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COUNCIL DIRECTIVE

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 of their trailers

(71/320/EEC)

(OJ L 202, 6.9.1971, p. 37)

Amended by:

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►**M1**	Commission Directive 74/132/EEC of 11 February 1974	L 74	7	19.3.1974
►**M2**	Commission Directive 75/524/EEC of 25 July 1975	L 236	3	8.9.1975
►**M3**	Commission Directive 79/489/EEC of 18 April 1979	L 128	12	26.5.1979
►**M4**	Commission Directive 85/647/EEC of 23 December 1985	L 380	1	31.12.1985

Amended by:

►**A1**	Act of Accession of Denmark, Ireland and the United Kingdom of Great Britain and Northern Ireland	L 73	14	27.3.1972

Corrected by:

►**C1** Consolidated text of corrigenda to instruments published in Special Editions 1952-72, p. 96 (71/320/EEC)

►**C2** Corrigendum, OJ L 247, 23.9.1975, p. 36 (75/524/EEC)

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COUNCIL DIRECTIVE

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 of their trailers

(71/320/EEC)

THE COUNCIL OF THE EUROPEAN COMMUNITIES,

Having regard to the Treaty establishing the European Economic Community, and in particular Article 100 thereof;

Having regard to the proposal from the Commission;

Having regard to the Opinion of the European Parliament [1];

Having regard to the Opinion of the Economic and Social Committee [2];

Whereas the technical requirements which motor vehicles must satisfy pursuant to national laws relate, *inter alia*, to the braking devices of certain categories of motor vehicles and of their trailers;

Whereas those requirements differ from one Member State to another; whereas it is therefore necessary that all Member States adopt the same requirements either in addition to or instead of their existing rules, in order, in particular, to allow the EEC type approval procedure which was the subject of the Council Directive 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 to be applied in respect of each type of vehicle [3];

Whereas the harmonised requirements must ensure road safety throughout the whole Community;

HAS ADOPTED THIS DIRECTIVE:

Article 1

1. For the purposes of this Directive, 'vehicle' means any motor vehicle falling within one of the international categories listed below and intended for use on the road, such vehicle being with or without bodywork, having at least four wheels and a maximum design speed exceeding 25 km/h, and its trailers, with the exception of vehicles which run on rails, agricultural tractors and machinery and public works vehicles:

(a) Category M: Motor vehicles having at least four wheels or having three wheels when the maximum weight exceeds 1 metric ton, and used for the carriage of passengers:

— Category M_1: Vehicles used for the carriage of passengers, and comprising not more than eight seats in addition to the driver's seat;

— Category M_2: Vehicles used for the carriage of passengers, comprising more than eight seats in addition to the driver's seat, and having a maximum weight not exceeding 5 metric tons;

— Category M_3: Vehicles used for the carriage of passengers, comprising more than eight seats in addition to the driver's seat, and having a maximum weight exceeding 5 metric tons.

(1) OJ No C 160, 18.12.1969, p. 7.
(2) OJ No C 100, 1.8.1969, p. 13.
(3) OJ No L 42, 23.2.1970, p. 1.

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(b) Category N: Motor vehicles having at least four wheels or having three wheels when the maximum weight exceeds 1 metric ton, and used for the carriage of goods:

— Category N_1: Vehicles used for the carriage of goods and having a maximum weight not exceeding 3·5 metric tons;

— Category N_2: Vehicles used for the carriage of goods and having a maximum weight exceeding 3·5 but not exceeding 12 metric tons;

— Category N_3: Vehicles used for the carriage of goods and having a maximum weight exceeding 12 metric tons.

(c) Category O: Trailers (including semi-trailers):

— Category O_1: Trailers with a maximum weight not exceeding 0·75 metric tons;

— Category O_2: Trailers with a maximum weight exceeding 0·75 but not exceeding 3·5 metric tons;

— Category O_3: Trailers with a maximum weight exceeding 3·5 but not exceeding 10 metric tons;

— Category O_4: Trailers with a maximum weight exceeding 10 metric tons.

2. Articulated category M vehicles made up of two non-separable but articulated units shall be considered to be single vehicles.

3. In the case of a category M or N drawing vehicle designed to be coupled to a semi-trailer, the maximum weight to be taken into consideration when classifying that vehicle shall be the weight of the drawing vehicle in running order plus the maximum weight transferred to the drawing vehicle by the semi-trailer and, where appropriate, the maximum weight of the drawing vehicle's own load.

4. In the case of category N vehicles, the equipment and fittings of certain special vehicles not intended for the carriage of passengers (such as crane vehicles, workshop vehicles, publicity vehicles) shall be considered to be goods.

5. The maximum weight to be taken into consideration when classifying a category O semi-trailer shall be the weight transmitted to the ground by the axle or axles of the semi-trailer when coupled to the drawing vehicle and laden with a maximum load.

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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.

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Article 2a

No Member State may refuse or prohibit the sale, registration, entry into service or use of a vehicle on grounds relating to its braking devices if that vehicle is equipped with the braking devices specified in Annexes I to VIII and if such braking devices satisfy the requirements set out therein.

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Article 3

The Member State which has granted type approval shall take the necessary measures to ensure that it is informed of any modification to a component or characteristic mentioned in item 1.1 of Annex I. The competent authorities of that State shall decide whether the modified prototype should be submitted to fresh tests and whether a fresh report should be drawn up thereon. If such tests reveal failure to comply with the requirements of this Directive, the modification shall not be authorised.

Article 4

Pending the entry into force of a separate Directive on the definition of an 'urban bus', such vehicles shall continue to be submitted to the Type II A test described in Annex II where their maximum weight exceeds 10 metric tons.

Article 5

The amendments necessary for adjusting the requirements of the Annexes so as to take account of technical progress shall be adopted in accordance with the procedure laid down in Article 13 of the Council Directive of 6 February 1970 on the type approval of motor vehicles and their trailers.

Article 6

1. Member States shall put into force the provisions containing the requirements needed in order to comply with this Directive within eighteen months of its notification and shall forthwith inform the Commission thereof.

2. With effect from 1 October 1974, the provisions of item 2.2.1.4 of Annex I shall also apply to vehicles other than those in category M_3 or category N_3.

3. Member States shall ensure that the texts of the main provisions of national law which they adopt in the field covered by this Directive are communicated to the Commission.

Article 7

This Directive is addressed to the Member States.

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ANNEX I

DEFINITIONS, REQUIREMENTS, CONSTRUCTION AND FITTING

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1. DEFINITIONS

For the purpose of this Directive:

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1.1. **'Type of vehicle with respect to the braking devices'**

'Type of vehicle with respect to the braking devices' means vehicles which do not differ in such essential respects as:

1.1.1. *In the case of motor vehicles*

1.1.1.1. the vehicle category, as defined in Article 1 of this Directive

1.1.1.2. the ►M3 maximum mass ◄, as defined in item 1.14

1.1.1.3. the distribution of ►M3 mass ◄ among the axles

1.1.1.4. the maximum design speed

1.1.1.5. a different type of braking device with particular reference to the presence or otherwise of devices for braking a trailer

1.1.1.6. the number and arrangement of the axles

1.1.1.7. the engine type

1.1.1.8. the number and ratios of gears

1.1.1.9. ratio(s) of rear drive axle(s)

1.1.1.10. the tyre dimensions

1.1.2. *In the case of trailers*

1.1.2.1. the vehicle category, as defined in Article 1 of this Directive

1.1.2.2. the ►M3 maximum mass ◄, as defined in item 1.14

1.1.2.3. the distribution of ►M3 mass ◄ among the axles

1.1.2.4. a different type of braking device

1.1.2.5. the number and arrangement of the axles

1.1.2.6. the tyre dimensions

1.2. **'Braking device'**

'Braking device' means the combination of parts whose function is progressively to reduce the speed of a moving vehicle or to bring it to a halt, or to keep it stationary if it is already halted. These functions are specified in item 2.1.2. The device shall consist of the brake control, the transmission and the brake proper.

1.3. **'Graduated braking'**

'Graduated braking' means braking during which, within the normal range of operation of the device, during either the application or the releasing of the brakes,

— the driver can, at any time, increase or reduce the braking force through action on the control,

— the braking force acts in the same direction as the action on the control (monotonic function),

— it is easily possible to make a sufficiently fine adjustment to the braking force.

1.4. **'Control'**

'Control' means the part actuated directly by the driver (or, where appropriate, in the case of a trailer, the driver's mate) to supply to the transmission the energy required for braking or controlling it. This

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energy may be the muscular energy of the driver, or energy from another source controlled by the driver, or in appropriate cases the kinetic energy of a trailer, or a combination of these various kinds of energy.

1.5. **'Transmission'**

'Transmission' means the combination of components situated between the control and the brake and connecting the two operationally. The transmission may be mechanical, hydraulic, pneumatic, electrical, or mixed. Where the braking power is derived from or assisted by a source of energy independent of the driver but controlled by him, the reserve of energy in the device shall likewise be regarded as part of the transmission.

1.6. **'Brake'**

'Brake' means the part in which the forces opposing the movement of the vehicle develop. It may be a friction brake (when the forces are generated by the friction between two parts of the vehicle moving relatively to one another); an electrical brake (when the forces are generated by electromagnetic action between two parts of the vehicle moving relatively to but not in contact with one another); a fluid brake (when the forces are generated by the action of a fluid situated between two parts of the vehicle moving relatively to one another); or an engine brake (when the forces are derived from a controlled increase in the braking action of the engine transmitted to the wheels).

1.7. **'Different types of braking devices'**

'Different types of braking devices' means equipment which differs in such essential respects as:

1.7.1. components having different characteristics,

1.7.2. a component made of materials having different characteristics or a component different in shape or size,

1.7.3. a different assembly of the components.

1.8. **'Braking system component'**

'Braking system component' means one of the individual parts which, when assembled, constitute the braking device.

1.9. **'Continuous braking'**

'Continuous braking' means the braking of combinations of vehicles through an installation having the following characteristics:

1.9.1. a single control which the driver actuates progressively, by a single movement, from his driving seat,

1.9.2. the energy used for braking the vehicles constituting the combination of vehicles is supplied from the same source (which may be the muscular energy of the driver),

1.9.3. the braking installation ensures simultaneous or suitably phased braking of each of the constituent vehicles of the combination, whatever their relative positions.

1.10. **'Semi-continuous braking'**

'Semi-continuous braking' means the braking of combinations of vehicles through an installation having the following characteristics:

1.10.1. a single control which the driver can actuate progressively, by a single movement, from his driving seat,

1.10.2. the energy used for braking the vehicles constituting the combination of vehicles is supplied from two different sources (one of which may be the muscular energy of the driver),

1.10.3. the braking installation ensures simultaneous or suitably phased braking of each of the constituent vehicles of the combination, whatever their relative positions.

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1.11. **'Automatic braking'**

'Automatic braking' means braking of the trailer or trailers occurring automatically in the event of separation of components of the combination of coupled vehicles, including such separation through coupling breakage, without the effectiveness of the remainder of the combination being affected.

1.12. **'Inertia or "overrun" braking'**

'Inertia braking' means braking by utilising the forces generated by the trailer's moving up on the drawing vehicle.

1.13. **'Laden vehicle'**

'Laden vehicle' means, except where otherwise stated, a vehicle laden to its '►M3 maximum mass ◄'.

1.14. **'►M3 Maximum mass ◄'**

'►M3 Maximum mass ◄' means the ►M3 maximum mass ◄ stated by the vehicle manufacturer to be technically permissible (this ►M3 mass ◄ may be higher than the 'permissible ►M3 maximum mass ◄').

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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] 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.

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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'* (1)

'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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2. CONSTRUCTION AND FITTING REQUIREMENTS

2.1. **General**

2.1.1. *Braking device*

2.1.1.1. The braking device must be so designed, constructed and fitted as to enable the vehicle in normal use, despite the vibration to which it may be subjected, to comply with the undermentioned requirements.

2.1.1.2. In particular, the braking device must be so designed, constructed and fitted as to be able to resist the corrosion and ageing phenomena to which it is exposed.

2.1.2. *Functions of the braking device*

The braking device defined in item 1.2 must fulfil the following conditions:

2.1.2.1. Service braking

The service braking must enable the driver to control the movement of the vehicle and to halt it safely, speedily and effectively, whatever its speed and load, on any up or down gradient. It must be possible to graduate this braking action. The driver must be able to achieve this braking action from his driving seat without removing his hands from the steering control.

2.1.2.2. Secondary braking

The secondary braking must make it possible to halt the vehicle within a reasonable distance in the event of the failure of the service braking. It must be possible to graduate this braking action. The driver must be able to obtain this braking action from his driving seat while keeping at least one hand on the steering control. For the purposes of these requirements, it is assumed that not more than one failure of the service braking can occur at one time.

2.1.2.3. Parking braking

The parking braking must enable the vehicle to be held stationary on an up or down gradient even in the absence of the driver, the working parts being then held in the locked position by a purely mechanical device. The driver must be able to achieve this braking action from his driving seat, subject, in the case of a trailer, to the requirements of item 2.2.2.10.

(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, 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.

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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.

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2.2. **Characteristics of braking devices**

2.2.1. *Vehicles of categories M and N*

2.2.1.1. The set of braking devices with which a vehicle is equipped must satisfy the requirements laid down for the service, secondary and parking brake

2.2.1.2. The devices providing service, secondary and parking braking may have common components, provided that they fulfil the following conditions:

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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;

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2.2.1.2.2. the control of the service braking device must be independent of the control of the parking braking device;

2.2.1.2.3. where the service and secondary braking devices have the same control, the effectiveness of the linkage between that control and the various components of the transmission systems must not be liable to diminish after a certain period of use;

2.2.1.2.4. where the service and secondary braking devices have the same control, the parking braking device must be so designed that it can be actuated when the vehicle is in motion. ►M3 This provision shall not apply where an auxiliary control permits at least partial actuation of the service braking system, as provided for in Annex II, item 2.1.3.6; ◄

2.2.1.2.5. in the event of a breakage of any component other than the brakes (as defined in item 1.6) or the components specified in item 2.2.1.2.7, or of any other failure of the service braking device (malfunction, partial or total exhaustion of an energy reserve), the secondary braking device or that part of the service braking device which is not affected by the failure must be able to bring the vehicle to a halt in the conditions prescribed for secondary braking;

2.2.1.2.6. in particular, where the secondary braking device and the service braking device have a common control and common transmission;

2.2.1.2.6.1. where the service braking is actuated by the muscular energy of the driver assisted by one or more energy reserves, the secondary braking must, in the

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event of failure of that assistance, be capable of being ensured by the muscular energy of the driver assisted by the energy reserves, if any, which are unaffected by the failure, the force applied to the control not exceeding the prescribed maxima;

2.2.1.2.6.2. where the force for the service braking and transmission depend exclusively on the use of an energy reserve controlled by the driver, there must be at least two completely independent energy reserves, each provided with its own independent transmission; each of them may act on the brakes of only two or more wheels so selected as to be capable of ensuring by themselves the prescribed degree of secondary braking without endangering the stability of the vehicle during braking; in addition, each of these energy reserves must be fitted with a warning device as defined in item 2.2.1.13;

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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.

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2.2.1.3. Where there are separate controls for the service and secondary braking devices, simultaneous actuation of the two controls must not render both the service and secondary braking devices inoperative, either when both braking devices are in good working order or when one of them is faulty.

2.2.1.4. In the event of failure in a part of the transmission of the service brake, the following conditions must be met:

2.2.1.4.1. a sufficient number of wheels must still be braked by actuation of the service braking device control, whatever the vehicle load;

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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;

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2.2.1.4.3. however, the above requirements shall not apply to drawing vehicles for semi-trailers when the transmission of the service braking

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device of the semi-trailer is independent of that of the drawing vehicle.

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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.

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 ofhalting 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 downcircuit 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.

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2.2.1.6. The requirements of items 2.2.1.2, 2.2.1.4 and 2.2.1.5 must be met without the use of any automatic device of a kind such that its ineffectiveness might pass unnoticed because the parts which are normally in an ‘at rest’ position are actuated only in the event of failure of the braking device.

2.2.1.7. The service braking device must act on all the wheels on the vehicle.

2.2.1.8. The action of the service braking device must be appropriately distributed among the axles.

2.2.1.9. The action of the service braking device must be distributed between the wheels of the same axle symmetrically in relation to the longitudinal median plane of the vehicle.

2.2.1.10. The service braking device and the parking braking device must act on braking surfaces permanently connected to the wheels through components of adequate strength. It must not be possible to disconnect a braking surface from the wheels; however, in the case of the servicing device and secondary braking device, such disconnection of the braking surfaces shall be permitted provided that it is only momentary, for instance during a change of gear, and that both the service braking and the secondary braking continue to operate with the prescribed degree of effectiveness. In addition, any such disconnection shall be permitted in the case of the parking braking device, provided that it is controlled exclusively by the driver from his driving seat by a system which cannot be actuated by a leak [1].

[1] This item must be interpreted in the following way: The performance of the service and secondary braking devices must remain within the limits prescribed in the Directive, even during momentary disconnection.

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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.

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2.2.1.12. In hydraulic braking devices:

2.2.1.12.1. the filling ports of the fluid reservoirs must be readily accessible; in addition, the containers of reserve fluid must be so made that the level of the reserve fluid can be easily checked without the containers having to be opened. Where this last condition is not fulfilled, a warning light must indicate to the driver when the reserve fluid falls to a level liable to cause a failure of the braking device. The driver must be able to check easily whether the light is functioning properly;

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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.

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2.2.1.13. Any vehicle fitted with a service brake actuated by an energy reservoir must, where the prescribed secondary braking performance cannot be obtained by means of this brake without the use of stored energy, be provided with a warning device — in addition to a pressure gauge, where fitted — giving an optical or acoustic signal when the stored energy in any part of the system falls to a value at which, without recharging of the reservoir and irrespective of the load conditions of the vehicle, it is possible to apply the service brake control a fifth time after four full-stroke actuations and obtain the prescribed secondary braking performance (without faults in the service-brake transmission device and with the brakes adjusted as closely as possible). The warning device must be directly and permanently connected to the circuit. When the engine is running under normal operating conditions and there are no faults in the braking system, the warning device must give no signal except during the time required for charging the energy reservoir(s) after start-up of the engine.

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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.

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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.

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.

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2.2.1.15. In the case of a motor vehicle to which the coupling of a trailer equipped with a brake controlled by the driver of the drawing vehicle is authorised, the service braking device of the drawing vehicle must be fitted with a device so designed that if the trailer braking device should fail, or the air supply pipe (or such other type of connection as may be adopted) between the drawing vehicle and trailer should break, it will still be possible to brake the drawing vehicle with the effectiveness prescribed for the secondary braking; it is accordingly prescribed, in particular, that this device be fitted to the drawing vehicle [1].

2.2.1.16. The auxiliary equipment must draw its energy only in such a way that its operation, even in the event of damage to the energy source, cannot cause the reserves of energy feeding the braking devices to fall below the level indicated in item 2.2.1.13.

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►M4 2.2.1.17. ◄ Where the trailer belongs to category O_3 or O_4, the service braking device must be of a continuous or semi-continuous type.

►M4 2.2.1.18. ◄ In the case of a vehicle authorised to draw a category O_3 or O_4 trailer, the braking devices must satisfy the following conditions:

►M4 2.2.1.18.1. ◄ when the secondary braking device of the drawing vehicle is actuated, there must also be a graduated braking action on the trailer;

►M4 2.2.1.18.2. ◄ should the main braking device of the drawing vehicle fail, and if this device is made up of at least two independent sections, the section or sections not affected by this failure must be able partially or fully to actuate the trailer brakes. It must be possible to graduate this braking action. ►M3 If this operation is achieved by a valve which is normally at rest, then such a valve may only be incorporated if its correct functioning can easily be checked by the driver, either from within the cab or from outside the vehicle, without the use of tools; ◄

[1] This point is to be interpreted in the following way: It is essential, in all cases, that the service braking device should be fitted with a device (for instance a limiting valve) ensuring that the vehicle can still be braked by the service brake, but with a performance equal to that of the secondary brake.

▼B

►M4 2.2.1.18.3. ◄ in the case of a break or leak in one of the air supply pipes (or in such other type of connection as may be adopted), it must nevertheless be possible for the driver to fully or partially actuate the trailer brakes, by means either of the service braking control or of the secondary braking control or of a separate control, unless the break or leak automatically causes the trailer to be braked;

▼M4

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.

▼B

►M4 2.2.1.19. ◄ Except in the case of 'urban buses', vehicles used for the carriage of passengers comprising more than eight seats in addition to the driver's seat, and having a ►M3 maximum mass ◄ exceeding 10 metric tons, must satisfy the Type II A test described in item 1.5 of Annex II and not the Type II test described in item 1.4 of that Annex.

▼M4

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.

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.

▼B

2.2.2. *Vehicles of category O*

2.2.2.1. Trailers of category O_1 need not be fitted with a service braking device; however, if trailers of this category are equipped with a service braking device this must comply with the same requirements as those of category O_2.

▼M4

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.

▼B

2.2.2.3. Every trailer of category O_3 or O_4 must be fitted with a service braking device of the continuous or semi-continuous type.

2.2.2.4. The service braking device must act on all the wheels of the trailer.

2.2.2.5. The action of the service braking device must be suitably distributed among the axles.

2.2.2.6. The action of every braking device must be distributed between the wheels of each axle symmetrically in relation to the longitudinal median plane of the vehicle.

2.2.2.7. The braking surfaces required to attain the prescribed degree of effectiveness must be in constant contact with the wheels, either rigidly or through components not liable to failure.

▼M4

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.

▼B

2.2.2.9. The braking devices must be such that the trailer is stopped automatically if the coupling breaks while the trailer is in motion. However, this requirement shall not apply to single-axled trailers with a ►M3 maximum mass ◄ not exceeding 1·5 metric tons provided that the trailers are fitted, in addition to the main coupling, with a secondary coupling (chain, cable, etc.) which, in the event of breakage of the main coupling, can stop the drawbar from touching the ground and provide some residual steering action on the trailer.

2.2.2.10. On every trailer which is required to be fitted with a service braking device, parking braking must be ensured even when the trailer is separated from the drawing vehicle. It must be possible for a person standing on the ground to actuate the parking braking device; however, in the case of a trailer used for the carriage of passengers, it must be possible to actuate this brake from inside the trailer. The expression 'actuate' also covers the action of releasing.

2.2.2.11. Where a trailer is fitted with a device enabling compressed-air actuation of the braking device to be cut out, the first-mentioned device must be so designed and constructed that it is positively restored to the 'at rest' position not later than on the resumption of the supply of compressed air to the trailer.

▼**M4**

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.

▼B

ANNEX II

BRAKING TESTS AND PERFORMANCE OF BRAKING DEVICES

1. BRAKING TESTS

1.1. **General**

1.1.1. The performance prescribed for braking devices shall be based on the stopping distance. The performance of a braking device shall be determined either by measuring the stopping distance in relation to the initial speed or by measuring the reaction time of the device and the mean deceleration in normal operation as prescribed in Annex III.

1.1.2. The stopping distance shall be the distance covered by the vehicle from the moment when the driver begins to actuate the control of the device until the moment when the vehicle stops; the initial speed shall be the speed at the moment when the driver begins to actuate the control of the device. In the formulae given below, for the measurement of braking performance,

v = initial speed in km/h

s = stopping distance in metres.

1.1.3. For the type approval of any vehicle, the braking performance shall be measured during road tests conducted in the following conditions:

1.1.3.1. the vehicle's condition as regards ►M3 mass ◄ must be as prescribed for each type of test and be specified in the test report;

1.1.3.2. the test must be carried out at the speeds prescribed for each type of test. Where a vehicle is so constructed that its maximum speed is lower than that prescribed for a test, the test must be performed at the maximum speed of the vehicle;

1.1.3.3. during the tests the force applied to the brake control in order to obtain the prescribed performance must not exceed the maximum laid down for the test vehicle's category;

1.1.3.4. ►M2 without prejudice to the requirements contained in item 1.1.4.2 below, the road shall possess a surface having good adhesion; ◄

1.1.3.5. the tests must be performed when there is no wind liable to affect the results;

1.1.3.6. at the start of the tests the tyres must be cold and at the pressure prescribed for the load actually borne by the wheels when the vehicle is stationary;

1.1.3.7. the prescribed performance must be obtained without locking of the wheels, without deviation of the vehicle from its course, and without abnormal vibration.

1.1.4. *Behaviour of the vehicle during braking*

1.1.4.1. In braking tests, and in particular in those at high speed, the general behaviour of the vehicle during braking must be checked.

▼M2

1.1.4.2. The behaviour of vehicles in categories M_1, M_2, M_3, N_1, N_2, N_3, O_3 and O_4 on a road surface having reduced adhesion shall fulfil the conditions laid down in the Appendix.

▼B

1.2. **Type O test**

(ordinary performance test with brakes cold)

1.2.1. *General*

1.2.1.1. The brakes must be cold. A brake is deemed to be cold when the temperature measured on the disc or on the outside of the drum is below 100ºC.

1.2.1.2. The test must be conducted in the following conditions:

1.2.1.2.1. the vehicle must be laden, the distribution of its ►M3 mass ◄ among the axles being that stated by the maker. Where provision is made for several arrangements of the load on the axles the distribution of the ►M3 maximum mass ◄ among the axles must be such that the load on each axle is proportional to the maximum permissible load for each axle. ►M4 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); ◄

▼M4

1.2.1.2.2. every text must be repeated on the unladen vehicle. In the cae 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;

▼B

1.2.1.2.3. the limits prescribed for minimum performance, both for tests with the vehicle unladen and for tests with the vehicle laden, shall be those laid down hereunder for each category of vehicle;

1.2.1.2.4. the road must be level.

1.2.2. *Type O test with engine disconnected*

1.2.2.1. The test must be carried out at the speed prescribed for the category to which the vehicle belongs, the figures prescribed in this connection being subject to a certain margin of tolerance. The minimum performance prescribed for each category must be attained.

1.2.3. *Type O test with engine connected*

▼M4

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.

▼M4

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.

▼B

1.3. **Type I test**

(fade test)

1.3.1. *With repeated braking*

1.3.1.1. The service brakes of vehicles in categories M_1, M_2, M_3, N_1, N_2 and N_3 shall be tested by successively applying and releasing the brakes a number of times, the vehicle being laden, in accordance with the conditions shown in the following table:

Conditions / Category of vehicle	v_1 km/h	v_2 km/h	Δt secs	n
M_1	80% v_{max} ≤ 120	½ v_1	45	15
M_2	80% v_{max} ≤ 100	½ v_1	55	15

▼B

Conditions / Category of vehicle	v_1 km/h	v_2 km/h	Δt secs	n
M_3	80% v_{max} ≤ 60	½ v_1	60	20
N_1	80% v_{max} ≤ 120	½ v_1	55	15
N_2	80% v_{max} ≤ 60	½ v_1	60	20
N_3	80% v_{max} ≤ 60	½ v_1	60	20

where:

v_1 = initial speed, when braking starts,

v_2 = speed at end of braking,

v_{max} = maximum speed of the vehicle,

n = number of times brakes applied,

Δt = duration of a braking cycle (time elapsing between the initiation of one brake application and the initiation of the next).

1.3.1.2. If the characteristics of the vehicle do not allow for the period of time prescribed for Δt, the duration may be increased; in any event, in addition to the time necessary for braking and accelerating the vehicle, a period of 10 seconds must be allowed in each cycle for stabilising the speed v_1.

1.3.1.3. In these tests, the force applied to the control must be so adjusted as to attain a mean deceleration of 3 m/sec^2 at the first application of the brakes. This force must remain constant throughout the succeeding brake applications.

1.3.1.4. During brake applications the highest gear ratio (excluding overdrive, etc.) must be continuously engaged.

1.3.1.5. For regaining speed after braking, the gearbox must be used in such a way as to attain the speed v_1 in the shortest possible time (maximum acceleration allowed by the engine and gearbox).

1.3.2. *With continuous braking*

1.3.2.1. ►**M3** The service brakes of trailers of categories O_2, O_3 and O_4 shall be tested in such a manner that ◄, the vehicle being laden, the energy input to the brakes is equivalent to that recorded in the same period of time with a laden vehicle driven at a steady speed of 40 km/h on a 7% down gradient for a distance of 1·7 km.

1.3.2.2. The test may be carried out on a level road, the trailer being drawn by a motor vehicle; during the test, the force applied to the control must be adjusted so as to keep the resistance of the trailer constant (7% of the ►**M3** mass ◄ of the trailer). If the power available for hauling is insufficient, the test can be conducted at a lower speed but over a greater distance, as shown in the following table:

Speed (km/h)	Distance (metres)
40	1 700
30	1 950
20	2 500
15	3 100

▼B

1.3.3. *Residual performance*

▼M4

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.

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.

▼B

1.4. **Type II test**

(downhill behaviour test)

1.4.1. Laden vehicles shall be tested in such a manner that the energy input is equivalent to that recorded in the same period of time with a laden vehicle driven at an average speed of 30 km/h on a 6% down gradient for a distance of 6 km, with the appropriate gear engaged (if the vehicle is a motor vehicle) and the retarder, if the vehicle is fitted with one, being used. The gear engaged must be such that the rpm of the engine does not exceed the maximum value prescribed by the manufacturer.

1.4.2. For vehicles in which the energy is absorbed by the braking action of the engine alone, a tolerance of ± 5 km/h on the average speed shall be permitted, and the gear enabling the speed to be stabilised at the value closest to 30 km/h on the 6% down gradient shall be engaged. If the performance of the braking action of the engine alone is determined by a measurement of deceleration, it shall be sufficient if the mean deceleration measured is at least 0·5 m/sec^2.

▼M4

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/s^2);

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/s^2).

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.

▼B

1.5. **Type IIA test**

(test for vehicles, other than 'urban buses', used for the carriage of passengers comprising more than eight seats in addition to the driver's seat and having a ►M3 maximum mass ◄ exceeding 10 metric tons)

▼B

1.5.1. Laden vehicles shall be tested in such a manner that the energy input is equivalent to that recorded in the same period of time with a laden vehicle driven at an average speed of 30 km/h on a 7% down gradient for a distance of 6 km. During the test, the service, secondary and parking braking devices must not be engaged. The gear engaged must be such that the rpm of the engine does not exceed the maximum value prescribed by the manufacturer. ►M4 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. ◄

1.5.2. For vehicles in which the energy is absorbed by the braking action of the engine alone, a tolerance of ± 5 km/h on the average speed shall be permitted and the gear enabling the speed to be stabilised at the value closest to 30 km/h on a 7% down gradient shall be engaged. If the performance of the braking action of the engine alone is determined by a measurement of deceleration, it shall be sufficient if the mean deceleration measured is at least 0·6 m/sec^2.

2. PERFORMANCE OF BRAKING DEVICES

2.1. **Vehicles of categories M and N**

2.1.1. *Service braking devices*

2.1.1.1. Provisions relating to tests

2.1.1.1.1. The service brakes of vehicles of categories M_1, M_2, M_3, N_1, N_2 and N_3 shall be tested under the conditions shown in the following table:

▼M4

	M_1	M_2	M_3	N_1	N_2	N_3
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
$s \leq$	$0,1V + \frac{V^2}{150}$	$0,15V + \frac{V^2}{130}$				
$d_m \geq$	5,8 m/s^2	5 m/s^2				
$f \leq$	500 N	700 N				

▼B

where:

v = test speed

s = stopping distance

dm = mean braking deceleration at normal engine speed

f = force applied to foot control

2.1.2. *Secondary braking devices*

▼M4

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

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

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

▼B

2.1.2.2. If the secondary braking control is a manual control, the prescribed performance must be obtained by applying to the control a force not exceeding ►M3 400 N ◄ in the case of category M_1 vehicles and ►M3 600 N ◄ in the case of other vehicles, and the control must be so placed that it can be easily and quickly grasped by the driver.

2.1.2.3. If the secondary braking control is a foot control, the prescribed performance must be obtained by applying to the control a force not exceeding ►M3 500 N ◄ in the case of category M_1 vehicles and ►M3 700 N ◄ in the case of other vehicles, and the control must be so placed that it can be easily and quickly actuated by the driver.

▼M4

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

N_1 = 70 km/h

M_2 = 60 km/h

N_2 = 50 km/h

M_3 = 60 km/h;

N_3 = 40 km/h.

▼B

2.1.3. *Parking braking devices*

2.1.3.1. The parking braking device must, even if it is combined with one of the other braking devices, be capable of holding a laden vehicle stationary on an 18% up or down gradient.

2.1.3.2. On vehicles to which the coupling of a trailer is authorised, the parking braking device of the drawing vehicle must be capable of holding the combination of vehicles stationary on a 12% gradient.

2.1.3.3. If the control is a manual control, the force applied to it must not exceed ►M3 400 N ◄ in the case of category M_1 vehicles and ►M3 600 N ◄ in the case of all other vehicles.

2.1.3.4. If it is a foot control, the force exerted on the control must not exceed ►M3 500 N ◄ in the case of category M_1 vehicles and ►M3 700 N ◄ in the case of all other vehicles.

2.1.3.5. A parking braking device which has to be actuated several times before attaining the prescribed performance is admissible.

▼M3

►M4 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 ◄ deceleration on application of either the parking brake or the auxiliary control of the service brake, and the deceleration immediately before the vehicle stops, shall be not less than 1·5 m/s^2. The test shall be carried out with the vehicle laden, and compliance with the requirements shall be deemed to be met if the braking performance has been achieved once. The force exerted on the braking control shall not exceed the specified values. In the case of vehicles of category M_1 or N_1, fitted with a parking brake using friction linings other than those for the service braking system, the test may be carried out from 60 km/h at the request of the manufacturer. In this case, the mean fully-developed deceleration must be not less than 2·0 m/s^2; deceleration immediately before the vehicle stops must not be less than 1·5 m/s^2.

▼M4

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/s²)

	(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)

▼B

2.2. **Vehicles of category O**

2.2.1. *Service braking devices*

2.2.1.1. Requirement relating to tests of category O_1 vehicles.

2.2.1.1.1. Where the provision of a service braking device is mandatory, the performance of the device must meet the requirements laid down for category O_2.

2.2.1.2. Requirements relating to tests of category O_2 vehicles.

▼M4

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.

[1] The pressures specified here and in the following Annexes are relative pressures measured in bars.

▼B

2.2.1.2.2. Where the braking device is of the inertia type, it must comply with the conditions laid down in Annex VIII.

2.2.1.2.3. In addition, these vehicles must be subjected to the Type I test.

2.2.1.2.4. In the Type I test of a semi-trailer, the ►M3 mass ◄ braked by its axles must be that corresponding to the load on the axle or axles of the semi-trailer when the latter is carrying its maximum load.

▼M3

2.2.1.3. Requirements relating to the testing of category O_3 vehicles. The same requirements apply as to category O_2.

▼B

2.2.1.4. Requirements relating to tests of category O_4 vehicles.

▼M3

2.2.1.4.1. The same requirements apply as apply to category O_2; in addition, these vehicles must be subjected to the Type II test.

▼B

2.2.1.4.2. In the Type I and Type II tests of a semi-trailer, the ►M3 mass ◄ braked by its axles must be that corresponding to the load on the axle or axles of the semi-trailer when the latter is carrying its maximum load.

2.2.2. *Parking braking devices*

2.2.2.1. The parking brake with which the trailer or semi-trailer is fitted must be capable of holding the laden trailer or semi-trailer stationary, when separated from the drawing vehicle, on an 18% up or down gradient. The force applied to the control must not exceed ►M3 600 N ◄.

2.3. **Reaction time**

Where a vehicle is fitted with a service braking device which is totally or partially dependent on a source of energy other than the muscular effort of the driver, the following requirements must be satisfied:

2.3.1. in an emergency manoeuvre, the time clapsing between the moment when the control begins to be actuated and the moment when the braking force on the least favourably placed axle reaches the level corresponding to the prescribed performance must not exceed 0·6 seconds;

▼M3

2.3.2. in the case of vehicles fitted with compressed air braking devices, the requirements of item 2.3.1 are considered to be satisfied if the vehicle complies with the provisions of Annex III;

▼M4

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.

▼M1

Appendix (See 1.1.4.2)

DISTRIBUTION OF BRAKING EFFORT AMONG VEHICLE AXLES

▼M4

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.

▼M2

2. SYMBOLS

i = axle index (i = 1, front axle; i = 2, second axle; etc.)

P_i = normal reaction of road surface on axle i under static conditions

N_i = normal reaction of road surface on axle i under braking

T_i = force exerted by the brakes on axle i under normal braking conditions on the road

f_i = T_i/N_i, adhesion used by axle i ([1])

J = deceleration of vehicle

g = acceleration due to gravity g = 10 m/s^2

z = braking rate of vehicle = J/g ([2])

P = ►M3 mass ◄ of vehicle

▼M4

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

▼M2

E = wheelbase

k = theoretical coefficient of adhesion between tyre and road

K_c = correction factor — semi-trailer laden

K_v = correction factor — semi-trailer unladen

TM = sum of braking forces at the periphery of wheels of drawing vehicles for trailers or semi-trailers

PM = total normal static reaction between road surface and wheels of drawing vehicles for trailer or semi-trailer as referred to in items 3.1.4 and 3.1.5 respectively

p_m = pressure at coupling head of service line

TR = sum of braking forces at periphery of all wheels of trailer or semi-trailer

PR = total normal static reaction of road surface on wheels of trailer or semi-trailer

PR_{max} = value of PR at ►M3 maximum mass ◄ of semi-trailer

E_R = distance between king-pin and centre of axle or axles of semi-trailer

▼M4

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

([1]) Adhesion curves used by each axle means curves showing the adhesion used by axle i plotted against the vehicle braking rate under the specified load conditions.

([2]) For semi-trailers, z is the braking force divided by the static ►M3 mass ◄ on the semi-trailer axle(s).

▼M2

3. REQUIREMENTS FOR MOTOR VEHICLES

3.1. **Two axle vehicles.**

▼M4

3.1.1. ([1]) For all categories of vehicles for k values between 0,2 and 0,8:

$$z \geq 0,1 + 0,85\ (k - 0,2)$$

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 ([2]).

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 $z \geq k - 0,08$, and between 0,5 and 0,61 with the relation $z \geq 0,5\ k + 0,21$,

— 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 $z \geq 0,3$ complies with the relation

$$z \geq 0,3 + 0,74\ (k - 0,38).$$

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.

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:

$$f_1 = \frac{T_1}{N_1} = \frac{T_1}{P_1 + z\,\frac{h}{E}\,P};$$

$$f_2 = \frac{T_2}{N_2} = \frac{T_2}{P_2 - z\,\frac{h}{E}\,P}.$$

([1]) The provisions of item 3.1.1 do not affect the requirements of Annex II relating to the braking efficiency. However, if, when verifying the provisions of item 3.1.1 braking efficiencies are obtained which are higher than those prescribed in Annex II, the provisions relating to the adhesion utilization curve shall be applied within the areas of diagrams IA and IB defined by the straight lines k = 0·8 and z = 0·8.

([2]) 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.

▼M4

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.

▼M2

3.1.4. Vehicles other than tractive units for semi-trailers.

▼M4

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.

▼M2

3.1.5. Tractive units for semi-trailers.

▼M4

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.

▼M2

3.1.5.2. Tractive units with laden semi-trailer

A laden articulated combination is considered to be a tractive unit in running order with the driver on board coupled to a laden semi-trailer. The dynamic load of the semi-trailer on the tractive unit shall be represented by a static ►M3 mass ◄ P_s applied at the coupling king-pin equal to:

$$P_s = P_{so}\ (1 + 0 \cdot 45\ z)$$

where P_{so} represents the difference between the maximum laden ►M3 mass ◄ of the tractive unit and its unladen ►M3 mass ◄.

For h the following value shall be taken: $h = \frac{h_o P_o + h_s P_s}{P}$

where:

h_o is the height of the centre of gravity of the tractive unit

h_s is the height of the coupling on which the semi-trailer rests

P_o is the unladen ►M3 mass ◄ of the solo tractive unit

$$P = P_o + P_s = P_1 + P_2.$$

3.1.5.3. In the case of a vehicle fitted with a compressed air braking system, the permissible relationship between the braking rate TM/PM and the pressure p_m shall be within the areas shown in diagram 3.

3.2. **Vehicles with more than two axles**

The requirements of item 3.1 shall apply to vehicles with more than two axles. The requirements of item 3.1.1 with respect to wheel lock sequence shall be considered to be met, if, in the case of braking rates of between 0·15 and 0·30, the adhesion used by at least one of the front axles is greater than that used by at least one of the rear axles.

▼M4

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.

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.

▼C2

6. CONDITIONS TO BE FULFILLED IN THE CASE OF FAILURE OF THE BRAKING DISTRIBUTION SYSTEM

When the requirements of this Appendix are met by means of a special device (e.g., controlled mechanically by the suspension of the vehicle), it shall be possible in the event of failure of this device or its control to stop the vehicle under the conditions prescribed for secondary braking in the case of motor vehicles; in the case of trailers and semi-trailers in the event of failure of the control a braking rate of at least 30 % of the service brake performance prescribed for the vehicle in question shall be attained.

▼M2

7. MARKINGS

7.1. Vehicles, other than those of category M_1, which meet the requirements of this Appendix by means of a device mechanically controlled by the suspension of the vehicle, shall be marked to show the useful travel of the device between the positions corresponding to vehicle unladen and laden states respectively.

7.2. When the requirements of this Appendix are met by means of a device actuated by compressed air, the vehicle shall be marked to show the pressure values at the outlet side of the device during full braking of the vehicle under both unladen and laden conditions.

7.3. The markings referred to under items 7.1 and 7.2 above shall be affixed in a visible position in indelible form.

▼M4

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.

▼**M4**

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

▼M2

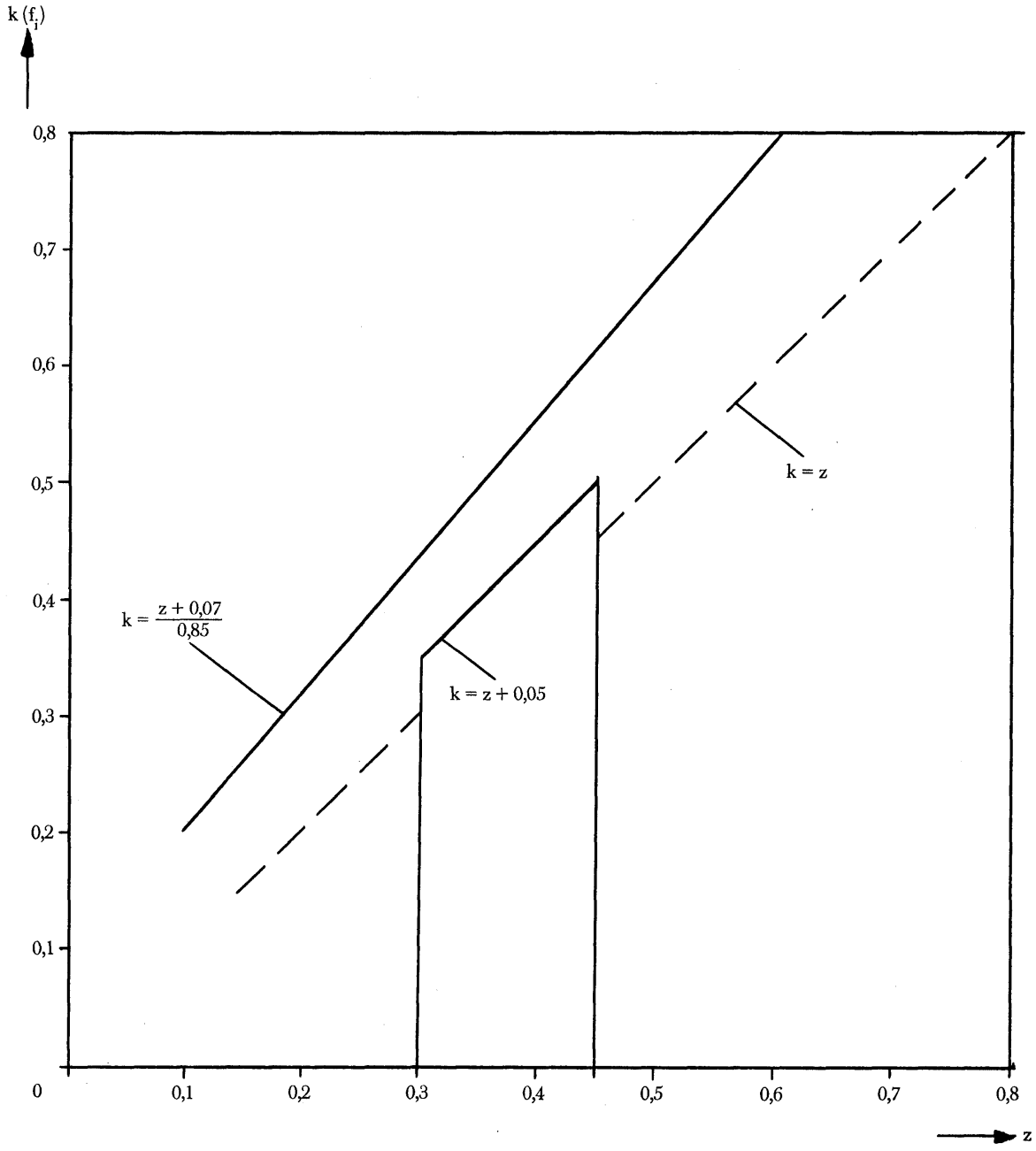
DIAGRAM 1 A

▼M4

VEHICLES OF CATEGORY M_1, AND CERTAIN VEHICLES OF CATEGORY N_1 FROM 1 OCTOBER 1990

(see item 3.1.1)

▼M2



▼M2

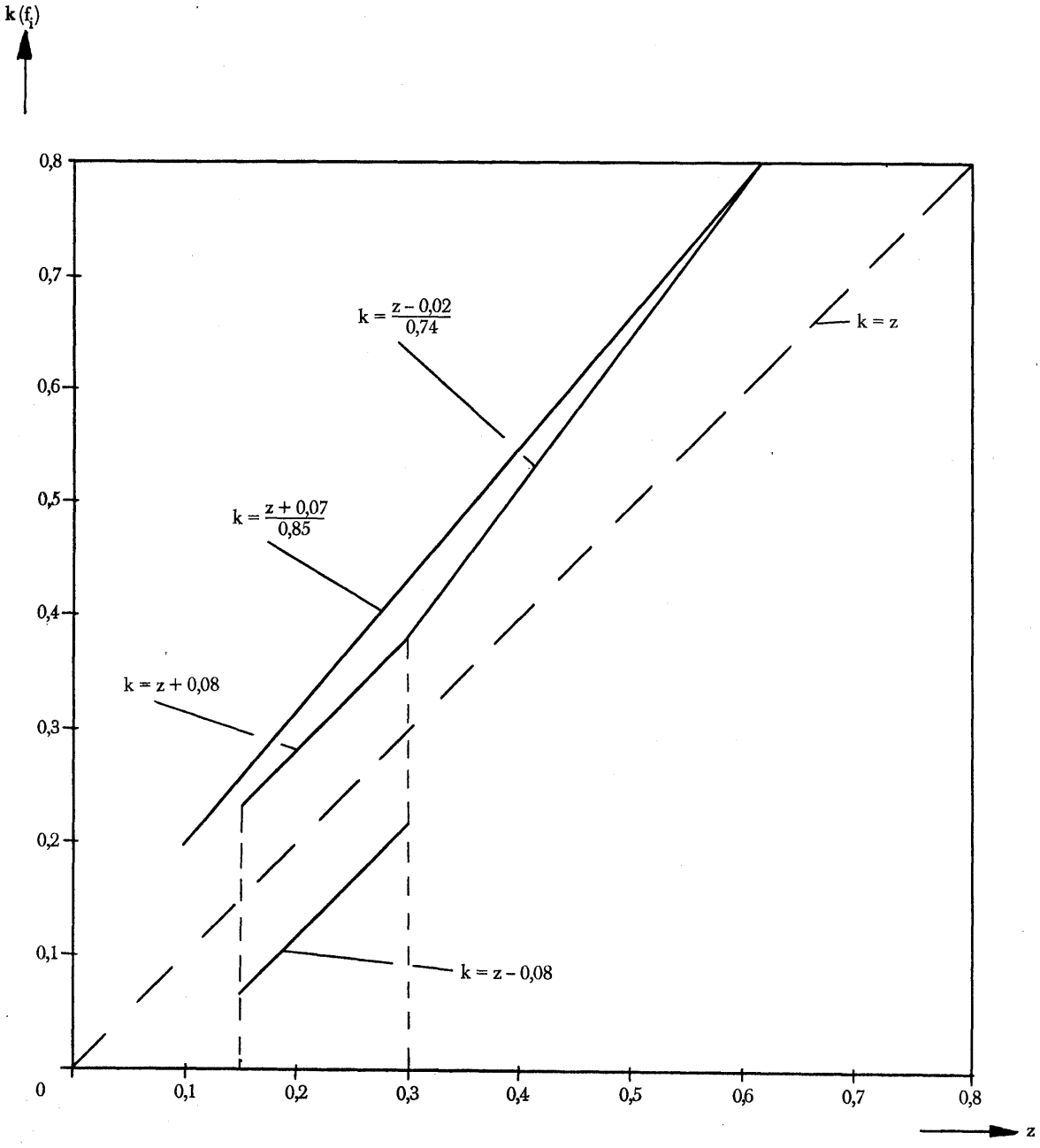
DIAGRAM 1 B

▼M4

VEHICLES OTHER THAN VEHICLES OF CATEGORY M_1 AND N_1

▼M2

(see item 3.1.1)



▼M4

Note:

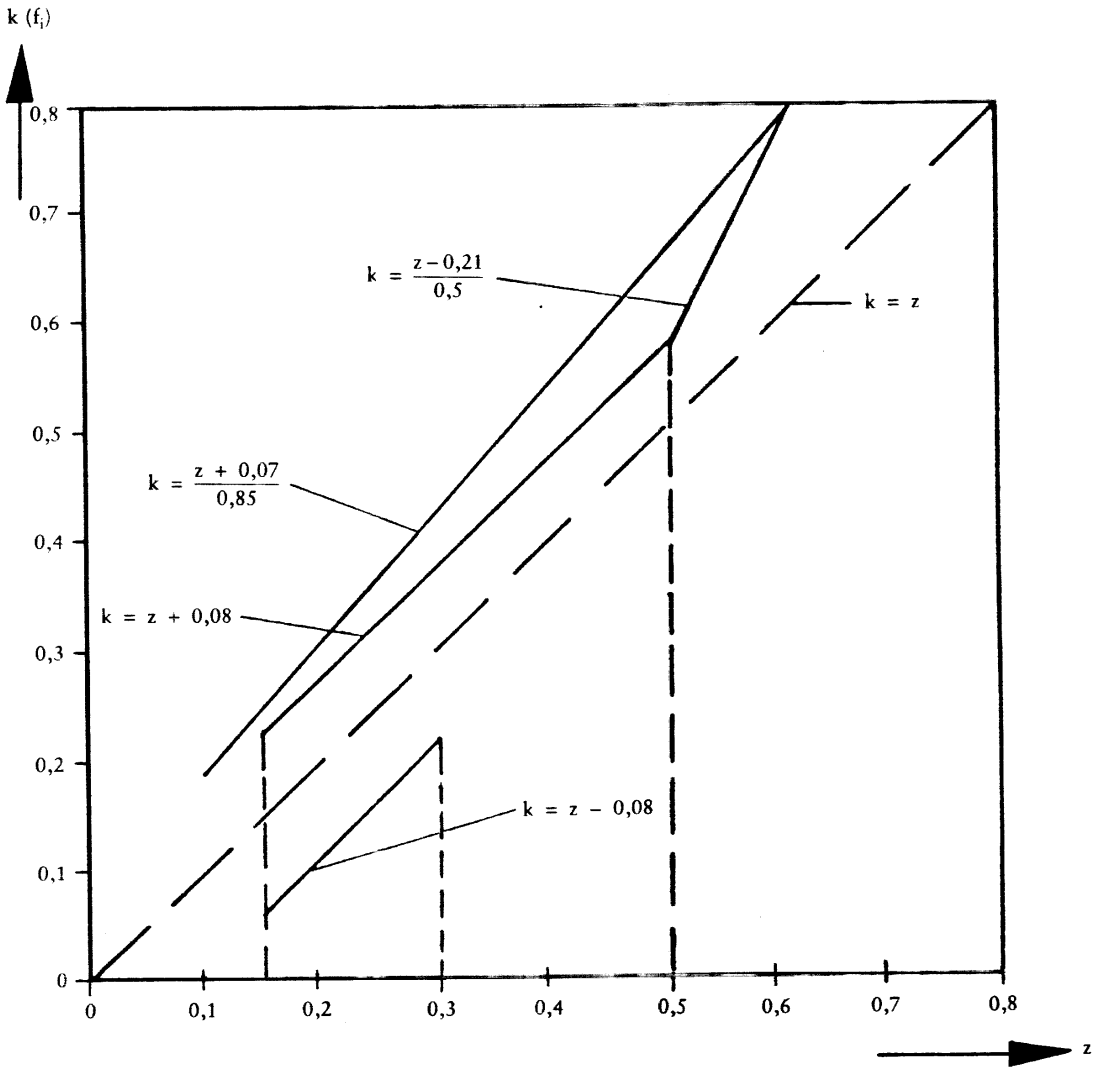
The lower limit of the corridor is not applicable for the adhesion utilization of the rear axle.

▼M4

DIAGRAM 1 C

VEHICLES OF CATEGORY N_1 (WITH CERTAIN EXCEPTIONS FROM 1 OCTOBER 1990)

(see item 3.1.1)



Note:

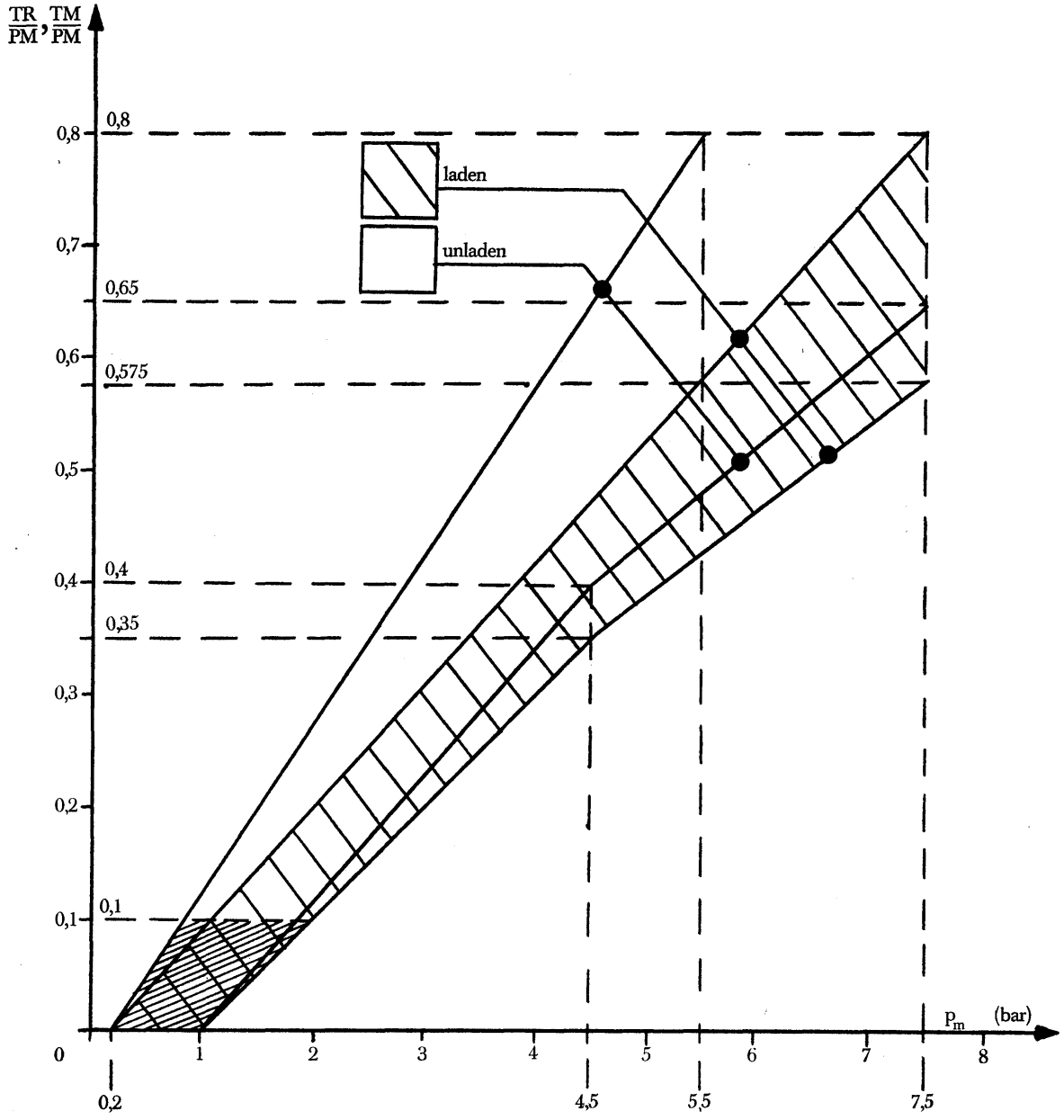
The lower limit of the corridor is not applicable for the adhesion utilization of the rear axle.

▼M2

DIAGRAM 2

DRAWING VEHICLES AND TRAILERS

(see item 3.1.4.1)



Note:

►M4 (1) ◄ It is understood that between the values $\frac{TM}{PM} = 0$ and $\frac{TM}{PM} = 0 \cdot 1$ or $\frac{TR}{PR} = 0$ and $\frac{TR}{PR} = 0 \cdot 1$ it is not necessary that there should be proportionality between the braking rate $\frac{TM}{PM}$ or $\frac{TR}{PR}$ and the control pressure as measured at the coupling head.

▼M4

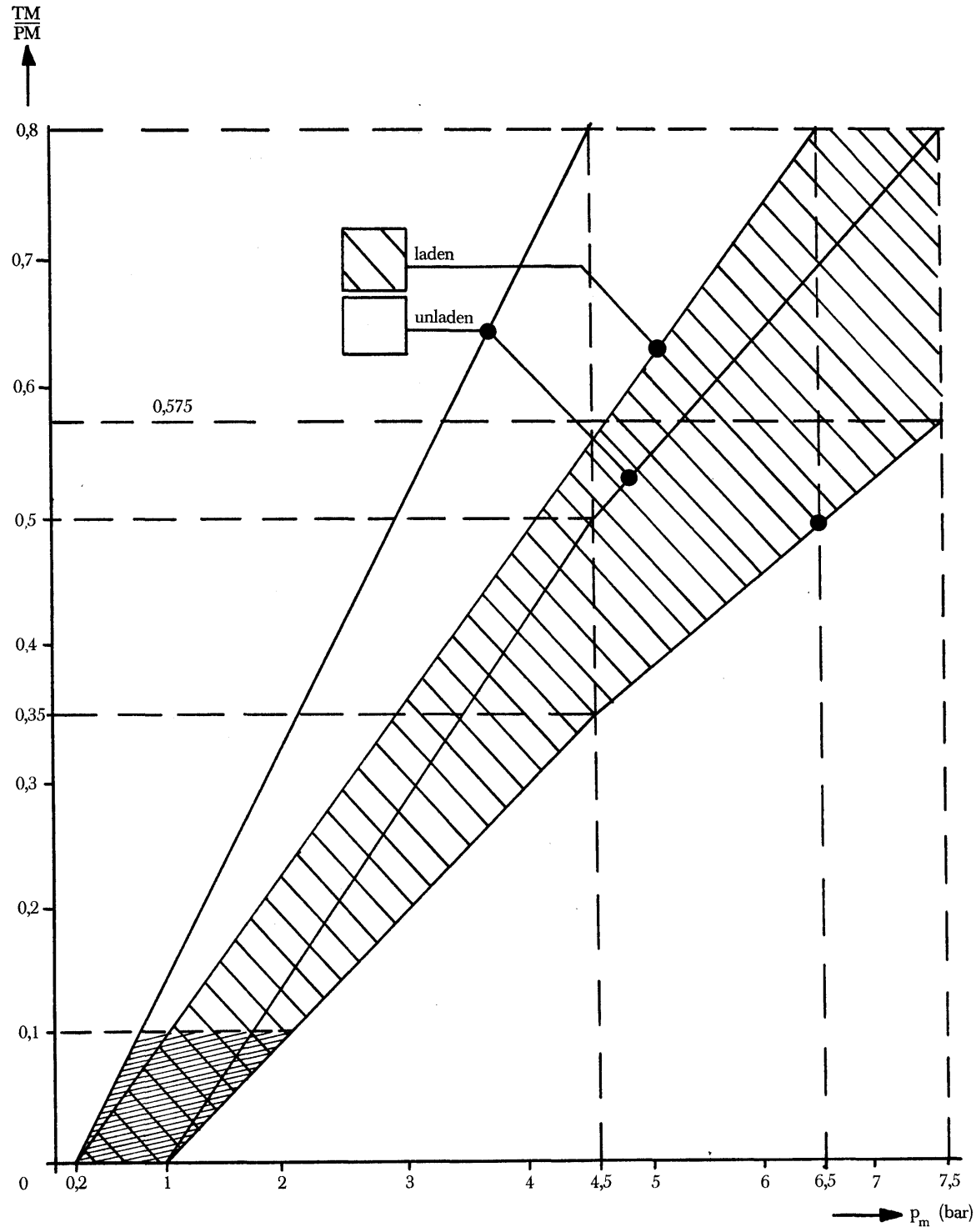
(2) The relationships required by the diagram shall apply progressively for intermediate states of loading between the laden and the unladen states and shall be achieved by automatic means.

▼M2

DIAGRAM 3

TRACTIVE UNITS FOR SEMI-TRAILERS

(see item 3.1.5)



Note:

(1) Between the values $\frac{TM}{PM} = 0$ and $\frac{TM}{PM} = 0 \cdot 1$, it is not necessary that there should be proportionality between the braking rate $\frac{TM}{PM}$ and the service line pressure as measured at the coupling head.

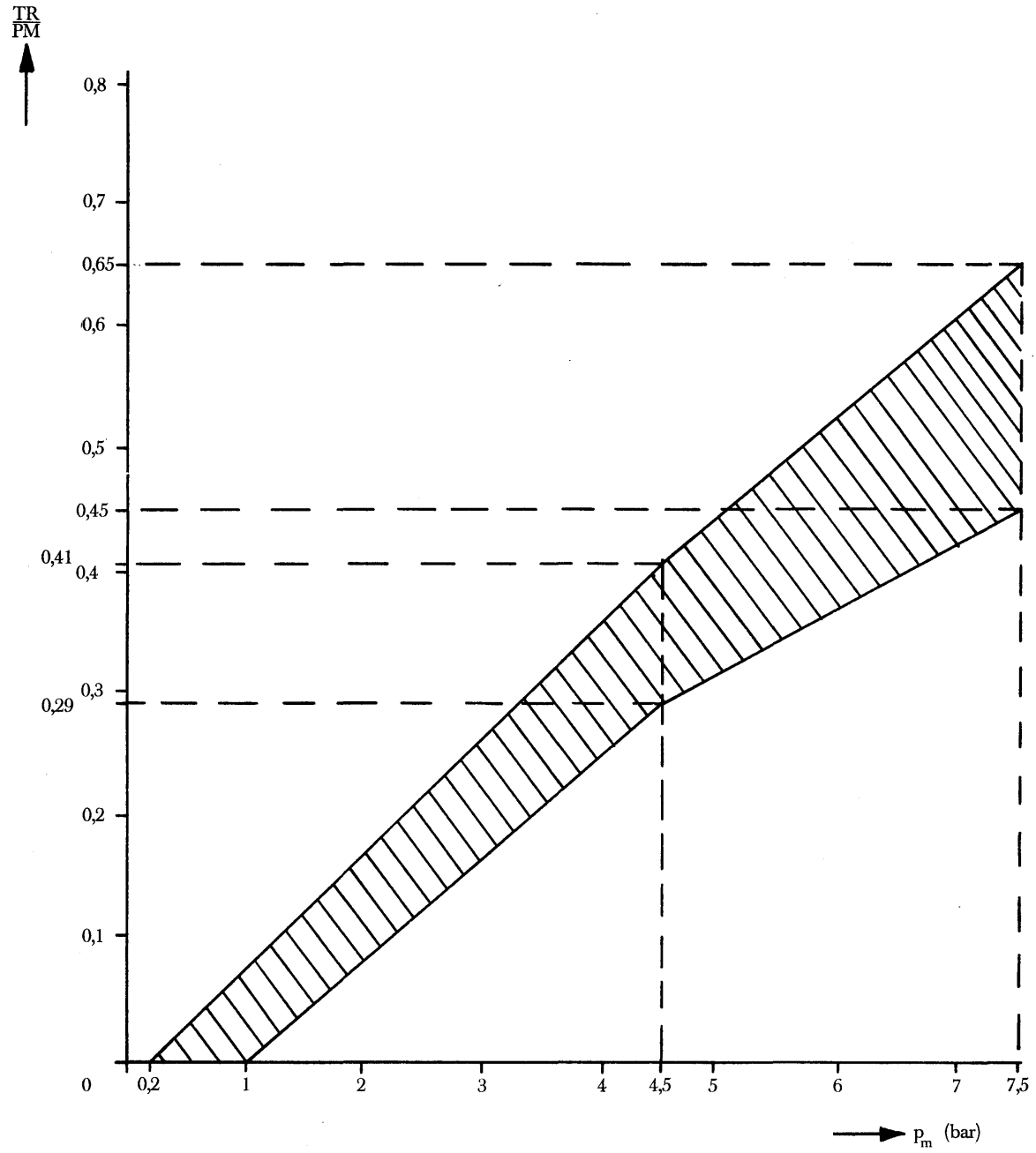
(2) The relationships required by the diagram shall apply progressively for intermediate states of loading between the laden and the unladen states and shall be achieved by automatic means.

▼M2

DIAGRAM 4 A

SEMI-TRAILERS

(see item 4)



The relationship between the braking rate $\frac{TR}{PR}$ and control line pressure for the laden and unladen condition is determined as follows:

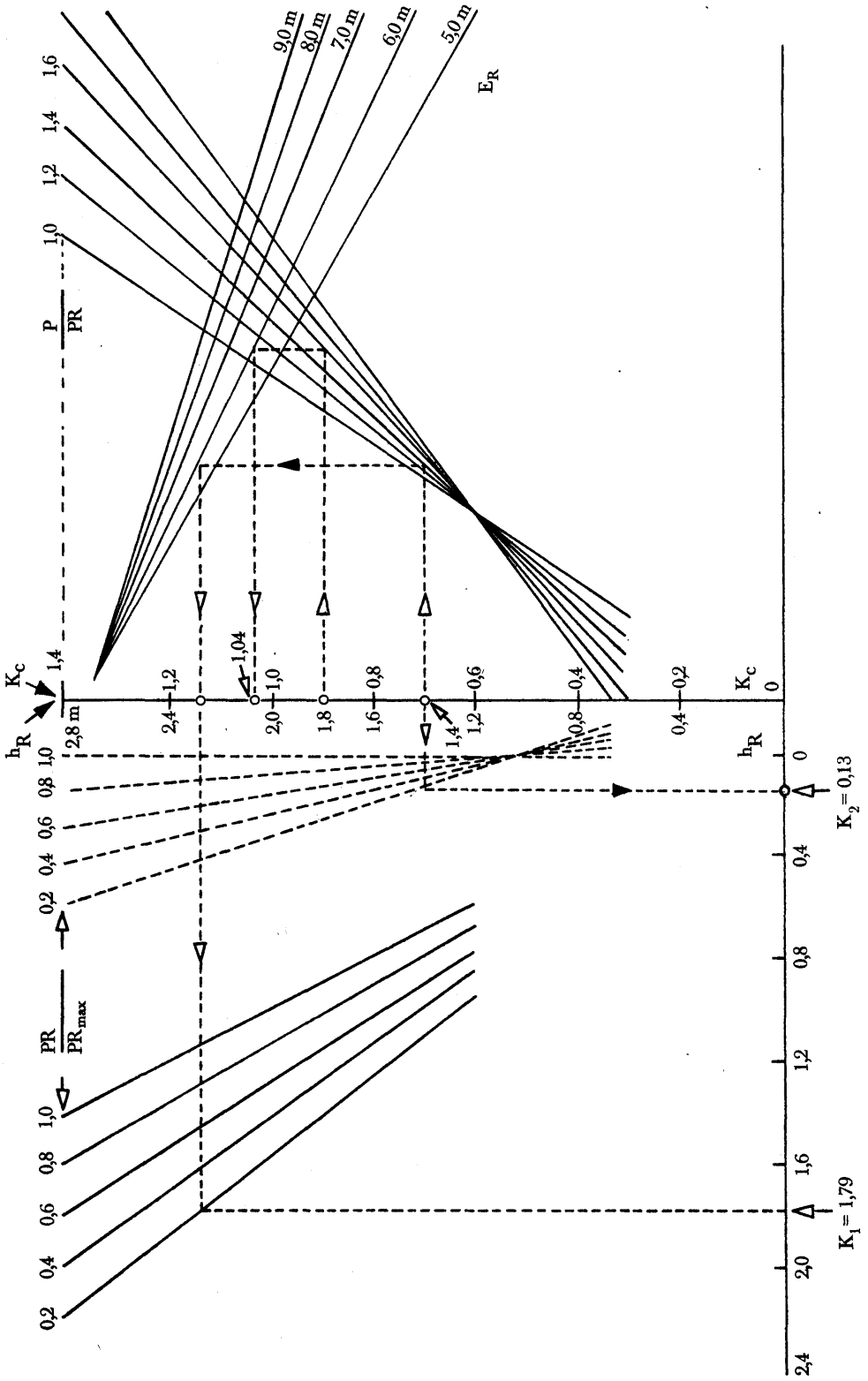
The factors K_c (laden), K_v (unladen) are obtained by reference to diagram 4 B.

Construct the laden and unladen bands by multiplying the upper and lower boundaries of the band in diagram 4 A shown below by the two factors obtained, K_c and K_v respectively.

▼**M2**

DIAGRAM 4 B

(see item 4)



▼M2

Explanatory note on the use of diagram 4B

1. Formula from which Diagram 4 B is derived is:

$$K = \left[1 \cdot 7 - \frac{0 \cdot 7\ PR}{PR_{max}}\right] \left[1 \cdot 35 - \frac{0 \cdot 96}{E_R}\left(1 \cdot 0 + (h_R - 1 \cdot 2)\ \frac{P}{PR}\right)\right] - \left[1 \cdot 0 - \frac{PR}{PR_{max}}\right] \left[\frac{h_R - 1 \cdot 0}{2 \cdot 5}\right]$$

2. Description of the method of use by means of a worked example.

2.1. The dashed lines shown on Diagram 4B refer to the determination of the factors K_c and K_v for the following vehicle where:

	Laden	Unladen
P	24 t	4·2 t
PR	15 t	3 t
PR_{max}	15 t	15 t
h_R	1·8 m	1·4 m
E_R	6·0 m	6·0 m

In the following items the figures in parenthesis relate only to the vehicle being used for the purpose of illustrating the method of use of Diagram 4B.

2.2. Calculate the ratios

(a) $\left[\frac{P}{PR}\right]$ laden (= 1·6)

(b) $\left[\frac{P}{PR}\right]$ unladen (= 1·4)

(c) $\left[\frac{PR}{PR_{max}}\right]$ unladen (= 0·2)

2.3. Determination of the laden factor, K_c

(a) Start at appropriate h_R (h_R = 1·8 m)

(b) Move horizontally to the appropriate P/PR line (P/PR = 1·6)

(c) Move vertically to appropriate E_R line (E_R = 6·0) m

(d) Move horizontally to K_c scale, K_c is the laden factor required (K_c = 1·04).

2.4. Determination of the unladen factor, K_v.

2.4.1. Determination of the factor K_2

(a) Start at appropriate h_R (h_R = 1·4) m

(b) Move horizontally to appropriate PR/PR_{max} line in group of curves nearest to vertical axis (PR/PR_{max} = 0·2)

(c) Move vertically to horizontal axis and read off the value of K_2 (K_2 = 0·13 m).

2.4.2. Determination of factor K_1

(a) Start at appropriate h_R (h_R = 1·4 m)

(b) Move horizontally to the appropriate P/PR line (P/PR = 1·4)

(c) Move vertically to the appropriate E_R line (E_R = 6·0 m)

(d) Move horizontally to the appropriate PR/PR_{max} line in group of curves furthest from the vertical axis.

(PR/PR_{max} = 0·2)

(e) Move vertically to horizontal axis and read off the value of K_1 (K_1 = 1·79).

2.4.3. Determination of factor K_v

The unladen factor K_v is obtained from the following expression: $K_v = K_1 - K_2$ ($K_v = 1 \cdot 66$).

▼B

ANNEX III

▼M3

METHOD OF MEASURING THE REACTION TIME FOR VEHICLES FITTED WITH COMPRESSED AIR BRAKING DEVICES

▼B

1. GENERAL REQUIREMENTS

▼M4

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.

▼B

1.2. During the tests, the stroke of the brake cylinders of the individual axles must be that corresponding to the most closely adjusted brakes.

▼M3

1.3. The times determined in implementing the provisions of this Annex shall be rounded to the nearest 10th of a second. If the figure representing the 100ths is five or more, the reaction time shall be rounded up to the next higher 10th.

▼B

2. MOTOR VEHICLES

2.1. At the start of each test, the pressure in the reservoirs must be equal to the minimum pressure at which the governor starts feeding the installation again. In installations not fitted with a governor (e.g. pressure limited compressor) the pressure in the reservoir at the start of each test must be equal to 90% of the pressure stated by the manufacturer, as defined in item 1.2.2.1 of Annex IV, to be used for tests prescribed in this Annex.

2.2. Reaction times in terms of actuation time (tf) shall be obtained by a series of actuations to the fullest extent, starting from the shortest possible up to a time of about 0·4 seconds. The values measured must be given on a diagram.

2.3. Reaction times corresponding to an actuation time of 0·2 seconds shall be determinant for the test. This reaction time can be obtained from the diagram by interpolation.

2.4. In the case of the actuation time of 0·2 seconds, the time elapsing between the beginning of actuation of the control pedal and the moment when the pressure in the brake cylinder reaches 75% of its asymptotic value must not exceed 0·6 seconds.

▼M3

2.5. In the case of motor vehicles having a brake coupling for trailers, in addition to the requirements of item 1.1 the reaction time must be measured at the extremity of a pipe 2·5 m long with an internal diameter of 13 mm which shall be joined to the coupling head of the control line of the service brake. During this test a volume of 385 ± 5 cm^3 (which is deemed to be equivalent to the volume of a pipe 2·5 m long with an internal diameter of 13 mm and under a pressure of 6·5 bar) shall be connected to the coupling head of the supply line.

Tractive units for semi-trailers must be equipped with flexible pipes for making the connection to semi-trailers. The coupling heads will therefore be at the extremity of those flexible pipes. The length and internal diameter of the pipes shall be entered at item 14.6 of the document corresponding to the model described in Annex IX.

▼B

2.6. The time which elapses between the start of the activation of the control pedal and the moment when the pressure measured at the coupling head of the control pipe reaches x% of its asymptotic value must not exceed the values listed in the table below:

▼B

x (%)	t (seconds)
10	0·2
75	0·4

3. TRAILERS (including semi-trailers)

3.1. The reaction times for trailers shall be measured without a drawing vehicle. To simulate the drawing vehicle it is necessary to provide a simulator to which the coupling heads of the control pipe and of the feed pipe of the trailer are to be connected.

3.2. The pressure in the feed pipe must be 6·5 bars. ►M3 ——————— ◄

3.3. The simulator must have the following features:

▼M3

3.3.1. It must have a reservoir with a capacity of 30 litres which shall be charged to a pressure of 6·5 bar before each test and which must not be recharged during each test. At the outlet of the braking control device the simulator must incorporate an orifice with a diameter of from 4·0 to 4·3 mm inclusive. The volume of the pipe measured from the orifice up to and including the coupling head shall be 385 ± 5 cm^3 (which is deemed to be equivalent to the volume of a pipe 2·5 m long with an internal diameter of 13 mm and under a pressure of 6·5 bar). The control line pressures referred to in item 3.3.3 shall be measured immediately downstream of the orifice.

3.3.2. The braking control device must be so designed that its performance in use is not affected by the tester.

3.3.3. The simulator must be set, e.g. through the choice of orifice in accordance with item 3.3.1, in such a way that, if a reservoir of 385 ± 5 cm^3 is joined to it, the time taken for the pressure to increase from 0·65 to 4·9 bar (10 and 75% respectively of the nominal pressure of 6·5 bar), shall be 0·2 ± 0·01 second. If a reservoir of 1 155 ± 15 cm^3 is substituted for the abovementioned reservoir, the time taken for the pressure to increase from 0·65 to 4·9 bar without further adjustment shall be 0·38 ± 0·02 second. Between these two pressure values the pressure must increase in an approximately linear way. These reservoirs shall be connected to the coupling head without using flexible pipes and shall have an internal diameter of not less than 10 mm.

3.3.4. The diagram in the Appendix to this Annex gives an example of the correct configuration and use of the simulator.

3.4. The time elapsing between the moment when the pressure produced in the control line by the simulator reaches 0·65 bar and the moment when the pressure in the brake actuator of the trailer reaches 75% of its asymptotic value must not exceed 0·4 second.

4. PRESSURE TEST CONNECTIONS

▼M4

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.

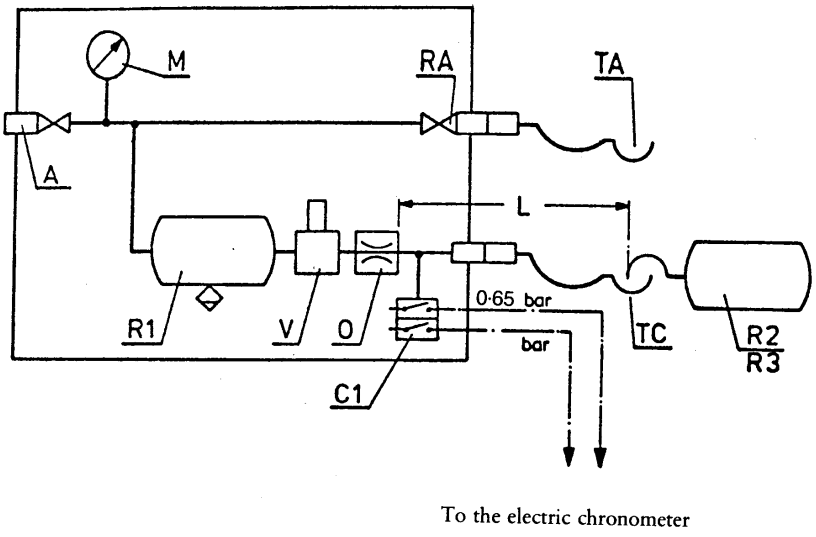
4.2. The pressure test connections shall comply with clause 3 of ISO Standard 3583/1982.

▼M3

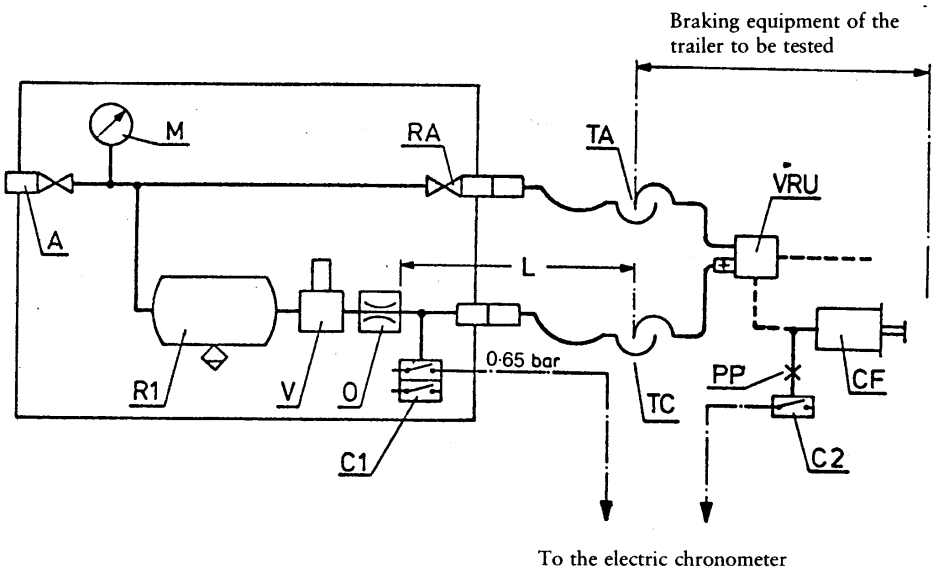
APPENDIX

EXAMPLE OF A SIMULATOR (SEE ANNEX III, ITEM 3)

1. Setting the simulator



2. Testing the trailer



A = supply connection with shut-off valve

C1 = pressure switch in the simulator, set at 0·65 bar and at 4·9 bar

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

CF = brake actuator

L = line from orifice O up to and including its coupling head TC, having an inner volume of 385 ± 5 cm^3 under a pressure of 6·5 bar

M = pressure gauge

O = orifice with a diameter of not less than 4 mm and not more than 4·3 mm

PP = pressure test connection

R1 = 30 litre air reservoir with drain valve

R2 = calibrating reservoir, including its coupling head TC, to be 385 ± 5 cm^3

R3 = calibrating reservoir, including its coupling head TC, to be 1 155 ± 15 cm^3

RA = shut-off valve

▼**M3**

TA = coupling head, supply line

TC = coupling head, control line

V = braking control device

VRU = emergency relay valve

▼B

ANNEX IV

▼M4

ENERGY RESERVOIRS AND SOURCES OF ENERGY

A. *COMPRESSED-AIR BRAKING SYSTEMS*

▼B

1. CAPACITY OF RESERVOIRS

1.1. **General requirements**

1.1.1. Vehicles on which the operation of the braking devices depends on the use of compressed air must be fitted with reservoirs of a capacity meeting the requirements of items 1.2 and 1.3 below.

1.1.2. Nevertheless, the capacity of reservoirs shall not be laid down where 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.

1.1.3. When verifying compliance with the requirements of items 1.2 and 1.3 the brakes must be adjusted as closely as possible.

1.2. **Motor vehicles**

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1.2.1. The air brake reservoirs of motor vehicles shall be so designed that after eight full-stroke actuations of the service brake control the pressure remaining in the air brake reservoir shall be not less than the pressure required to obtain the specified secondary braking performance.

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1.2.2. During the test, the following requirements are to be satisfied:

1.2.2.1. The initial pressure in the reservoirs must be that indicated by the manufacturer. This pressure must be such as to enable the prescribed performance for the service braking to be achieved;

1.2.2.2. The reservoir or reservoirs must not be replenished; in addition, the reservoir or reservoirs of auxiliary equipment must be isolated;

1.2.2.3. In the case of motor vehicles to which the coupling of a trailer or semi-trailer is authorised, the feed line must be blocked off and a reservoir of 0·5 litre capacity must be connected to the control line. The pressure in this reservoir must be exhausted before each actuation of the brakes. After the test referred to in item 1.2.1 the pressure in the control line must not be less than one half of the pressure obtained at the first brake application.

1.3. **Trailers (including semi-trailers)**

1.3.1. Reservoirs fitted to trailers must be such that after eight full-stroke actuations of the drawing vehicle's service braking device, the pressure supplied to the operating parts using it is not less than one half of the pressure obtained at the first brake application.

1.3.2. During the test, the following requirements are to be satisfied:

1.3.2.1. The pressure in the reservoirs at the beginning of the test must be equal to the maximum specified by the manufacturers;

1.3.2.2. The feed line must be blocked off; in addition, the auxiliary equipment reservoirs must be isolated;

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

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1.3.2.4. For each application of the brakes, the pressure in the control pipe must correspond to the maximum specified by the manufacturer.

▼B

2. CAPACITY OF ENERGY SOURCES

2.1. **General provisions**

Compressors must satisfy the requirements laid down in the following items:

2.2. **Definitions**

2.2.1. p_1 is the pressure corresponding to 65% of the pressure p_2 defined in item 2.2.2

2.2.2. p_2 is the value specified by the manufacturer and referred to in item 1.2.2.1

2.2.3. T_1 is the time required for the relative pressure to rise from O to p_1; T_2 is the time required for the relative pressure to rise from O to p_2.

2.3. **Conditions of measurement**

2.3.1. In all cases the rpm speed of the compressor shall be that obtained when the engine is running at the speed corresponding to its maximum power or at the speed allowed by the control valve.

2.3.2. The auxiliary equipment reservoirs shall be isolated during the tests for determining the periods T_1 and T_2.

2.3.3. On motor vehicles constructed to draw trailers, the trailer shall be represented by a reservoir whose maximum relative pressure p (expressed in bars) is that which can be supplied through the feed circuit of the drawing vehicle and whose volume V (expressed in litres) is given by the formula $p \cdot V = 20\ R$ (R being the permissible maximum load, expressed in metric tons, on the axles of the trailer or semi-trailer).

2.4. **Interpretation of results**

2.4.1. The time T_1 for the least efficient reservoir must not exceed:

— three minutes in the case of vehicles to which the coupling of a trailer or semi-trailer is not authorised;

— six minutes in the case of vehicles to which the coupling of a trailer or semi-trailer is authorised.

2.4.2. The time T_2 for the least efficient reservoir must not exceed:

— six minutes in the case of vehicles to which the coupling of a trailer or semi-trailer is not authorised;

— nine minutes in the case of vehicles to which the coupling of a trailer or semi-trailer is authorised.

2.5. **Additional test**

2.5.1. When the vehicle is equipped with an auxiliary equipment reservoir or reservoirs with a total capacity exceeding 20% of the total capacity of the brake reservoirs, an additional test must be carried out during the course of which there must be no interference with the functioning of the valves controlling the filling of the auxiliary equipment reservoir(s). A check must be made during the course of this test that the period T_3 required to bring about a rise in the pressure in the brake reservoirs from O to p_2 is less than:

— eight minutes in the case of vehicles to which the coupling of a trailer or semi-trailer is not authorised;

— eleven minutes in the case of vehicles to which the coupling of a trailer or semi-trailer is authorised.

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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.

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3. PRESSURE TEST CONNECTIONS

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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.

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

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] The initial energy level shall be stated in the approval document.

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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.

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] The initial energy level shall be stated in the approval document.

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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.

▼**M4**

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.

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ANNEX V

SPRING BRAKES

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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.

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2. GENERAL REQUIREMENTS

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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.

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.

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.

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2.4. In motor vehicles, the system must be so designed that it is possible to apply and release the brakes at least three times if the initial pressure in the spring compression chamber is equal to the maximum design pressure. In the case of trailers, it must be possible to release the brakes at least three times after the trailer has been uncoupled, the pressure in the supply line being 6·5 bar before the uncoupling. These conditions must be satisfied when the brakes are adjusted as closely as possible. In addition, it must be possible to apply and release the parking brake as specified in Annex I, item 2.2.2.10, when the trailer is coupled to the towing vehicle.

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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.

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.

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2.7. On motor vehicles fitted with spring brakes and authorised to draw trailers with continuous or semi-continuous brakes, automatic application of the spring brakes must cause the trailer brakes to be applied.

3. RELEASE SYSTEM

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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.

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3.2. If the operation of the auxiliary device referred to in item 3.1 requires the use of a tool or spanner, the tool or spanner must be kept on the vehicle.

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ANNEX VI

PARKING BRAKING BY MECHANICAL LOCKING OF THE BRAKE CYLINDERS

(lock actuators)

1. DEFINITION

'Mechanical locking of the brake cylinders' means a device for ensuring parking braking by mechanical wedging of the brake piston rod.

Mechanical locking occurs when the locking chamber is emptied of compressed air; the mechanical locking device shall be designed in such a way that it can be released when the locking chamber is again subjected to pressure.

2. SPECIAL PROVISIONS

2.1. When the pressure in the locking chamber approaches the level corresponding to mechanical locking, an optical or audible warning system must be actuated. ►M3 This provision shall not apply to trailers. In the case of trailers the pressure corresponding to mechanical locking must not exceed 4 bar. It must be possible to achieve parking brake performance after any single failure of the trailer service braking system. In addition, it must be possible to release the brakes at least three times after the trailer has been uncoupled, the pressure in the supply line being 6·5 bar before the uncoupling. These conditions must be satisfied when the brakes are adjusted as closely as possible. It must also be possible to apply and release the parking brake as specified in Annex I, item 2.2.2.10, when the trailer is coupled to the towing vehicle. ◄

2.2. In the case of brake actuators fitted with a mechanical locking device, the brake actuator must be capable of being actuated by either of two energy reserves.

2.3. The locked brake cylinder may only be released if it is certain that the brake can be operated again after such release.

2.4. In the event of a failure of the source of energy supplying the locking chamber, an auxiliary unlocking device (mechanical or pneumatic, for instance) using, for example, the air in one of the tyres of the vehicle, must be provided.

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2.5. The control must be such that, when actuated, it performs the following operations in sequence: it applies the brakes so as to provide the degree of efficiency required for parking braking, locks the brakes in that position and then cancels out the brake-application force.

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ANNEX VII

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

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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:

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1.1. where the vehicle in question is a motor vehicle, a trailer or a semi-trailer which, in respect of tyres, braking energy absorbed by each axle and method of fitting of tyres and brakes, is identical, as far as braking is concerned, to a motor vehicle, a trailer, or a semi-trailer which:

1.1.1. has passed a Type I and/or II (or II A) test;

1.1.2. has been type approved, with regard to braking energy absorbed, for axle ►M3 masses ◄ greater than or equal to those of the vehicle submitted for type approval.

1.2. where the vehicle in question is a motor vehicle, a trailer or a semi-trailer of which the axle or axles, in respect of tyres, braking energy absorbed by each axle and method of fitting of tyres and brakes, is or are identical, as far as braking is concerned, to an axle or axles which has or have individually passed a Type I and/or II test for axle ►M3 masses ◄ greater than or equal to those of the vehicle submitted for type approval, provided that the braking energy absorbed by each axle does not exceed the energy absorbed by that axle during the reference test or tests carried out separately on that axle.

1.3. where the vehicle submitted for type approval is fitted with a retarder, other than an engine brake, identical to a retarder which has already been tested under the following conditions:

1.3.1. in a test carried out on a gradient of at least 6% (Type II test) or of at least 7% (Type II A test), this retarder has, on its own, stabilised the speed of a vehicle with a ►M3 maximum mass ◄ at the time of testing at least equal to the ►M3 maximum mass ◄ of the vehicle submitted for type approval;

1.3.2. in the above test, a check must be made as to whether the speed of rotation of the revolving parts of the retarder is such that, when the vehicle submitted for type approval is travelling at a speed of 30 km/h, the retarding torque is at least equal to the retarding torque in the test mentioned in item 1.3.1.

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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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2. The term 'identical' as used in items 1.1, 1.2 and 1.3 means identical as regards the geometrical and mechanical characteristics of the vehicle parts mentioned in those items, and also as regards the characteristics of the materials from which these parts are made.

3. When advantage is taken of the above provisions, the type approval communication in respect of braking (Annex IX) must contain the following particulars:

3.1. where item 1.1 is applicable, the type of the approval number of the vehicle on which the Type I and/or II (or II A) test serving as a reference test has been carried out (item 14.7.1 of Annex IX);

3.2. where item 1.2 is applicable, the table in item 14.7.2 of the model item of the communication in Annex IV must be completed;

3.3. where item 1.3 is applicable, the table in item 14.7.3 of the model of the communication in Annex IX must be completed;

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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.

[1] Other brake designs may be approved upon presentation of equivalent information.

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4. When a person applying for type approval in a Member State refers to a type approval granted in another Member State, that person must produce the documents relating to such approval.

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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

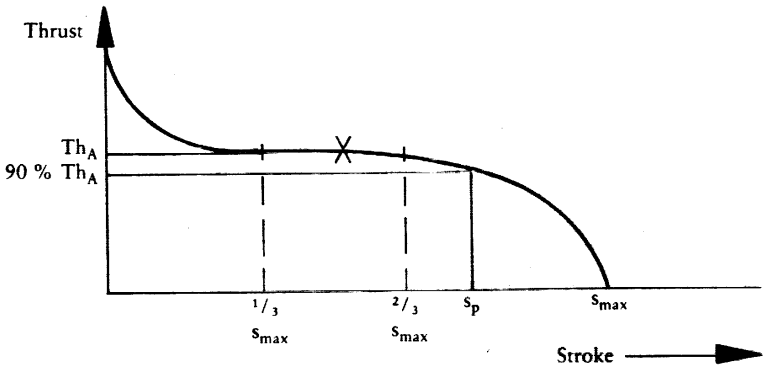
M = braking torque = $T \cdot R$

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

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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;

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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 ºC, 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 ºC, 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 ºC, 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:

▼M4

	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

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

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

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

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

▼M4

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.

▼M4

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.

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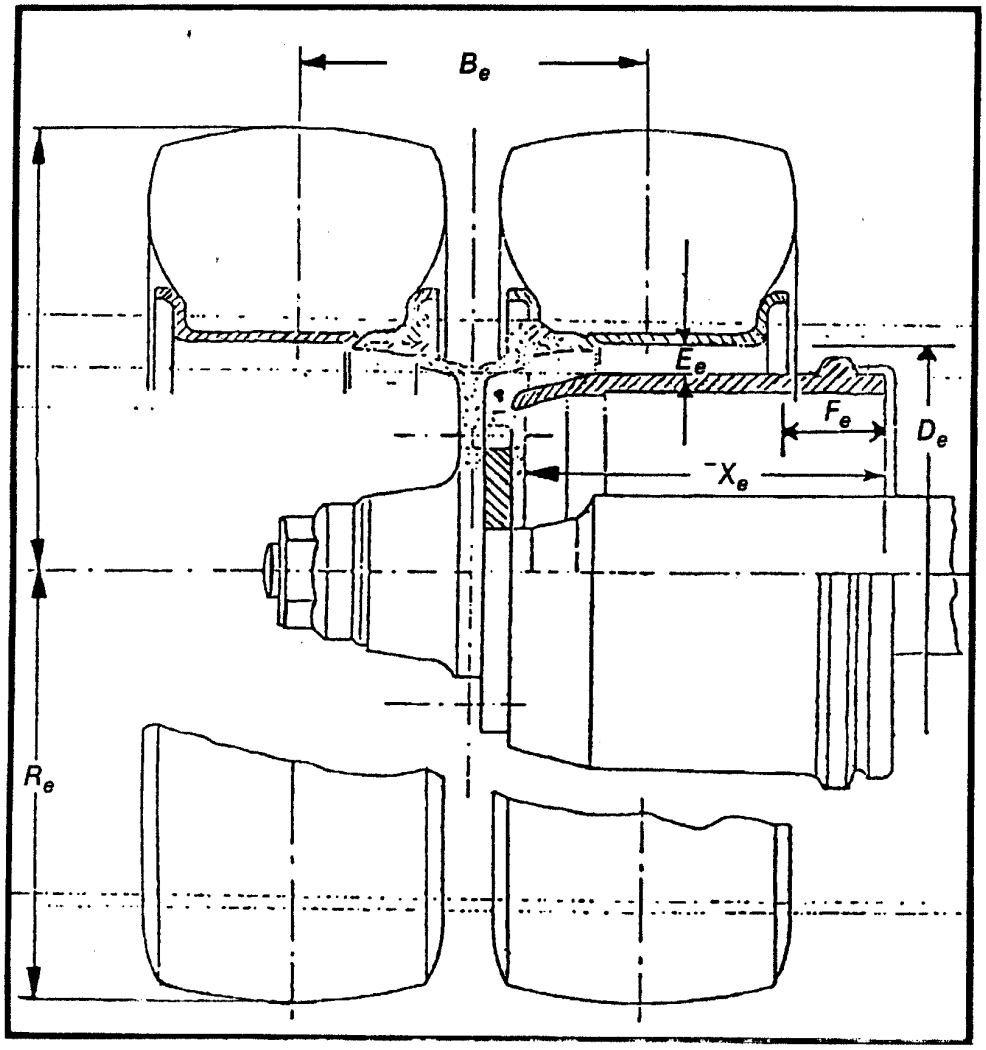
3. Name of technical service conducting the test:

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_c	Axle load (kg)	Tyre	Rim	B_c	R_c	D_e	E_c	F_c
				← mm →				

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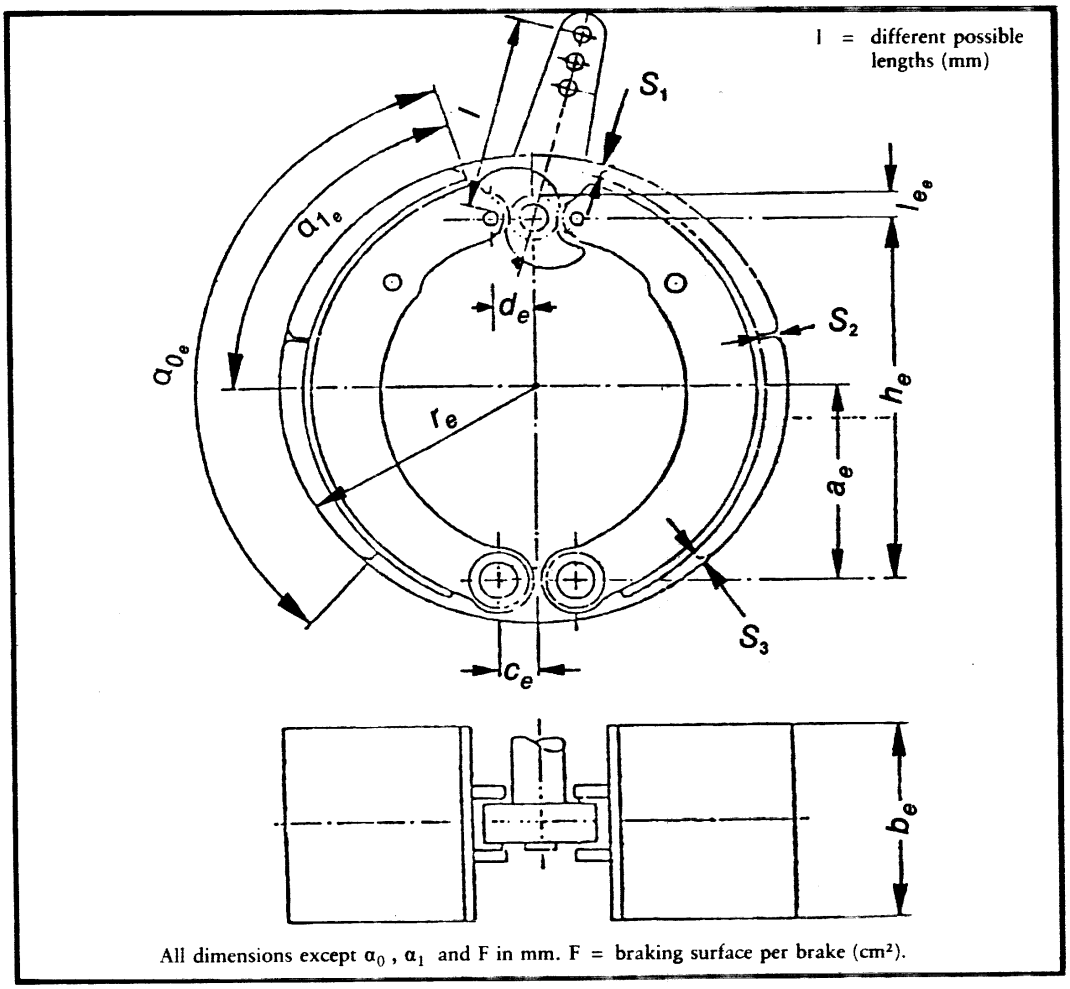
Figure 2

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}

▼B

ANNEX VIII

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

1. GENERAL PROVISIONS

1.1. The inertia (overrun) braking device of a trailer comprises the control device, the transmission and the brakes proper, hereinafter called 'brakes'.

1.2. The control device is the combination of components comprising the coupling head.

1.3. The transmission is the combination of components comprised between the coupling head and the first part of the brake.

1.4. The 'brake' is the part in which the forces opposing the movement of the vehicle develop. The first part of the brake is either the lever actuating the brake cam or similar parts (mechanical-transmission inertia brake) or the brake cylinder (hydraulic-transmission inertia brake).

1.5. Braking devices in which accumulated energy (for instance, electric, pneumatic or hydraulic) is transmitted to the trailer by the drawing vehicle and is only controlled by the force at the coupling shall not be deemed to be inertia braking devices within the meaning of this Directive.

1.6. Two axles with a wheelbase of less than one metre (tandem axle) shall, for the purposes of this Annex, also be deemed to be one axle.

1.7. **Tests**

1.7.1. Determination of the main characteristics of the brake.

1.7.2. Determination of the main characteristics of the control device and testing as to whether that device conforms with the provisions of this Directive.

1.7.3. Testing on the vehicle

— the compatibility of the control device and the brake

— the transmission.

2. SYMBOLS AND DEFINITIONS

2.1. **Units used**

2.1.1. ►**M3** Masses ◄ and forces:	►**M3** Newton (N) ◄
2.1.2. Torques and moments:	►**M3** Newton metre (Nm) ◄
2.1.3. Areas:	cm^2
2.1.4. Pressures:	►**M3** bar (bar) ◄
2.1.5. Lengths:	units specified in each case.

2.2. **Symbols valid for all types of brakes** (see diagram in Appendix 1, p. 771)

2.2.1. G_A: '►**M3** maximum mass ◄' of the trailer declared to be technically permissible by the manufacturer;

2.2.2. G'_A: '►**M3** maximum mass ◄' of the trailer which, according to the manufacturer's declaration, can be braked by the control device;

2.2.3. G_B: '►**M3** maximum mass ◄' of the trailer which can be braked by the joint operation of all the trailer brakes

$$G_B = n \cdot G_{Bo}$$

2.2.4. G_{Bo}: Fraction of the permissible '►**M3** maximum mass ◄' which, according to the manufacturer's declaration, can be braked by one brake;

2.2.5. B*: braking force required;

▼B

2.2.6. B: required braking force taking account of rolling resistance;

2.2.7. D*: permitted thrust on coupling;

2.2.8. D: load on the coupling;

2.2.9. P′: control device output force;

2.2.10. K: supplementary force of control device by convention; this is defined as the force D corresponding to the point of intersection of the x axes of the extrapolated curve expressing P′ in terms of D, measured with the control system in the mid-travel position (see graph in Appendix 1, p. 772);

2.2.11. K_A: threshold force of control device—this is the maximum force on the coupling head which can be applied for a short period of time without producing any output force on the control device. By convention, K_A is defined as the force measured when force begins to be exerted on the coupling head at a speed of from 10 to 15 mm/s, the control device transmission being uncoupled;

2.2.12. D_1: this is the maximum force applied to the coupling head when it is forced rearward at a speed of s mm/s ± 10%, the transmission being uncoupled;

2.2.13. D_2: this is the maximum force applied to the coupling head when this is pulled forward at a speed of s mm/s ± 10% from its rearmost position, the transmission being uncoupled;

2.2.14. ηHo: efficiency of the inertia control device;

2.2.15. ηH_1: efficiency of the transmission system;

2.2.16. ηH: total efficiency of the control device and of the transmission

$$\eta H = \eta Ho \cdot \eta H_1;$$

2.2.17. s: travel of control (expressed in millimetres);

2.2.18. s′: effective travel of control (expressed in millimetres) fixed in accordance with the requirements of item 9.4.1;

2.2.19. s′: ►**M4** spare travel ◄ of the master cylinder actuator, measured in millimetres at the coupling head;

2.2.20. s_o: loss of travel, that is to say the travel, measured in millimetres, of the coupling head when it is actuated in such a way as to travel from a point 300 mm above the horizontal plane to a point 300 mm below, the transmission remaining stationary;

2.2.21. $2s_B$: brake-shoe lift measured on the diameter parallel to the operating mechanism and without the brakes being adjusted during the test (expressed in millimetres);

2.2.22. $2s_B$*: minimum brake-shoe lift (expressed in millimetres)

$$2s_{B*} = 2 \cdot 4 + \frac{4}{1000} \cdot 2r;$$

2r being the diameter of the brake drum expressed in millimetres (see diagram in Appendix 1, p. 773);

2.2.23. M: braking moment;

2.2.24. R: radius of pneumatic tyres (in metres) measured under load from wheel centre to ground level on the vehicle being tested (rounded to the nearest centimetre);

2.2.24. n: number of brakes;

2.3. **Symbols for mechanical transmission brakes** (see diagram in Appendix 1, p. 774)

2.3.1. i_{Ho}: reduction ratio between travel of the coupling head and travel of the lever at the output side of the control device;

▼B

2.3.2. $i_{H'}$: reduction ratio between travel of the lever at the output side of the control device and travel of the brake lever (gearing down of transmission);

2.3.3. i_H: reduction ratio between travel of the coupling head and travel of the brake lever

$i_H = i_{Ho} \cdot i_{H_1}$;

2.3.4. i_g: reduction ratio between travel of the brake lever and the brake-shoe centre lift (see diagram in Appendix 1, page 773);

2.3.5. P: force applied to the brake control lever;

2.3.6. P_o: brake retraction force; that is, in the graph M = f (P), the value of the force P at the point of intersection of the extrapolation of this function with the abscissa (see graph in Appendix 1, p. 775);

2.3.7. ρ: characteristic of the brake defined by: $M = \rho\ (P - P_o)$

2.4. **Symbols for hydraulic-transmission brakes** (see diagram in Appendix 1, p. 776).

2.4.1. i_h: reduction ratio between travel of the coupling head and travel of the piston in master cylinder;

2.4.2. i_g': reduction ratio between travel of the actuation point of the cylinders and the brake-shoe centre lift;

2.4.3. F_{RZ}: surface area of piston in brake cylinder;

2.4.4. F_{HZ}: surface area of piston in master cylinder;

2.4.5. p: hydraulic pressure in brake cylinder;

2.4.6. p_o: retraction pressure in brake cylinder; that is, in the graph M = f(p), the value of the pressure p at the point of intersection of the extension of this function with the abscissa (see graph in Appendix 1, p. 775).

2.4.7. ρ′: characteristic of the brake defined by: $M = \rho'\ (p - p_o)$.

3. GENERAL REQUIREMENTS

3.1. The transmission of braking power from the coupling head to the trailer's brakes must be effected either by a rod linkage or by means of one or more fluids. However, a sheathed cable (Bowden cable) may be used to provide part of the transmission. This part must be as short as possible.

3.2. All pins at joints must be adequately protected. In addition, these joints must be either self-lubricating or easily accessible for lubrication.

▼M4

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.

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.

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.

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4. REQUIREMENTS FOR CONTROL DEVICES

4.1. The sliding members of the control device must be long enough to enable the brake to be fully applied, even when the trailer is coupled.

4.2. The sliding members must be protected by a bellows or some equivalent device. They must either be lubricated or be constructed of self-lubricating materials. The surfaces in frictional contact must be made

▼B

of a material such that there is neither electrochemical torque nor any mechanical incompatibility liable to cause the sliding members to seize.

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▼B

►M4 4.3. ◄ The threshold force of the control equipment (K_A) must be not less than 0·02 G'_A and not more than 0·04 G'_A.

▼M4

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.

▼B

►M4 4.5. ◄ The maximum towing force D_2 must be between 0·1 G'_A and 0·5 G'_A.

5. TESTS AND MEASUREMENTS TO BE CARRIED OUT ON THE CONTROL SYSTEM

5.1. Compliance with the requirements of items 3 and 4 above must be verified on the control device submitted to the technical service conducting the tests.

5.2. The following shall be measured in respect of all types of brakes:

5.2.1. the travel s and the available travel s′;

5.2.2. the supplementary force K;

5.2.3. the threshold force K_A;

5.2.4. the damping force D_1;

5.2.5. the towing force D_2.

5.3. In the case of mechanical-transmission inertia brakes, the following shall be determined:

5.3.1. the reduction ratio i_{Ho}, measured at the mid-travel portion of the control;

5.3.2. the force P′ at the output side of the control device as a function of the thrust D on the drawbar.

The supplementary force K and the efficiency are derived from the representative curve obtained from these measurements.

$$\eta H_o = \frac{1}{i_{Ho}} \cdot \frac{P'}{D - K}$$

(see graph in Appendix 1, p. 772)

5.4. In the case of hydraulic-transmission inertia brakes, the following shall be determined:

5.4.1. the reduction ratio i_h measured at the mid-travel position of the control;

5.4.2. the pressure p at the output side of the master cylinder as a function of the thrust D on the drawbar and of the surface area F_{HZ} in the master cylinder piston, as specified by the manufacturer. The supplementary force K and the efficiency are derived from the representative curve obtained from these measurements

$$\eta H_o = \frac{1}{i_h} \cdot \frac{p \cdot F_{HZ}}{D - K}$$

(see graph in Appendix 1, page 772);

5.4.3. the ►M4 spare travel ◄ of the master cylinder actuator s″ mentioned in item 2.2.19.

▼M4

▼B

►M4 5.5. ◄ In the case of inertia brakes on multi-axle trailers, the loss of travel s_o mentioned in item 9.4.1 shall be measured.

6. REQUIREMENTS FOR BRAKES

6.1. The manufacturer must make available to the technical service responsible for the tests, in addition to the brakes to be tested, drawings of

▼B

the brakes showing the type, dimensions and material of the main parts, and the make and type of the linings. These drawings must indicate the surface area F_{RZ} of the brake cylinders in the case of hydraulic brakes. The manufacturer must also indicate the maximum braking torque M_{max} which is allowed, as well as the ►M3 mass ◄ G_{Bo} mentioned in item 2.2.4.

▼M4

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}.

▼B

7. TESTS AND MEASUREMENTS TO BE CARRIED OUT ON THE BRAKES

7.1. The brakes and items of equipment made available to the technical service responsible for the tests must be tested to check whether they conform to the requirements of item 6.

7.2. The following shall be determined:

7.2.1. the minimum shoe centre lift $2s_B$*;

7.2.2. the shoe centre lift $2s_B$ (which must be greater than $2s_B$*);

7.2.3. the braking moment M as a function of the force P applied to the control lever in the case of devices with mechanical transmission, and of the pressure p in the brake cylinder in the case of devices with hydraulic transmission.

▼M4

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:

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7.2.3.1. the retraction force P and the characteristic ρ in the case of mechanically actuated brakes (see graph in Appendix 1, p. 775).

7.2.3.2. the retraction pressure p_o and the characteristic ρ in the case of hydraulically actuated brakes (see graph in Appendix 1, p. 775).

8. TEST REPORTS

Where applications are made for type approval of trailers fitted with inertia brakes, such applications are to be accompanied by the test reports relating to the control system and the brakes, as well as the test report on the compatibility between the inertia control device, the transmission and the brakes on the trailer; these reports are to include at least the particulars shown in Appendices 2, 3 and 4 to this Annex.

9. COMPATIBILITY OF THE CONTROL DEVICE AND THE INERTIA BRAKES OF A VEHICLE

9.1. A check must be made on the vehicle, taking into account the characteristics of the control device (Appendix 2) and of the brakes (Appendix 3) as well as the trailer characteristics mentioned in item 4 of Appendix 4, as to whether the inertia braking device of the trailer complies with the requirements laid down.

9.2. **General tests for all types of brakes**

9.2.1. Those parts of the transmission which have not been tested at the same time as the brake control device or the brakes must be tested on the vehicle. The results of the test must be entered in Appendix 4 (for example $i_{H'}$ and $\eta_{H'}$).

9.2.2. ►M3 *Mass* ◄

9.2.2.1. The ►M3 maximum mass ◄ of the trailer G_A must not exceed the ►M3 maximum mass ◄ G'_A for which the control device is authorised.

▼B

9.2.2.2. The ►M3 maximum mass ◄ of the trailer G_A must not exceed the ►M3 maximum mass ◄ G_B which can be braked by the joint operation of all the trailer brakes.

9.2.3. *Forces*

9.2.3.1. The threshold force K_A must not be less than 0·02 G_A nor greater than 0·04 G_A.

9.2.3.2. The maximum damping force D_1 must not exceed 0·09 G_A in the case of single-axle trailers, nor 0·06 G_A in the case of multi-axle trailers.

9.2.3.3. The maximum pulling force D_2 must be between 0·1 G_A and 0·5 G_A.

▼M4

▼B

9.3. **Test of braking efficiency**

▼M4

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:

▼B

9.3.1.1. In the case of inertia brakes with mechanical transmission:

$$\left[\frac{B \cdot R}{\rho} + n\ P_o\right] \quad \frac{1}{(D* - K) \cdot \eta_H} \leq i_H$$

9.3.1.2. In the case of inertia brakes with hydraulic transmission:

$$\left[\frac{B \cdot R}{n \cdot \rho'} + p_o\right] \quad \frac{1}{(D* - K) \cdot \eta_H} \leq \frac{i_h}{F_{HZ}}$$

9.4. **Control travel test**

▼M4

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′.

▼B

9.4.2. The available travel of the control s′ shall be determined in the following way:

9.4.2.1. if the brake rod system is affected by the relative position of the towing device, then:

$$s' = s - s_o;$$

9.4.2.2. if there is no loss of travel, then:

$$s' = s;$$

9.4.2.3. in the case of hydraulic braking systems:

$$s' = s - s''.$$

9.4.3. The following inequalities shall be applied in order to check whether the travel of the control is adequate:

▼B

9.4.3.1. in the case of inertia brakes with mechanical transmission:

$$i_H \leq \frac{s'}{s_B * \cdot i_g}$$

9.4.3.2. in the case of inertia brakes with hydraulic transmission:

$$\frac{i_h}{F_{HZ}} \leq \frac{s'}{2s_B * \cdot n\ F_{RZ} \cdot i'_g}$$

9.5. **Additional tests**

9.5.1. In the case of inertia brakes with mechanical transmission, a check shall be made as to whether the rod system by which the forces are transmitted from the control device is correctly fitted.

9.5.2. In the case of inertia brakes with hydraulic transmission, a check shall be made as to whether the travel of the master cylinder actuator reaches a minimum level of s/i_h.

A lower level will not be permitted.

9.5.3. A road test must be carried out to determine the general reaction of the vehicle to braking.

10. GENERAL COMMENTS

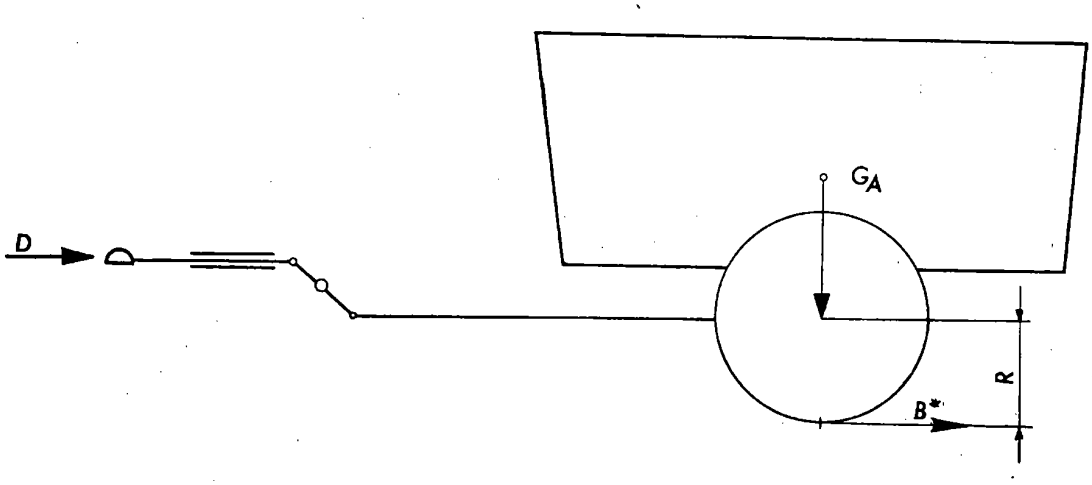
The above provisions apply to the latest models of inertia brakes with mechanical or hydraulic transmission; in the case of these models, in particular, all the wheels of the trailer are fitted with the same type of brake and the same type of tyre.

When testing special models, the above requirements are to be adapted.

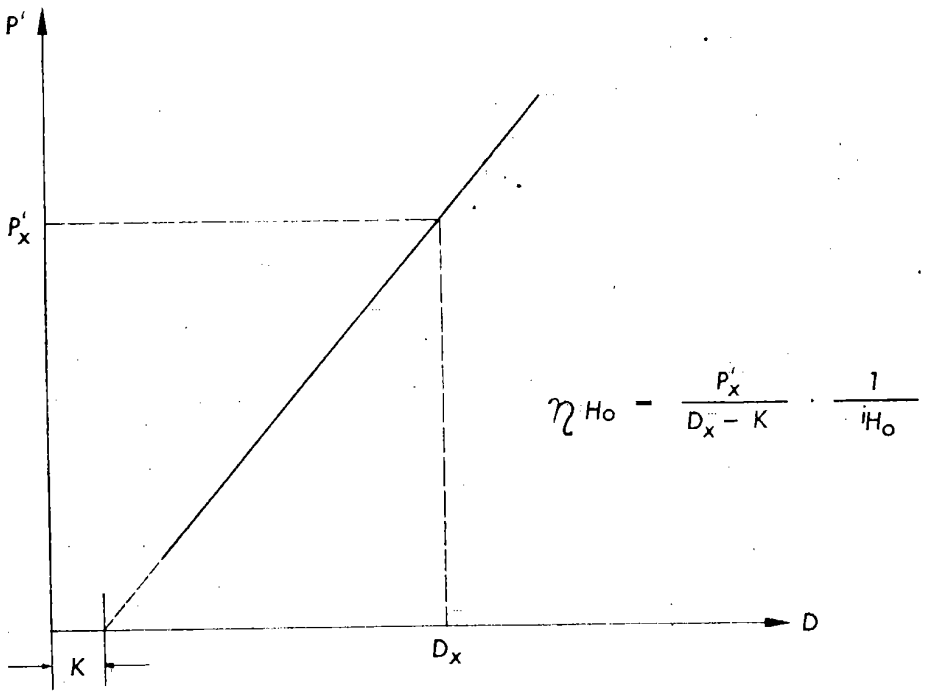
▼B

Appendix 1

See 2.2

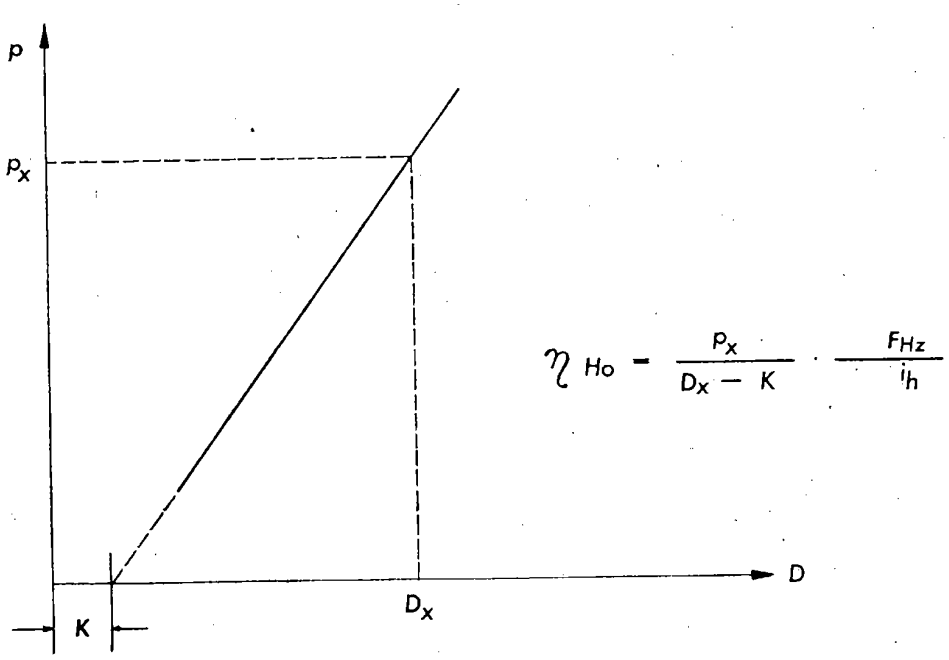


See 2.2.10 and 5.3.2 (devices with mechanical transmission)



▼B

See 2.2.10 and 5.4.2 (devices with hydraulic transmission)



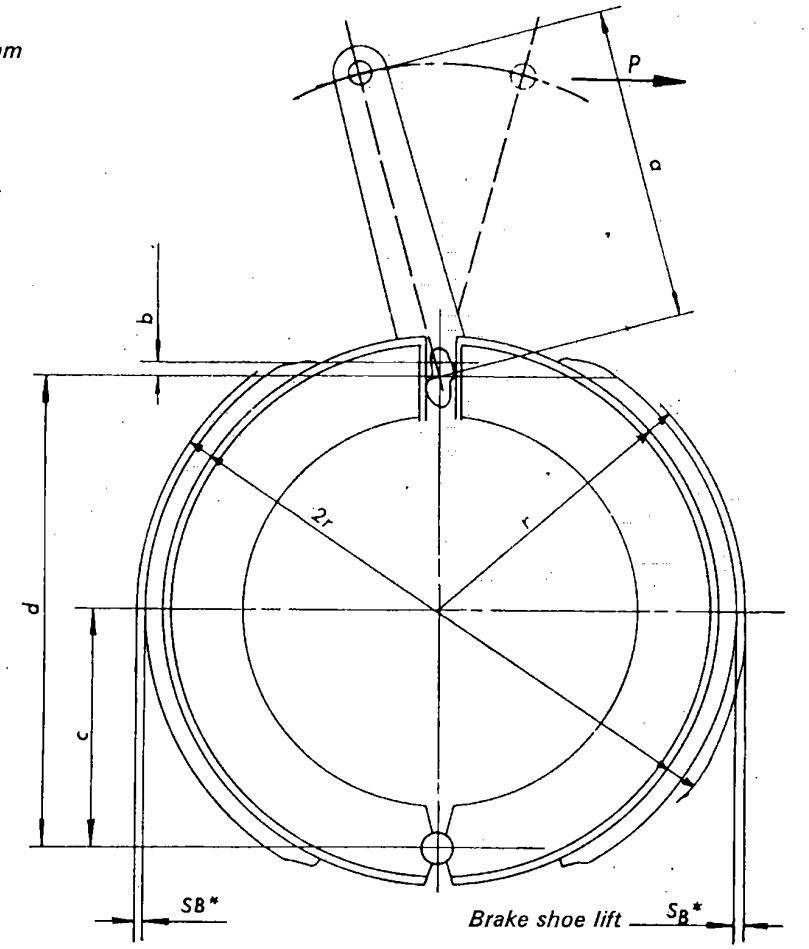
▼B

See 2.2.22 and 2.3.4

Push rod cam

$i_a = \frac{a}{2b}$

$i_g = \frac{a \cdot d}{b \cdot c}$



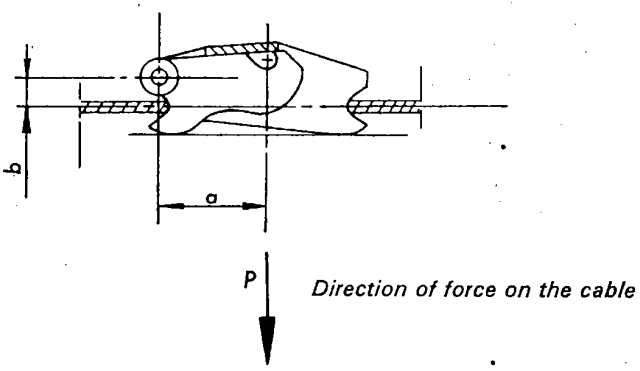
Brake shoe centre lift

$S_B^* = 1{\cdot}2\ ^{m}/_{m} + 0{\cdot}2\ \% \cdot 2r$

Retractor

$i_a = \frac{a}{b}$

$i_g = 2 \cdot \frac{a \cdot d}{b \cdot c}$

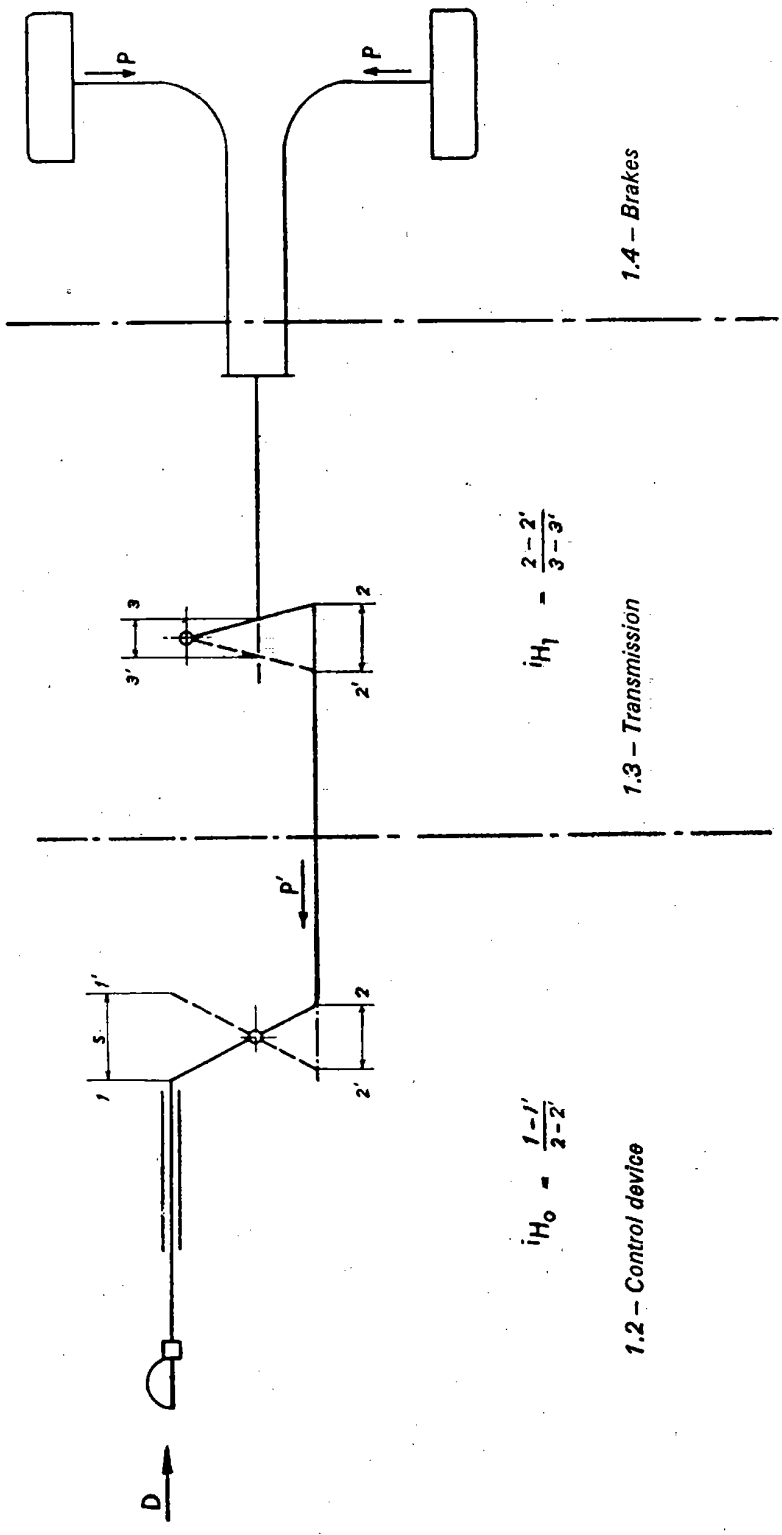


Tests to be carried out on the brakes

▼B

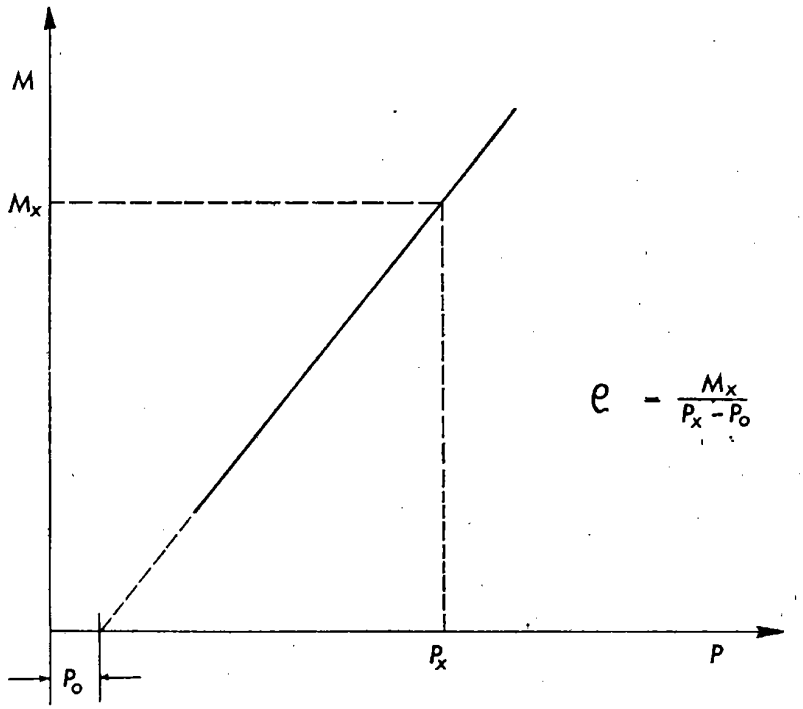
Brakes with mechanical transmission

See 2.3

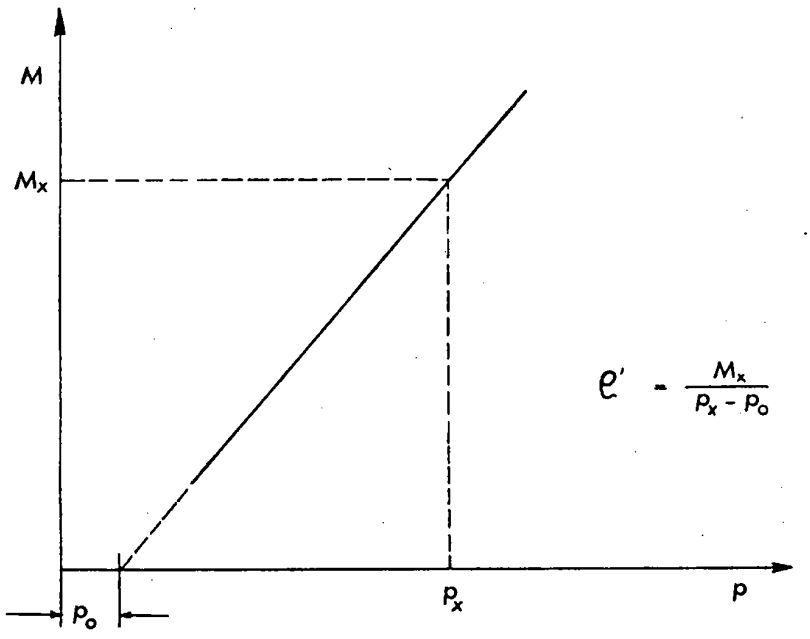


▼B

See 2.3.6 and 7.2.3.1 (mechanical brake)



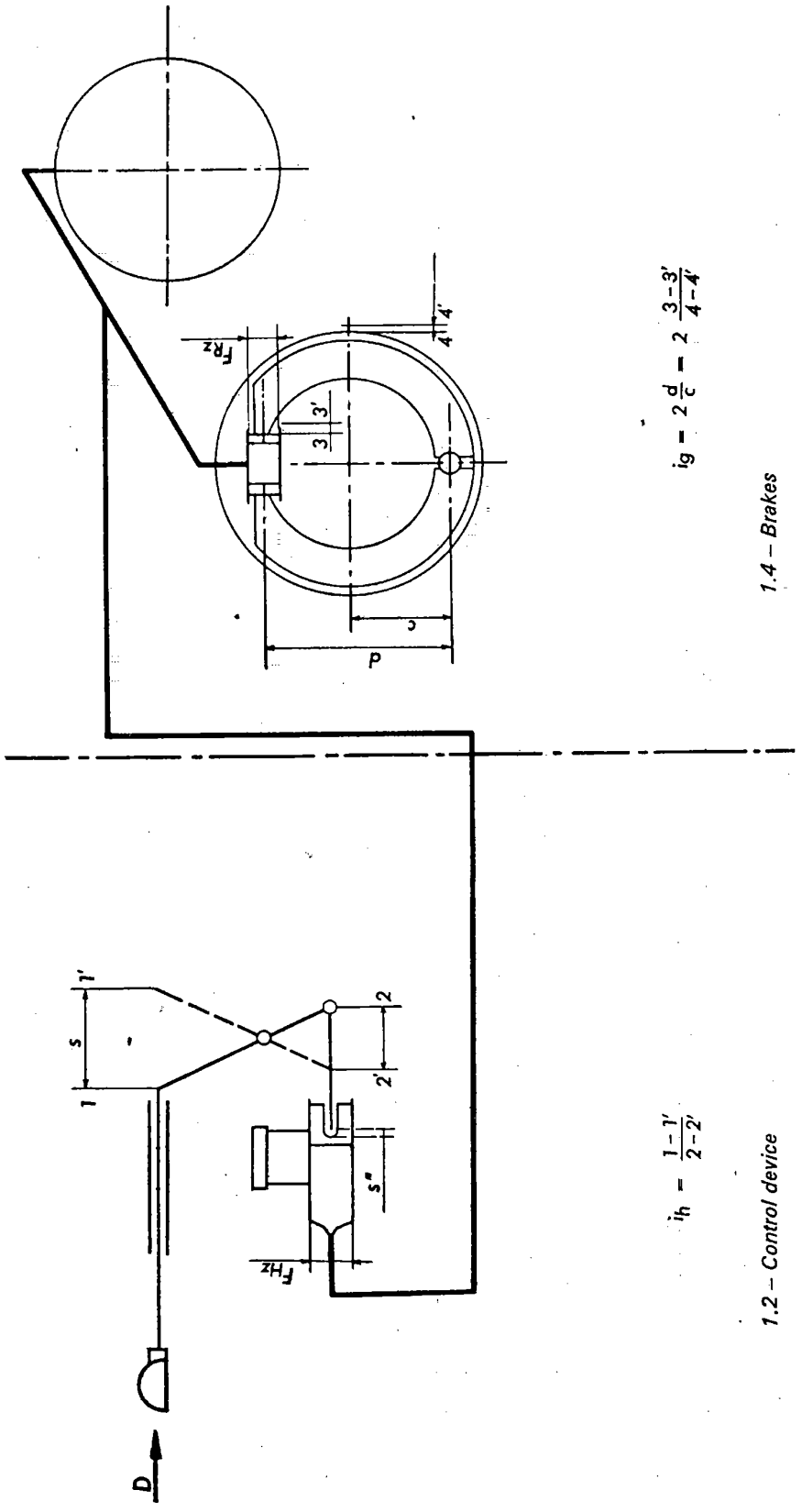
See 2.4.6 and 7.2.3.2 (hydraulic brake)



▼B

Brakes with hydraulic transmission

See 2.4



$i_g = 2\frac{d}{c} = 2\frac{3-3'}{4-4'}$

1.4 – Brakes

$i_h = \frac{1-1'}{2-2'}$

1.2 – Control device

▼B

Appendix 2

Test report on inertia brake control device

1. Manufacturer .....
2. Make .....
3. Type .....
4. Characteristics of the trailers for which the control device is intended by the manufacturer:
   4.1. ▶(1) mass ◀ G'_A = ... kg
   4.2. permissible vertical static force at the head of the towing device ..... ▶(2) N ◀
   4.3. single-axle trailer[a] or multi-axle trailer[a].
5. Brief description
   (List of attached plans and dimensional drawings)
6. Main diagram of the control device
7. Travel s = ... mm
8. Reduction ratio of the control device:
   8.1. in the case of a device with mechanical transmission[a]
   i_{Ho} = from ..... to .....[b]
   8.2. in the case of a device with hydraulic transmission[a]
   i_h = from ..... to .....[b]
   F_{HZ} = ... cm^2
   travel of the master cylinder actuator ..... mm.
9. Test results:
   9.1. Efficiency
   in the case of a device with mechanical transmission η_H = ...
   in the case of a device with hydraulic transmission η_H = ...
   9.2. Complementary force K = ... ▶(2) N ◀
   9.3. Maximum damping force D_1 = ... ▶(2) N ◀
   9.4. Maximum pulling force D_2 = ... ▶(2) N ◀
   9.5. Threshold force K_A = ... ▶(2) N ◀
   9.6. Loss of travel and ▶(3) spare travel ◀:
   where the position of the towing device has an effect s_o[a] = ...
   in the case of a device with hydraulic transmission s''[a] = ...
   9.7. Available travel of the control s' = ... mm
   ▶(4) —— ◀
10. Technical service which carried out the tests
11. The control device described above does/does not[a] comply with the requirements of items 3, 4 and 5 of the testing conditions for vehicles fitted with inertia brakes.

Signature

---

[a] Delete as appropriate.
[b] Indicate the lengths whose ratio was used to determine i_{Ho} or i_h.

▶(1) (2) M3
▶(3) (4) M4

▼B

Appendix 3

Brake test report

1. Manufacturer .....
2. Make .....
3. Type .....
4. Technically permissible ▶(1) maximum mass ◀ per wheel G_{Bo} = ... kg
5. Maximum braking moment M_{max} = ... ▶(2) Nm ◀
6. Diameter of pneumatic tyte used during the test: ..... m
7. Brief description
   (list of plans and dimensional drawings)
8. Main diagram of the brake
9. Test result:

mechanical brake[a]	hydraulic brake[a]
9.1. Reduction ratio i_g = ...[b]	9.1a. Reduction ratio i_g' = ...[b]
9.2. Half shoe centre lift s_B = ... mm	9.2a. Half shoe centre lift s_B = ... mm
9.3. Half minimum shoe centre lift s_B* ..... mm	9.3a. Half minimum shoe centre lift s_B* ..... mm
9.4. Withdrawal force P_o = ... ▶(3) N ◀	9.4a. Withdrawal pressure p_o = ... ▶(4) bar ◀
9.5. Coefficient ρ = ... m	9.5a. Coefficient ρ' = ... m cm²
▶(5) —— ◀	▶(6) —— ◀
	▶(7) 9.6a. ◀ Surface area of the wheel cylinder F_{RZ} = ... cm²
	▶(8) 9.7a. ◀ Maximum permissible pressure for M_{max}: p_{max} = ... ▶(4) bar ◀

10. Technical service which carried out the tests
▶(9) 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 ◀

---

[a] Delete as appropriate.
[b] Indicate the lengths which have been used to determine i_g or i_g'.

▶(1) (2) (3) (4) M3
▶(5) (6) (7) (8) (9) M4

▼B

Appendix 4

Test report on the compatibility of the inertia control device, the transmission and the brakes on the trailer

1. Control device
described in the attached test report (see Appendix 2)
Reduction ratio selected:
i_{Ho}[a] = ...[b] or i_h[a] = ...[b]
(must be between the limits specified in Appendix 2, item 8.1 or 8.2)

2. Brakes
described in the attached test report (see Appendix 3)

3. Transmission devices on the trailer

3.1. Brief description with main diagram

3.2. Reduction ratio and efficiency of the mechanical transmission device on the trailer
i_{H_1}[a] = ...[b]
η_{H_1}[a] = ...

4. Trailer

4.1. Manufacturer

4.2. Make

4.3. Type

4.4. Number of axles[c]

4.5. Number of brakes n = ...

4.6. Technically permissible ▶[1]maximum mass◀ G_A = ... kg

4.7. Radius of tyres under load R = ... m

▶[2] 4.8. Permissible force on the coupling $D^* = 0{,}10\ G_A$ ..... da N[d]
or $D^* = 0{,}067 G_A$ = ... da N[d]

4.9. Required braking force $B^* = 0{,}5\ G_A$ = ... da N

4.10. Braking force $B = 0{,}49 G_A$ = ... da N◀

5. Compatibility — Test results

5.1. Threshold ratio $100\ K_A/G_A$ .....
(must be between 2 and 4)

5.2. Maximum damping force $100\ D_1/G_A$ .....
(must not exceed 9 for single-axle trailers[c], or 6 for multi-axle trailers)

5.3. Maximum towing force $100\ D_2/G_A$ .....
(must be between 10 and 50)

5.4. Technically permissible ▶[1]maximum mass◀ for the inertia control device
G'_A = ... kg
(must not be less than G_A)

5.5. Technically permissible ▶[1]maximum mass◀ for all the trailer brakes $G_B = n \cdot G_{Bo}$
= ..... kg
(must not be less than G_A)

▶[3]——◀

▶[1] [3] M3
▶[2] [4] M4

▼B

▶(1)—— ◀

▶(2)5.6.◀ Inertia braking device with mechanical transmission[a]

▶(2)5.6.◀1. $i_H = i_{Ho} \cdot i_{H_1}$ = ...

▶(2)5.6.◀2. $\eta_H = \eta_H \cdot \eta_{H_1}$ = ...

▶(2)5.6.◀3. $\left[\frac{B \cdot R}{\rho} + n \cdot P_o\right] \cdot \frac{1}{(D^* - K) \cdot \eta_H}$ .....

(must be not greater than i_H).

▶(2)5.6.◀4. $\frac{s'}{s_B^* \cdot i_g}$ = ...

▶(3)5.7.◀ Inertia controlled braking device with hydraulic transmission[a]

▶(3)5.7.◀1. i_h/F_{HZ} = ...

▶(3)5.7.◀2. $\left[\frac{B \cdot R}{n \cdot \rho'} + p_o\right] \cdot \frac{1}{(D^* - K) \cdot \eta_H}$ .....

(must be not greater than i_h/F_{HZ}).

▶(3)5.7.◀3. $\frac{s'}{2s_B^* \cdot n \cdot F_{RZ} \cdot i_g'}$ = ...

(must be not less than i_h/F_{HZ}).

▶(3)5.7.◀4. s/i_h = ...

(must be not greater than the travel of the master cylinder actuator as specified in item 8.2. of Appendix 2)

6. Technical service which carried out the tests

7. The inertia braking device described above does/does not[a] comply with the requirements of items 3 to 9 of the testing conditions for vehicles fitted with inertia brakes

Signature

---

[a] Delete as appropriate.

[b] Indicate the lengths which have been used to determine i_{Ho}, i_h, i_{H_1}.

[c] Two axles with a wheelbase of less than 1 metre (tandem axle) shall, for the purposes of these testing conditions, be deemed to be one axle.

▼B

ANNEX IX

Name of administration

►(1) MODEL

ANNEX TO THE EEC VEHICLE TYPE-APPROVAL CERTIFICATE CONCERNING BRAKING DEVICES
(Articles 4 (2) and 10 of 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 Taking into account the amendments introduced pursuant to Directive 79/489/EEC ◄

Type Approval No .....

1. Make (name of company or firm).....
2. Type and commercial description .....
3. Vehicle category .....
4. Name and address of manufacturer .....
5. Name and address of manufacturer's authorised representative (if any).....

.....

►(4) 6. Mass of vehicle .....

6.1. maximum mass of vehicle.....

6.2. minimum mass of vehicle ..... ◄

7. Distribution of the ►(2) mass ◄ on each axle (maximum value) .....
8. Make and type of brake linings.....
9. In the case of a motor vehicle:

9.1. engine type .....

9.2. number and ratios of gears.....

9.3. ratio(s) of the driving axle(s) .....

.....

►(5) 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 ..... ◄

►(6) 9.5. vehicle is/is not (4) equipped to tow a trailer with electric service brakes ..... ◄

10. Tyre dimensions .....
11. Number and arrangement of axles .....
12. Brief description of the braking device .....

.....

13. ►(3) Mass ◄ of vehicle at the time of testing:

	unladen (kg)	laden (kg)
Axle No 1[1]	.....	.....
Axle No 2	.....	.....
Axle No 3	.....	.....
Axle No 4	.....	.....
Total:	.....	.....

►M4 a ◄

►(1) (2) (3) (4) M3
►(5) (6) M4

▼B

14. Result of the tests:

	Test speed km/h	Measured performance	Measured force applied to the control ▶(1)N◀
14.1. Type O tests, engine disconnected			
service braking	.....	.....	.....
secondary braking	.....	.....	.....
14.2. Type O tests, engine connected			
service braking	.....	.....	.....
secondary braking	.....	.....	.....
14.3. Type I tests			
with repeated braking[3]	.....	.....	.....
with continuous braking[3]	.....	.....	.....
14.4. Type II or II A[4] tests, as appropriate			
service braking	.....	.....	.....

14.5. Was the secondary braking device used during the Type II/II A[4] test? yes/no[4]

▶(2) 14.6. Response time and dimensions of flexible pipes

14.6.1. Response time at the brake actuator ... s

14.6.2. Response time at the control line coupling head ... s

14.6.3. Flexible pipes of tractive units for semi-trailers:

-length: ... m,

-internal diameter ... mm ◀

14.7. Cases in which Type I and/or II (or II A) tests do not have to be carried out (Annex VII)

14.7.1. Type Approval No of the reference vehicle .....

14.7.2.

	Vehicle axles			Reference axles		
	▶(3)Mass◀ per axle *	Required braking force to the wheels	Speed	▶(3)Mass◀ per axle *	Actual braking force developed at the wheels	Speed
	kg	▶(1)N◀	km/h	kg	▶(1)N◀	km/h
Axle 1	.....	.....	.....	.....	.....	.....
Axle 2	.....	.....	.....	.....	.....	.....
Axle 3	.....	.....	.....	.....	.....	.....
Axle 4	.....	.....	.....	.....	.....	.....

* This is the technically permissible ▶(4)maximum mass◀ per axle.

14.7.3.

▶(5)Maximum mass◀ of the vehicle presented for type approval	.....kg
Required braking force to the wheels	.....▶(1)N◀
Required retarding torque on the main shaft of the brake	.....▶(6)Nm◀
Retarding torque obtained on the main shaft of the brake (according to diagram)	.....▶(6)Nm◀

▶(1) (2) (3) (4) (5) (6) M3

▼M4

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

▼B

15. Reservoirs and energy sources using compressed air:

15.1. Total volume of the brake reservoirs .....

15.2. Value p_2 declared by manufacturer .....

15.3. Pressure in the reservoir after a test of eight brake applications

.....

15.4. Characteristics of the compressor .....

.....

.....

15.5. Charging time T_1 .....

15.6. Charging time T_2 .....

15.7. Total volume of the reservoirs of auxiliary systems

.....

15.8. Charging time T_3 .....

16. Spring brakes

16.1. Description of the braking system and of its release device(s) .....

.....

16.2. Maximum pressure in the spring chamber .....

.....

16.3. Pressure at which the springs begin to operate the brake .....

.....

16.4. Warning-device release pressure .....

.....

17. Parking braking by mechanical locking of the brake cylinders (lock actuators)

17.1. Description of the braking system, of its method of supply and of its release

.....

▶(1)▶(5)18.◀ Distribution of braking among the axles of a vehicle

▶(6)18.◀1. Does the vehicle fulfil the requirements contained in the Appendix (see item 1.1.4.2.) ... yes/no (4)◀

▶(2)▶(7)18.◀2. Information required in item 7.3 of the Appendix to item 1.1.4.2 of Annex II ◀

▶(8)19. Vehicle 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 ani-lock device: category 1/2/3 (2)(4) ◀

▶(9)20.◀ Vehicle submitted for type approval on .....

▶(10)21.◀ Technical service conducting type approval tests

.....

▶(11)22.◀ Date of the report issued by that service .....

.....

▶(12)23.◀ Number of the report issued by that service .....

.....

▶(13)24.◀ Type approval in respect of braking is granted/refused[4]

▶(14)25.◀ Place .....

▶(15)26.◀ Date .....

▶(16)27.◀ Signature .....

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[1] In the case of a semi-trailer, indicate here the laden ▶(17) mass ◀ on the fifth wheel lead.

[2] Applies only to vehicles of categories M_1, M_2, M_3, N_1, N_2 and N_3.

▶(4) [3] Applies only to vehicles of categories O_2, O_3 and O_4.◀

[4] Delete as appropriate.

▶(17) [5] "Coupling overhang" is the horizontal distance between the coupling for centre-axle trailers and the centreline of the rear axle(s).◀

▶(1) M2

▶(2) (3) (4) M3

▶(5) (6) (7) (8) (9) (10) (11) (12) (13) (14) (15) (16) (17) M4

▼M4

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]).

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,

([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.

▼M4

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.

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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 $\varepsilon \geq 0{,}75$ 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

[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.

▼M4

construed as requiring a braking performance better than that prescribed in Annex II for the vehicle in question.

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 $\varepsilon \geq 0{,}75$ 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 $V \approx 0{,}8\ V_{max} \leq 120$ km/h.

5.3.2. When an axle passes from a high-adhesion surface (K_1) to a low-adhesion surface (K_2) where $K_1 \geq 0{,}5$ and $K_1/K_2 \geq 2$ [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 $K_1 \geq 0{,}5$ and $K_1/K_2 \geq 2$, 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 $K_1 \geq 0{,}5$ and $K_1/K_2 \geq 2$, 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 120º during the initial 2 seconds and not more than 240º in all. Furthermore, at the beginning of these

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(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.

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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.

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 $\varepsilon \geq 0{,}75$ 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 $V \approx 80$ 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.

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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.

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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:

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

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*).

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

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where:

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

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

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

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

▼M4

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:

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

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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 electro-mechanical 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.

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

[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.

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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 above-mentioned conditions.

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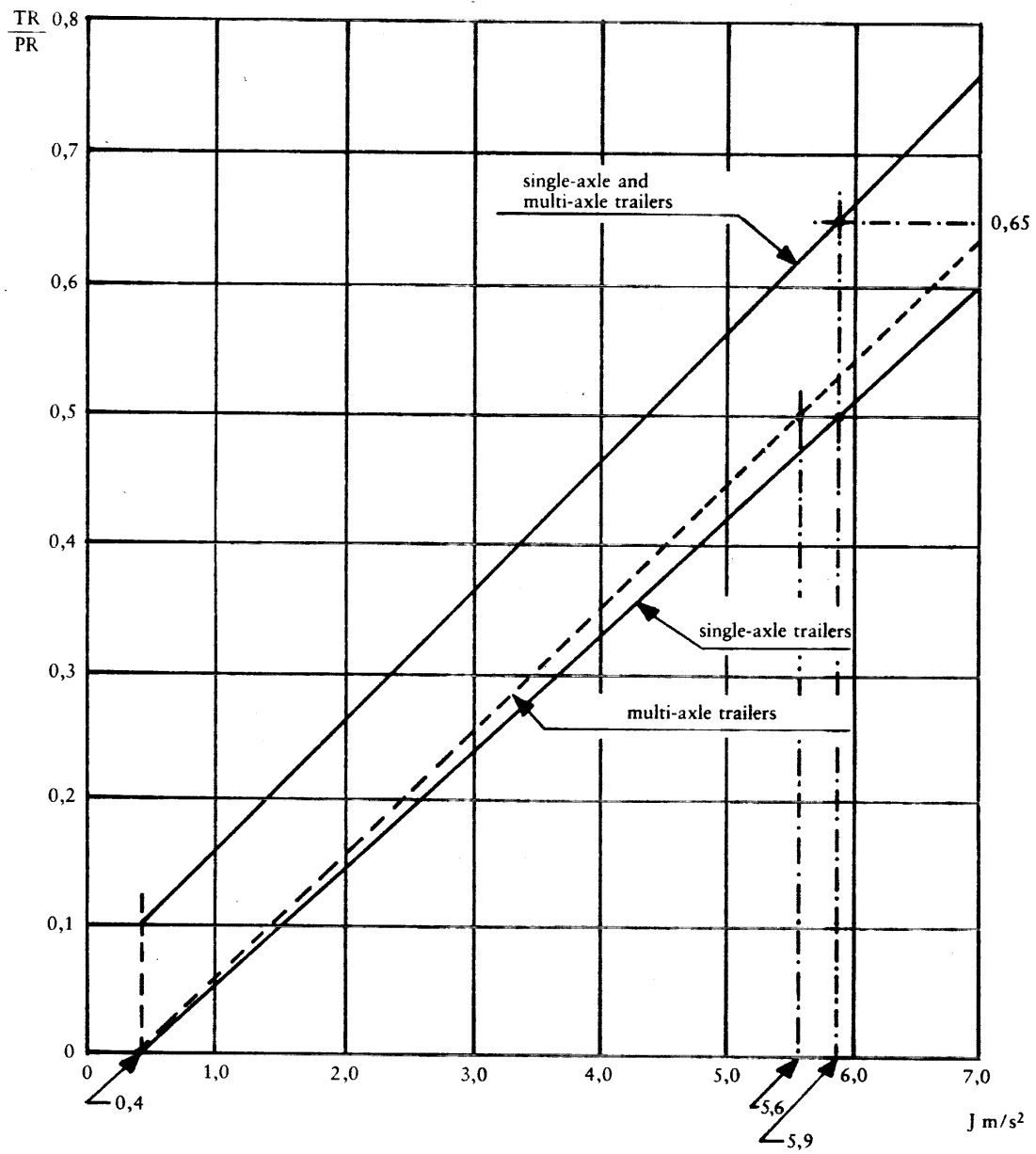
Appendix

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.

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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

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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 ºC 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 ºC. 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.

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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.