose of comparison shall, for the same input measurement, be within the test limits ± 15 % of the mean braking torque recorded with the brake linings conforming to the component identified in the relevant application for type approval.

5. INSPECTION OF BRAKE LININGS

5.1. Brake linings shall be visually inspected on completion of the tests outlined above to check that they are in satisfactory condition for continued use in normal service.'