Proposal for a

REGULATION OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL

of […]


(Text with EEA relevance)
Proposal for a

REGULATION OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL

of […]


(Text with EEA relevance)

THE EUROPEAN PARLIAMENT AND THE COUNCIL OF THE EUROPEAN UNION,

Having regard to the Treaty establishing the European Community, and in particular Article 95 (1) thereof,

Having regard to the proposal from the Commission¹,

Having regard to the opinion of the European Economic and Social Committee²,

Having regard to the opinion of the Committee of the Regions³,

Acting in accordance with the procedure laid down in Article 251 of the Treaty⁴,

Whereas:

(1) The setting up of the European whole vehicle type-approval system of Directive 2003/37/EC has made it necessary to establish requirements with respect to braking for trailers and interchangeable towed machinery,

(2) Council Directive 76/432/EEC of 6 April 1976 is one of the separate regulatory acts under the type-approval procedure for tractors in Directive 2003/37/EC. Given the extent of the modifications to be introduced and the high number of amendments of Directive 76/432/EEC introduced in the past, a new legislative act will better serve legal certainty than a further amendment to Council Directive 76/432/EEC, it is thus proposed to repeal that Directive.

(3) It is therefore necessary to reconsider the balance the technical requirements to be imposed against the availability and the economic feasibility of new technologies

¹ OJ C […] , […], p. […].
² OJ C […] , […], p. […].
³ OJ C […] , […], p. […].
⁴ OJ C […] , […], p. […].
while at the same time taking account of progress achieved in the implementation of certain new requirements.

(4) Technical progress requires inter alia the adaptation of the test rules, as well as the introduction of specific provisions for energy reservoirs and vehicles with hydrostatic drive.

(5) The issues of brake control of towed vehicles and brake coupling between the tractor and towed vehicles should be better dealt with in this Regulation; Directive 89/173/EEC should thus be amended accordingly.

(6) As the needed specifications for braking systems do not leave any discretion for the Member States, a regulation is the most appropriate legal act to ensure the uniform application within the internal market; therefore, it is necessary to amend the Framework Directive 2003/37/EC, to allow the use of EC Regulations within the EC type-approval system for tractors.

HAVE ADOPTED THIS REGULATION:

CHAPTER I
Objectives, Scope and Subject matter, definitions

Article 1

Objectives

This Regulation aims at ensuring that braking systems used on agricultural or forestry vehicles are effective and perform well even under severe usage conditions.

Article 2

Scope and subject matter

This Regulation applies to vehicles of categories T1, T2, T3, T4, T5, C, Ra, Rb, Sa and Sb as defined in Annex II, Chapter A to Directive 2003/37/EC, with regard to their braking systems.

Article 3

Definitions

For the purpose of this Regulation the definitions of Directive 2003/37/EC and of Annexes I, V, VI, IX, XIII and XIV of this regulation apply.
Chapter II
Obligations of manufacturers

Article 4

General obligations

1. Manufacturers shall demonstrate that all new vehicles sold, registered or put into service in the Community are type-approved in accordance with this Regulation.

2. Manufacturers shall also demonstrate that all separate technical units or components within the field of application of this Regulation which are sold or put into service in the Community are type approved in accordance with this Regulation.

Article 5

Requirements and tests

1. The manufacturer shall equip vehicles so that the braking systems are appropriate for the purpose they are used. They shall fulfil the requirements set out in Annex I, Part 2, Annex II and Annex IV, unless otherwise stated.

2. Vehicles fitted with a service braking system which comply with the provisions in Annex III are considered to satisfy the requirements for reaction time.

3. Spring brakes are forbidden, unless they are in conformity with the conditions set out in Annex V.

4. Parking braking by mechanical locking of the brake cylinders shall also fulfil the requirements set out in Annex VI.

5. Vehicles of categories S1, R1 and R2 equipped with a service braking system of the inertia type shall, in addition, comply with the conditions laid down in Annex VIII.

6. Vehicles with hydrostatic drive must, in addition to the general construction and fitting requirements of Annex I, comply with the construction and fitting requirements laid down in Annex IX. The requirements regarding braking tests and performance of hydrostatic braking systems replace the requirements of Annex II.

7. The fitment of anti-lock braking systems (ABS) is not mandatory, except in cases stated in Annex I point 2.2.1.22. However, wherever ABS is fitted to a vehicle it must conform to the requirements laid out in Annex XIV.

It is understood that ABS does not yet exist for vehicles equipped with in-board brakes mounted within the transmission rather than at the wheels. Therefore, categories of vehicles that use this braking technology and are required to fit ABS are accepted without ABS during a transitional period ending on [five years after the date of publication of the present Regulation] provided that:
– their maximum design speed does not exceed 60 km/h; and
– they meet all of the other requirements of Annex II.

Article 6

Documentation

1. Type-approval documentation must conform to the provisions of Annex X.

2. The information documents for tractors shall conform to the provisions of Annex XI in the case of tractors and to those of Annex XII in the case of towed vehicles with other than inertia (overrun) brakes.

3. The special requirements for documentation, fault strategy and verification with respect to the safety aspects of complex electronic tractor control systems shall conform to the provisions of Annex XIII.

Article 7

Exemptions

Vehicles may be exempted from undergoing a Type-I test as described in Annex II point 1.3. in accordance with the conditions set out in Annex VII.

CHAPTER III
Obligations of Member States

Article 8

Type approval of braking systems

1. With effect from [1st day of month beginning 1 year after the date of the publication of this Regulation], Member States shall not, on grounds relating to vehicle braking systems
   – refuse, in respect of a type of vehicle, to grant EC type-approval or national type-approval,
   – prohibit the registration, sale or entry into service of a vehicle,
   if the vehicle complies with the requirements of this Regulation.

2. With effect from [1st day of month beginning 2 years after the date of publication of this Regulation], Member States
– shall no longer grant EC type-approval, and
– may refuse to grant national type-approval for a new type of vehicle on
grounds relating to the vehicle braking system

if the requirements of this Regulation are not fulfilled.

3. With effect from [1st day of month beginning 3 years after the date of publication of
this Regulation], Member States

– shall consider certificates of conformity which accompany new vehicles in
accordance with the provisions of Directive 2003/37EC to be no longer valid
for the purposes of Article 7 (1) of that Directive, and
– may refuse the registration, sale and entry into service of new vehicles on
grounds relating to the braking systems

if the requirements of this Regulation are not fulfilled.

Article 9

Penalties

1. Member States shall lay down the provisions on penalties applicable for infringement
by manufacturers of the provisions of the present Regulation and shall take all measures
necessary to ensure that they are implemented. The penalties provided for must be effective,
proportionate and dissuasive. Member States shall notify those provisions to the Commission
by [18 months after entry into force of this Regulation] and shall notify to the Commission
without delay of any subsequent amendment affecting them.

2. The types of infringements which are subject to a penalty shall be the following:

(a) making false declarations during the approval procedures or procedures leading to a
recall;
(b) falsifying test results for type approval; and
(c) withholding data or technical specifications which could lead to recall or withdrawal
of type approval.

Article 10

Amendments to EC type-approvals

A Member State which has granted EC type-approval or national type-approval of a vehicle
shall take the necessary measures to ensure that it is informed of any modification to a
component or characteristic mentioned in section 2 of Annex I. The competent authorities of
that Member State shall decide whether fresh tests should be carried out on the modified type
of vehicle and a fresh report be drawn up. If such tests reveal failure to comply with the requirements of this Regulation, the modification shall not be approved.

CHAPTER IV
Final provisions

Article 11

Adaptation of the Annexes

The amendments necessary for adapting the requirements of the Annexes to take account of technical progress shall be adopted in accordance with the procedure laid down in Article 20(2) of Directive 2003/37/EC.

Article 12

Technical Review

The Commission shall study possible technical difficulties in complying with the certain requirements, in particular those for category C tractors and ABS systems for category T5 tractors with a maximum design speed between 40 and 60 km/h. If the Commission studies conclude that for technical reasons certain vehicles cannot meet these deadlines, it shall submit, by [2 years after publication of this Regulation] a report accompanied by appropriate proposals for extensions of the period referred to in Article 8 and/or further derogations, not exceeding five years, unless in exceptional circumstances, for such vehicles, under the procedure laid down in Article 11.

Article 13

Legislation to be amended

1. Directive 89/173/EEC is hereby amended as follows:

(1) List of Annexes: the last paragraph, relating to Annex VI and its Appendix, is deleted.

(2) Annex VI and its Appendix are deleted.

2. Directive 2003/37/EC is hereby amended as follows:

(3) the term “directive” is replaced by the term “directive or regulation” in the following provisions:

Recital (3), Articles 2 (u), 2 (v), 2 (w), 3.3, , 4.1.(c), 5.5 (c), 6.3, , ,23.2 (a), 23.2 (b), 23.3; Annex I model B Part I third paragraph, Annex I model B Part III, Annex II, Chapter B Part I legend of table “SD”, Annex II Chapter B, Part II.B first paragraph, heading and footnotes (*) and (***)
Annex II, Appendix 1 Part II, footnote (1), Annex II, Appendix 2 sections 1. (b) and (c), Annex II Chapter C Part I model heading of third column, Annex II Chapter C Part II, numbers 1, 2 and 3, Annex II Chapter C Part II Appendix 1 first paragraph indents 2.3 and 4, Annex II Chapter C Part II Appendix 1 paragraphs 4 and 5, Annex III Part IA points 13, 14 and 15, Annex IV points 2.1, 2.2, 2.3.5 and 2.4.2, Annex VII paragraphs 2.(a) and (d),

(4) (2) the term “directives” is replaced by the terms “directives or regulations”, as appropriate, in the following provisions:

Articles 2 (t), 4.1.(a), 4.1.(b), 7.2, 8.2, 11, 11 (a) (i), 11 (a) (iii), 11 (d), 11 (e), 12.1, 12.2, 12.4, 15.2, 16.1, 19, 19.1 (b), 19.1 (c), 21 (b) (i), 23.2, 23.3; List of Annexes on page 11: titles to Annex II, Chapter B, Appendix 1 and Annex VI; Annex I first paragraph, Annex I model A first paragraph, Annex I model B and Part I first paragraph and Part III, Annex II, Chapter B Part I title and heading of column two and footnote (1), Annex II Chapter B, Part II.A first paragraph and heading of table , Annex II Chapter B, Part II.B first paragraph, Annex II Chapter B, Part II.C first paragraph, heading of table, second column, Annex II, Appendix 1 Part II, heading of table, third column , footnote (1), Annex II, Appendix 2 sections 1. (a) and (b), Annex II Appendix 2 3 (a) and (b), Annex II Chapter C Part I, points 0.8 1 and 2 and paragraph above the model for incomplete vehicles, Annex II Chapter C Part II Appendix 1 first paragraph, Annex II Chapter C Part II Appendix 1 first paragraph, third indent, Annex IV points 2.4.4, Annex VI heading, Annex VII point 1.1 and paragraph 2 (c),

(5) In Annex I Model A the following items are inserted:

8.12. Brief description of the braking systems (according to point 1.6. of the Addendum of Appendix 1 of Annex IX to [this Regulation]:

8.13. If claiming exemptions from the Type-I tests, state the number of the report in accordance with Annex VII to [this Regulation]:”

(6) Annex II Chapter B is amended as follows:

(a) Below the heading of Part I the following subheading is inserted:

“(As appropriate, taking account of the scope and latest amendment to each of the separate Directives or Regulations listed below)”

(b) In Part I item 22.7 is deleted

(c) In Appendix 1 Part II item 22.7 is deleted

(c) In Part I and in Appendix 1 Part II the references in item 7.1 to Directive 76/432/EEC are replaced by the references to this Regulation.
Article 14

Legislation to be repealed

With effect from [same date as in art. 8 para. 2] Directive 76/432/EEC is repealed.

Article 15

Entry into force

This Regulation shall enter into force on [the first day of the month after its publication].

This Regulation shall be binding in its entirety and directly applicable in all Member States.

Done at Brussels, […]

For the European Parliament
The President
[…]

For the Council
The President
[…]
LIST OF ANNEXES

Annex I  Definitions, construction and fitting requirements
Annex II  Braking tests and performance of braking systems
          Appendix 1: Distribution of braking effort among vehicle axles
Annex III Method of measuring braking systems reaction times.
          Appendix 1: Example of a simulator
Annex IV  Energy reservoirs and sources of energy
          A: Compressed-air braking systems
          B: Vacuum braking systems
          C: Hydraulic braking systems with stored energy
Annex V   Spring brakes
Annex VI  Parking braking by mechanical locking of the brake cylinders (lock actuators)
Annex VII Cases in which Type-I tests do not have to be carried out on a vehicle submitted for type-approval
          Appendix 1: Alternative procedures for Type-I tests for towed vehicle brakes
          Appendix 2: Model reference axle test report form
Annex VIII Conditions governing the testing of vehicles with inertia ( overrun) braking systems
          Appendix 1: Explanatory diagrams
          Appendix 2: Test report on the control device
          Appendix 3: Test report on the brake
          Appendix 4: Test report on the compatibility of the control device, the transmission and the brakes
Annex IX  Braking systems for vehicles with hydrostatic drive
Annex X   Type-approval documentation
          Appendix 1: Type-approval certificate
          Appendix 2: Test report
Annex XI  Information document for tractors
Annex XII Information document for towed vehicles
Annex XIII Special requirements to be applied to the safety control aspects of complex electronic tractor control systems

Annex XIV Requirements for vehicles equipped with ABS
ANNEX I
Definitions, construction and fitting requirements

1. DEFINITIONS

For the purpose of this Regulation:

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

1.1.1. In the case of tractors

1.1.1.1. the vehicle category, as defined in Article 2 of this Regulation

1.1.1.2. the maximum mass, as defined in point 1.14.1

1.1.1.3. the distribution of mass among the axles

1.1.1.4. the maximum design speed

1.1.1.5. a different type of braking equipment with particular reference to the presence or otherwise of equipment for braking a towed vehicle

1.1.1.6. the number and arrangement of the axles

1.1.1.7. the engine type

1.1.1.8. overall transmission ratio corresponding to maximum speed

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

1.1.1.10 the maximum tyre dimensions of the braked axles

1.1.2. In the case of trailers or interchangeable towed machinery

1.1.2.1. the vehicle category, as defined in Article 2 of this Regulation

1.1.2.2. the maximum mass, as defined in point 1.14.1

1.1.2.3. the distribution of mass among the axles

1.1.2.4. the maximum design speed

1.1.2.5. a different type of braking equipment

1.1.2.6. the number and arrangement of the axles

1.1.2.7. the maximum tyre dimensions of the braked axle(s).

1.2. 'Braking system'
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 has already halted. These functions are specified in point 2.1.2. The equipment shall consist of the brake control (as defined in 1.4), the transmission (as defined in 1.5) and the brake (as defined in 1.6).

1.3. 'Graduated braking'

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

- the driver can, at any time, increase or reduce the braking force through action of the control,
- the braking force acts in the same direction as the action on the control (monotonic function),
- it shall be easily possible to make a sufficiently fine adjustment to the braking force.

1.4. 'Control'

means the part actuated directly by the driver to supply to the transmission the energy required for braking or controlling it. This 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 towed vehicle, or a combination of these various kinds of energy.

1.5. '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'

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);
- an engine brake (when the forces are derived from a controlled increase in the braking action of the engine transmitted to the wheels)
– a device that mechanically locks the transmission but cannot be used when the tractor is in motion

1.7. 'Different types of braking systems'

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'

means one of the individual parts which, when assembled, constitute the braking equipment.

1.9. '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'

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, wherever their relative positions.

1.11. 'Automatic braking'

means braking of the towed vehicle or towed vehicles 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'
means braking by utilising the forces generated by the towed vehicle's moving up on the towing vehicle.

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

1.14. 'Mass'

1.14.1. 'Maximum mass'
means the maximum mass stated by the vehicle manufacturer to be technically permissible

1.14.1.1 'The distribution of mass among the axles'
means the distribution of the effect of the gravity on the mass of the vehicle and/or its contents among the axles

1.14.1.2. 'Wheel/axle load'
means the vertical static reaction (force) of the road surface in the contact area on the wheel/wheels of the axle

1.14.1.3. Maximum stationary wheel/axle load'
means the stationary wheel/axle load achieved under the condition of the laden vehicle.

1.14.1.4. Vertical static load at the coupling head'
means the maximum technically permissible vertical static load at the coupling head stated by the manufacturer (this load may be higher than the 'permissible vertical static load').

1.14.2. 'Unladen mass'
means the mass of the vehicle in running order, if applicable with full fuel, lubricant and coolant tanks and with a driver of a mass of 75kg, but without passengers, optional accessories or load.

1.15. 'Hydraulic braking system 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. 'Towed vehicle'
means any “trailer” as defined in Article 2 k) or any “interchangeable towed machinery” as defined in Article 2 l) of Directive 2003/37/EC.

1.16.1 ‘Full towed vehicle’

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

1.16.2. ‘Centre-axle towed vehicle’

means a towed vehicle equipped with a towing device which cannot move vertically (in relation to the towed vehicle), 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 that corresponding to the maximum mass of the towed vehicle, or a load of 10,000 N (whichever is the lesser) is transmitted to the towing vehicle.

1.16.2.1. ‘Semi-mounted towed vehicle’

means a towed vehicle with one axle or axle group of land wheels and a drawbar towing device (drawbar) which cannot move relative to the vehicle allowing the transmission of vertical forces from the towed vehicle through the drawbar to the towing vehicle. Notes:
1. Some slight vertical movement may occur at a rigid drawbar e.g. due to suspension movements.
2. A hydraulically adjustable articulated drawbar is considered to be a rigid drawbar.

1.17. ‘Endurance braking system’

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.

1.17.1. ‘Independent endurance braking system’

means an endurance braking system whose control device is separate from that of the service and other braking systems

1.17.2. ‘Integrated endurance braking system’

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

1.17.3. ‘Combined endurance braking system’

means an integrated endurance braking system which in addition has a cut-out device, which allows the combined control to apply the service braking system alone.
2. CONSTRUCTION AND FITTING REQUIREMENTS

2.1. General

2.1.1. Braking equipment

2.1.1.1. The braking equipment shall 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 under mentioned requirements.

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

2.1.1.3. Brake linings shall not contain asbestos

2.1.1.4. It is not permitted to fit any adjustable valves that would allow the performance of the braking system to be changed by the user of the vehicle such that, in service, it falls outside the requirements of this Regulation. An adjustable valve that can only be operated by the manufacturer through the use of special tool or the provision of a tamper proof seal shall be permitted provided that the user of the vehicle is not able to adjust this valve or that any user adjustment is readily identifiable by enforcement authorities.

Devices intended solely for the purpose of achieving the requirements of Appendix 1 in Annex II, in all conditions of load, and with up to [two] discrete settings, may be used on vehicles of category R and S where the use of automatic load sensing valves is not technically feasible.

2.1.2. Functions of the braking equipment

The braking equipment defined in point 1.2 shall fulfil the following functions:

2.1.2.1. Service braking system

The service braking system shall 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 shall be possible to graduate this braking action. The driver must be able to apply the service brake from his seat and retain control of the steering device on the tractor with both hands on the steering wheel.

For vehicles equipped with hydrostatic drive, the driver must be able to apply the service brake from his seat and retain control of the steering device on the tractor with at least one hand on the steering wheel.

2.1.2.2. Secondary braking system

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

2.1.2.3. Parking braking system
The parking braking system shall 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 shall be able to achieve this braking action from his driving seat, subject, in the case of a towed vehicle, to the requirements of point 2.2.2.10.

The towed vehicle braking system and the parking braking system of the towing vehicle may be operated simultaneously, provided that the driver is able to check, at any time, that the parking brake performance of the vehicle combination, obtained by the purely mechanical action of the parking braking system, is sufficient.

2.1.3. Pneumatic connections between tractors and towed vehicles

In the case of a braking system operated by compressed air, the pneumatic link with the towed vehicle shall be of the type with two lines. Shut-off devices which are not automatically actuated shall not be permitted. The flexible hoses shall be a part of the towed vehicle.

However, types of connections in use at the date of adoption of this Regulation which do not meet some of the requirements of this point, are accepted during a transitional period ending on [ten years from the date of publication of the present Regulation] provided that:

– they are in accordance with a national or international standard;
– wrong connections are rendered impossible by mechanical design or by the working pressure; and
– they satisfy the function and performance requirements of the present Regulation.

2.1.4 Hydraulic connections between tractors and towed vehicles

When the operation of the braking system requires hydraulic connection(s) the connector(s) shall comply with ISO Standard ISO 5676 of 1983. The flexible hoses shall be part of the towed vehicle.

However, types of connections in use at the date of adoption of this Regulation which do not meet some of the requirements of this point, are accepted during a transitional period ending on [ten years from the date of publication of the present Regulation] provided that:

– they are in accordance with a national or international standard;
– wrong connections are rendered impossible by mechanical design or by the working pressure; and

they satisfy the function and performance requirements of the present Regulation.

2.1.5 Electrical connection between tractors and towed vehicle

When the operation of a braking system requires an electrical connection, the connectors shall comply with the relevant section of ISO 7638.

2.1.6 Pneumatic braking systems
Pneumatic braking systems may be fitted with an adequate system for preventing condensation of water within the system (dryer) and/or drain valves in the area where condensation is likely to accumulate.

2.2. Characteristics of braking systems

2.2.1. Vehicles of categories T and C

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

The service brake of the tractor may be divided into right and left hand circuits. It must be possible for the left and right circuits to be connected and balanced so that they can only be actuated in a single operation.

The service braking system must guarantee that it is not possible for the vehicle to travel at speeds in excess of [30] km/h when the left and right braking circuits are not connected.

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

2.2.1.2.1. There shall 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, every brake control (excluding endurance braking system 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 and/or it is utilised for the secondary braking.

2.2.1.2.2. The control of the service braking system shall be independent of the control of the parking braking system.

2.2.1.2.3. Where the service and secondary braking systems have the same control, the effectiveness of the linkage between that control and the various components of the transmission systems shall not be liable to deteriorate after a certain period of use.

2.2.1.2.4. Where the service and secondary braking systems have the same control, the parking braking system shall be so designed that it can be actuated when the vehicle is in motion.

2.2.1.2.5. In the event of a breakage of any component other than the brakes (as defined in point 1.6) or the components specified in point 2.2.1.2.7, or of any other failure of the service braking system (malfunction, partial or total exhaustion of an energy reserve), the secondary braking system or that part of the service braking system which is not affected by the failure shall 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 system and the service braking system have a common control and common transmission:

2.2.1.2.6.1. where the service braking system is actuated by the muscular energy of the driver assisted by one or more energy reserves, the secondary braking performance shall, in the 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 forces for the service braking system and transmission depend exclusively on the use of an energy reserve controlled by the driver, there shall 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 performance without endangering the stability of the vehicle during braking; in addition, each of these energy reserves shall be fitted with a warning device as defined in point 2.2.1.12.

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 system that part shall be made of metal or of a material with equivalent characteristics and shall not be subject to significant distortion in the normal operation of the braking equipment.

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

2.2.1.4. 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 shall be as safe as practicable.

2.2.1.4.1. In the event of failure in any part of the transmission of a vehicle's braking systems, the supply to the part not affected by the failure shall continue to be ensured where this is required for the purpose of halting the vehicle with the degree of effectiveness prescribed for residual and/or for secondary braking. This condition shall be satisfied by means of devices which can be easily actuated when the vehicle is stationary, or by automatic means.

2.2.1.4.2. Furthermore, storage devices located down-circuit of this device are such that in the event of a failure in the energy supply, after four full-stroke actuations of the service braking system control under the testing conditions prescribed in point 1.2 of Annex IV, section A and B 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. The requirements of points 2.2.1.4 shall be satisfied 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 system.
2.2.1.6. On vehicles with a maximum design speed not exceeding 30 km/h, the service braking system shall act on all the wheels of at least one axle. In all other cases the service braking system shall act on all the wheels of the vehicle. However, in case of vehicles with a braked rear axle and an automatic engagement of the front drive during braking, the front axle is deemed to be braked.

For category C vehicles this condition is considered to be met if all of the tracks of the vehicle are braked where a track is defined as all wheels that are grouped together by a single continuous track. For category C vehicles with a design speed of less than 30 km/h, this condition is considered to be met if at least one track on each side of the vehicle is braked.

2.2.1.7. If the service braking system acts on all wheels/tracks of the vehicle, the action shall be appropriately distributed among the axles. Where this is achieved by means of a device which modulates the pressure in the brake transmission, this must conform to the requirements of points 1 and 2 of Appendix 1 of Annex II.

In the case of vehicles with more than two axles, in order to avoid wheel-locking or glazing of the brake linings, the brake force on certain axles may be reduced to zero automatically when carrying a much reduced load, provided that the vehicle meets all the performance requirements prescribed in Annex II.

2.2.1.8. The action of the service braking system shall be distributed between the wheels/tracks of the same axle symmetrically in relation to the longitudinal median plane of the vehicle.

2.2.1.9. The service braking system and the parking braking system shall act on braking surfaces permanently connected to the wheels through components of adequate strength. It shall not be possible to disconnect a braking surface from the wheels; however, such disconnection shall be permitted in the case of the parking braking system, provided that it is controlled exclusively by the driver from his driving seat by a system which cannot be actuated by a leak\(^5\). When more than one axle is normally subject to braking in the case of vehicles of categories T1, T2, T3 and T4, one axle may be decoupled provided that activation of the service brake automatically re-couples this axle and that, if the re-coupling device fails, this is done automatically.

2.2.1.10 It must be possible for the wear of the service brakes to be compensated by means of a system of manual adjustment. For vehicles of category T5, the wear of the brakes shall be compensated by means of a system of automatic adjustment. In addition, the control and the components of the transmission and of the brakes shall 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 shall be ensured without immediate adjustment being necessary.

Vehicles of categories T1, T2, T3 and T4, and category C, do not need to be fitted with a system where the wear of the brakes are compensated by means of a system

\(^5\) This point must be interpreted in the following way: the performance of the service and secondary braking systems must remain within prescribed in the Regulation, even during momentary disconnection.
of automatic adjustment. However, if vehicles of these categories are equipped with system where the wear of the brakes are compensated by means of a system of automatic adjustment, this system shall comply with the same requirements as those of category T5.

2.2.1.10.1. Automatic wear adjustment devices, if fitted, shall be such that after heating followed by cooling of the brakes, effective braking is still ensured. In particular, the vehicle shall remain capable of normal running after the tests conducted in accordance with Annex II, point 1.3 (Type-I test).

It shall be possible to easily check this wear on service brake linings from the outside or underside of the vehicle, utilising only the tools or equipment normally supplied with the vehicle; for instance, by the provision of appropriate inspection holes or by some other means. Alternatively, acoustical or optical devices warning the driver at his driving position when lining replacement is necessary are acceptable.

This requirement is not applicable to oil immersed brakes which are designed for the whole lifetime of the vehicle without servicing.

2.2.1.11. In hydraulic braking systems:

2.2.1.11.1. The filling ports of the fluid reservoirs shall be readily accessible; in addition, the containers of reserve fluid shall 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, an acoustical or optical warning device shall indicate to the driver when the reserve fluid falls to a level liable to cause a failure of the braking system. The driver shall be able to check easily whether the warning device is functioning properly.

2.2.1.11.2. 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 reservoir falls below the value specified by the manufacturer shall be admissible. The tell-tale lamp shall be visible even in daylight; the satisfactory condition of the lamp shall 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 system in question.

2.2.1.11.3. The type of fluid to be used in the hydraulic transmission of braking systems should be identified in accordance with ISO standard 9128-1987. The relevant symbol according to Figure 1 or 2 shall be affixed in a visible position in indelible form within 100 mm of the filling ports of the fluid reservoirs, additional information may be provided by the manufacturers. This requirement does not apply to vehicles with common hydraulic fluid supply.

2.2.1.12. Any vehicle fitted with a service braking system actuated by an energy reservoir shall, where the prescribed secondary braking performance cannot be obtained by means of this braking system 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 loading conditions of the vehicle, it shall be possible to apply the service braking system control a fifth time after four full-stroke actuations and obtain the prescribed secondary braking performance (without faults in the service-brake transmission and with the brakes adjusted as closely as possible). The warning device shall 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 shall give no signal except during the time required for charging the energy reservoir(s) after start-up of the engine.

2.2.1.12.1. However, in the case of vehicles which are only considered to comply with the requirements of point 2.2.1.4.1 by virtue of meeting the requirements of point 1.2.2 of Annex IV, section C, the alarm device shall consist of an acoustic signal in addition to an optical signal. These devices need not operate simultaneously, provided that each of them meets the above requirements and the acoustic signal is not actuated before the optical signal.

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

2.2.1.13. Without prejudice to the requirements of point 2.1.2.3, where the use of an auxiliary energy source is essential for the operation of a braking system, the energy reserve shall 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 braking system is reinforced by some aid, the actuation of the parking braking system shall be ensured in the event of failure of that aid, if necessary by using a reserve of energy independent of that normally supplying such aid. This reserve of energy may be that intended for the service braking system. The expression 'actuation' also covers the action of releasing.

2.2.1.14. In the case of a tractor to which the coupling of a towed vehicle equipped with a brake controlled by the driver of the towing vehicle is authorised, the service braking system of the towing vehicle shall be fitted with a device so designed that if the towed vehicle braking system should fail, or the supply line (or such other type of connection as may be adopted) between the towing vehicle and towed vehicle should break, it will still be possible to brake the towing vehicle with the effectiveness prescribed for the secondary braking system; it is accordingly prescribed, in particular, that this device be fitted to the towing vehicle6.

2.2.1.15. The auxiliary equipment shall be automatically supplied with energy in such a way that during its operation the prescribed performance values can be reached and that even in the event of damage to the source of energy, the operation of the auxiliary equipment cannot cause the reserves of energy feeding the braking systems to fall below the level indicated in point 2.2.1.13.

---

6 This point must be interpreted in the following way: it is essential in all cases, that the service braking system should be fitted with a device (for instance a limiting valve) ensuring that the vehicle can still be braked by the service braking system, but with a performance prescribed for the secondary braking system.
2.2.1.16. Where a towed vehicle belongs to category R3, R4 or S2, the service braking system must be of a continuous or semi-continuous type.

2.2.1.17. The braking system of a vehicle authorised to tow a category R2, R3, R4 or S2 vehicle shall satisfy the following conditions:

2.2.1.17.1 When the service braking system of the towing vehicle is actuated and with the engine running, there shall also be a graduated braking action on the towed vehicle. When the secondary and/or parking braking system of the towing vehicle is fully actuated and with the engine running, there shall also be a braking action on the towed vehicle.

2.2.1.17.2 In the case of a fracture or leak in a supply line, it shall nevertheless be possible for the driver to fully or partially actuate the towed vehicle brakes, by means either of the service braking system control or of the secondary braking system control or of the parking braking system control, unless the fracture or leak automatically causes the towed vehicle to be braked with the performance prescribed in point 2.2.3 of Annex II.

2.2.1.17.3 Should the service braking system of the towing vehicle fail, and if this system is made up of at least two independent sections, the section or sections not affected by this failure must be able to fully or partially actuate the towed vehicle brakes. This requirement does not apply where the two independent sections consist in one section braking left hand wheels and one section braking right hand wheels, such a design aiming at permitting differential braking for cornering in the fields. Should in the latter case, the service braking system of the towing vehicle fail, then the secondary braking system must be able to fully or partially actuate the towed vehicle brakes with the performance required for secondary braking. 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.

2.2.1.18. For two-line pneumatic braking systems, the requirements of 2.2.1.17 shall be considered to be met when the following conditions are fulfilled.

2.2.1.18.1 For vehicles of categories T1, T2, T3 and T4 and category C, with the engine running and with the service brake of the towing vehicle applied, the pressure supplied at the coupling head of the control line shall fall between the limits defined by diagram 1 in the appendix of Annex II.

2.2.1.18.2 For vehicles of category T5, with the engine running and with the service brake of the towing vehicle applied, the pressure supplied at the coupling head of the control line shall fall between the limits defined by diagram 3 in the appendix of Annex II.

2.2.1.18.3 The secondary and parking brake action on the towed vehicle shall be controlled by pressure supplied from the towing vehicle. This pressure shall not be less than 650 kPa.

2.2.1.18.4 In case of a fracture or a leak in the control line, the automatic braking in paragraph 2.2.1.17.2 shall be considered to be met when the designated brake control of those mentioned in paragraph 2.2.1.17.2. above is fully actuated, the pressure in the
supply line must fall to 150 kPa or less within the following two seconds; in addition, when the brake control is released, the supply line shall be re-pressurised;

2.2.1.18.4 In case of a fracture or a leak in the supply line, the automatic braking in paragraph 2.2.1.17.2 must start to operate before the pressure in the supply line falls to 200 kPa, when the supply line is evacuated at the rate of at least 100 kPa per second.

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

2.2.1.19 For two-line hydraulic braking systems, the requirements of 2.2.1.17 shall be considered to be met when the following conditions are fulfilled.

2.2.1.19.1 There shall be two hydraulic connectors at the rear of the towing vehicle and one optional electrical connector. The hydraulic connectors shall meet ISO 5676. One connector shall have the male part (0-15.000 kPa circuit) on the towing vehicle; the other shall have the female part (0-1.500/3.500 kPa circuit) on the towing vehicle. The electrical connector, if provided shall be a socket according to the relevant part of ISO 7638.

2.2.1.19.2 The pressure supplied at both coupling heads with the engine not running shall always be 0 kPa.

2.2.1.19.3 On the coupling head with the male part on the towing vehicle: with the engine running and with no braking control applied on the towing vehicle (driving or standby condition), the pressure supplied at the coupling head shall be 0 kPa.

For vehicles of categories T1, T2, T3 and T4 and category C, with the engine running and with the service brake applied, the pressure supplied at the coupling head shall fall between the limits defined by diagram 4 in the appendix of Annex II.

For vehicles of category T5, with the engine running and with the service brake applied, the pressure supplied at the coupling head shall fall between the limits defined by diagram 6 in the appendix of Annex II.

2.2.1.19.4 On the coupling head with the female part on the tractor: with the engine running and with no braking control (driving or standby condition) or with the service brake applied on the towing vehicle, the pressure supplied at the coupling head shall be at least 1.500 kPa and under no condition exceed 3.500 kPa.

2.2.1.19.5 With the engine running and with the tractor secondary braking and/or parking brake mode activated, the pressure supplied at both coupling heads shall be 0 kPa. Optionally and at the choice of the manufacturer, the pressure supplied at the coupling head with the male part on the towing vehicle may be between 11.500 kPa and 15.000 kPa. In the latter case, a device to release the pressure in the connecting lines shall be provided on the towing vehicle to be able to connect and disconnect the hydraulic lines with running engine and parking brake engaged. Upon release of this device, the previous pressure level shall be restored.

2.2.1.19.6 The towing vehicle shall have a provision for an optical warning device to indicate a low level of stored energy on the towed vehicle.
2.2.1.20 Vehicles fitted with hydrostatic drive shall comply with the requirements of Annex IX.

2.2.1.21 In the case of a tractor authorised to tow a vehicle of category R2, R3, R4 or S2 the service braking system of the towed vehicle shall only be operated in conjunction with the service, secondary and parking braking system of the towing vehicle.

2.2.1.22 All vehicles of category T5 shall be fitted with an anti-lock braking system which meets the requirements of Annex XIV.

Vehicles of categories T1-T4, and category C, do not need to be fitted with an anti-lock braking system. However, if vehicles of these categories are equipped with an anti-lock braking system, this system shall comply with the same requirements as those of category T5.

2.2.2. Vehicles of categories R and S

2.2.2.1. Vehicles of the following categories

Ra1, Rb1 (where the sum of the technically permissible mass per axle is less than or equal to 750kg), Sa1
Sb1 (where the sum of the technically permissible mass per axle is less than or equal to 750kg),

do not need to be fitted with a service braking system. However, if vehicles of these categories are equipped with a service braking system, this system shall comply with the same requirements as those of category R2.

2.2.2.2. Vehicles of categories Rb1 and Sb1 (where the sum of the technically permitted mass per axle exceeds 750kg), R2 shall be fitted with a service braking system either of the continuous or semi-continuous type, operated by the control on the towing vehicle, or of the inertia (overrun) type. However, if trailers of this category are equipped with a continuous or semi-continuous service braking device, this device shall meet the same requirements as those of category R3.

2.2.2.3. The braking action shall be appropriately distributed among the axles.

2.2.2.4. The action of every braking system shall be distributed between the wheels of each axle symmetrically in relation to the longitudinal median plane of the towed vehicle.

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

2.2.2.6. Wear of the brakes shall be easily compensated by a system of manual or automatic adjustment. This system shall be automatic for service brakes on R4 trailers. In addition, the control and the components of the transmission and of the brakes shall 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 shall be ensured without immediate adjustment being necessary.

In particular, the towed vehicle shall remain capable of normal running after the tests conducted in accordance with Annex II, point 1.3 (Type-I test). It shall be possible to easily check the wear on service brake linings from the outside or underside of the towed vehicle, utilising only the tools or equipment normally supplied with the towed vehicle; for instance, by the provision of appropriate inspection holes or by some other means.

2.2.2.6.1. The fitting of automatic adjustment devices is optional for vehicles of categories R1, R2, R3, S1 and S2. If automatic adjustment is fitted to these vehicles it shall conform to the same requirements as for vehicles of category R4.

2.2.2.7. On a towed vehicle, where a service braking system is fitted either voluntarily or as a mandatory requirement, the braking system shall be such that the towed vehicle is stopped automatically if the coupling separates while the towed vehicle is in motion.

Where stored energy is used to provide the automatic brake function, a warning must be transmitted into the cab to alert the operator of an insufficient level of stored pressure. The information shall be provided to the operator by means of the device prescribed in 2.2.1.11.2.

2.2.2.7.1. Vehicles of categories R1 and S1, without a braking system, shall be equipped, in addition to the main coupling device, with a secondary coupling (chain, cable etc) capable, in the event of separation of the main coupling, of preventing the drawbar from touching the ground and providing some residual steering action on the towed vehicle.

2.2.2.7.2. Vehicles of categories R1, R2 and S1, where an inertia braking system is fitted either voluntarily or as a mandatory requirement, shall be equipped with a device (chain, cable etc) capable, in the event of separation of the coupling, of applying the towed vehicle brakes.

2.2.2.8. On every towed vehicle which is required to be fitted with a service braking system (except vehicles fitted with an inertia braking system) parking braking shall be ensured even when the towed vehicle is separated from the towing vehicle. It shall be possible for a person standing on the ground to actuate the parking braking system. The expression 'actuate' also covers the action of releasing.

2.2.2.9 On every towed vehicle which is required to be fitted with a service braking system the vehicle shall be so designed such that when all braking connections between the towing vehicle and the towed vehicle have been disconnected the parking brake and/or secondary braking system shall be automatically applied. A valve may be included to allow a person standing on the ground to manually override this braking action.

2.2.2.10 If the towed vehicle is fitted with a device enabling actuation of the braking system to be cut out, other than the parking braking system, the device shall 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 or hydraulic oil or electrical supply to the towed vehicle.

2.2.2.11. Vehicles of categories R3, R4 and S2 shall satisfy the conditions specified in point 2.2.1.17.3.

2.2.2.12. The auxiliary equipment shall be supplied with energy in such a way that during its operation, the service braking energy storage device(s) shall be maintained at a pressure of at least 80% of the minimum towing vehicle supply pressure as prescribed in point 1.2.3.2 of Annex II.

2.2.2.13. In addition to the above, towed vehicles with pneumatic braking systems shall comply with the following:

2.2.2.13.1 The configuration and dimension of the transmission parts of the brake and any devices to modulate the braking force in function of the partially laden condition shall be such to meet the limits defined by diagram 2 in the appendix of Annex II.

2.2.2.14. In addition to the above, towed vehicles with hydraulic braking systems shall comply with the following:

2.2.2.14.1 The configuration and dimension of the transmission parts of the brake and any devices to modulate the braking force in function of the partially laden condition shall be such to meet the limits defined by diagram 5 in the appendix of Annex II.

2.2.2.14.2 The service brake line shall have a female connector according to ISO 5676.

2.2.2.14.3 Energy for braking as a result of actuation of the secondary and/or parking brake on the towing vehicle or as a result of separation of both vehicles may be stored energy in hydraulic accumulators or by one or more spring loaded actuators. The control line to the towing vehicle shall have a male connector according to ISO 5676 and braking shall start when the pressure in this control line drops below 800 kPa. As an alternative, braking shall start as a result of the interruption of the 12 V power supply to the towed vehicle. The service brake line to the towing vehicle shall have a female connector according to ISO 5676. The electrical connector shall be a plug according to the relevant part of ISO 7638.

2.2.2.14.4 In case of energy stored in hydraulic accumulators, there shall be an optical warning device in the towing vehicle to indicate a low level of stored energy on the towed vehicle. The threshold shall be set at 800 kPa. The hydraulic accumulators on the towed vehicle shall be charged at least when the service brakes of the towing vehicle are applied. Additionally, there may be other devices installed on the towed vehicle to charge the accumulators.

2.2.2.14.5 A device may be installed on the towed vehicle to temporary release the brakes in the case that no suitable towing vehicle is available. One of the ISO 5676 connectors on the hydraulic lines shall be connected to this device for this temporary purpose. The device must be so constructed to avoid any unintentional leakage and to return automatically to the applied brake mode when not in use.
ANNEX II

Braking tests and performance of braking systems

1. BRAKING TESTS

1.1. General

1.1.1. The performance prescribed for braking systems shall be based on the stopping distance and/or the mean fully developed deceleration. The performance of a braking system shall be determined by measuring the stopping distance in relation to the initial speed of the vehicle and/or by measuring the mean fully developed deceleration during the test.

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 braking system until the moment when the vehicle stops; the initial vehicle speed (v₁) shall be the speed at the moment when the driver begins to actuate the control of the braking system; the initial speed shall not be less than 98 % of the prescribed speed for the test in question. The mean fully developed deceleration dₘ shall be calculated as the deceleration averaged with respect to distance over the interval vᵦ to vₑ according to the following formula:

\[ dₘ = \frac{vₑ² - vᵦ²}{25,92(sₑ - sᵦ)} \text{ m/s}² \]

Where:
- \( v₁ \) = as defined above
- \( vᵦ \) = vehicle speed at 0,8 \( v₁ \) in km/h
- \( vₑ \) = vehicle speed at 0,1 \( v₁ \) in km/h
- \( sᵦ \) = distance travelled between \( v₁ \) and \( vᵦ \) in metres
- \( sₑ \) = distance travelled between \( v₁ \) and \( vₑ \) in metres

The speed and distance shall be determined using instrumentation having an accuracy of ± 1 % at the prescribed speed for the test. The \( dₘ \) may be determined by other methods than the measurement of speed and distance; in this case, the accuracy of the \( dₘ \) shall be within ± 3 %.

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 mass shall be as prescribed for each type of test and be specified in the test report (see Annex X Appendix 2)

1.1.3.2. The tests shall be carried out at the maximum forward speed of the vehicle.
1.1.3.3. During the tests, the force applied to the control of the braking system in order to obtain the prescribed performance shall not exceed 600 N on the foot or 400 N on the hand operated controls.

1.1.3.4. The road shall possess a surface having a good adhesion.

1.1.3.5. The tests shall 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 shall be obtained without deviation of the vehicle from its course, without abnormal vibrations and without wheel locking. Wheel-locking is permitted where specifically mentioned.

1.1.4. For vehicles of categories T and C authorised to tow vehicles of category S2, R3 or R4, and for vehicles of category S2, R3 and R4, the permissible relationship between the braking rate $T_M/P_M$ or $T_R/P_R$ and the pressure $p_m$ shall be within the areas shown in diagrams 1 to 6.

In the case of vehicles of categories T and C, this requirement applies only to vehicles with maximum design speed exceeding 30 km/h.

1.2. Type-0 braking test (ordinary performance test with brakes cold)

1.2.1. General

1.2.1.1. The brake shall be cold. A brake is deemed to be cold when one of the following conditions is met:

1.2.1.1.1. The temperature measured on the disc or on the outside of the drum is below 100 °C.

1.2.1.1.2. In the case of totally enclosed brakes, including oil immersed brakes, the temperature measured on the outside of the housing is below 50 °C.

1.2.1.1.3. The brakes have not been used for one hour before the test.

1.2.1.2. During the braking test, an un-braked axle, when capable of being declutched, shall not be connected with a braked axle. However, in case of tractors with a braked rear axle and an automatic engagement of the front drive during braking, the front axle is deemed to be braked.

1.2.1.3. The test must be conducted under the following conditions:

1.2.1.3.1. The vehicle shall be laden to its maximum permissible mass specified by the manufacturer, with an un-braked axle also loaded to its maximum permissible mass. The braked axle wheels shall be fitted with the largest diameter tyres intended by the manufacturer for that vehicle type when carrying the maximum permissible mass. For vehicles braking on all wheels, the front axle shall be laden to its maximum permissible mass.
1.2.1.3.2. The test shall be repeated on an unladen vehicle; in case of tractors, carrying only the driver and if necessary a person responsible for monitoring the results of the test.

1.2.1.3.3. The limits prescribed for minimum performance, both for tests with the vehicle unladen and for tests with the vehicle laden, are those laid down hereunder for each category of vehicle, the vehicle shall satisfy both the prescribed stopping distance and the prescribed mean fully developed deceleration for the relevant vehicle category, but it may not be necessary to actually measure both parameters. However, the prescribed mean fully developed deceleration does not apply to vehicles with maximum design speed not exceeding 30 km/h.

1.2.1.3.4. The road shall be level.

1.2.2. Type-0 test for categories T and C vehicles

1.2.2.1. The test shall be carried out at the maximum design speed of the vehicle, with the engine disconnected.

1.2.2.2. A tolerance as mentioned in 1.1.2 is permitted on the test speed.

1.2.2.3. The minimum prescribed performance shall be attained.

1.2.2.4. To check compliance with the requirements of Annex I, point 2.2.1.2.4, a Type-0 test shall be carried out with the engine disconnected at the initial speed of not less than 98 % of the maximum design speed of the vehicle. The mean fully developed deceleration on application of the control of the parking braking system or on application of an auxiliary control, which permits at least partial actuation of the service brake and the deceleration immediately before the vehicle stops shall not be less than 1,5 m/s² up to 30 km/h and 2,2 m/s² above 30 km/h. The test shall be carried out with the laden vehicle. The force exerted on the braking control device shall not exceed the specified values.

1.2.3. Type-0 test for categories R and S vehicles:

1.2.3.1. The braking performance of the vehicle can be calculated either from the braking rate of the towing vehicle plus the vehicle and the measured thrust on the coupling or, in certain cases, from the braking rate of the towing vehicle plus the towed vehicle with only the towed vehicle being braked. The engine of the towing vehicle shall be disconnected during the braking test.

In the case where only the towed vehicle is braked, to take account of the extra mass being retarded, the performance will be taken to be the mean fully developed deceleration

1.2.3.2. The prescribed minimum braking performance shall be achieved with a pressure at the coupling head not exceeding:

- 11.500 kPa for hydraulic braking system
- 650 kPa for a dual line pneumatic braking system

1.2.3.3. The maximum pressure delivered at the coupling head shall not exceed:
– 15,000 kPa in the case of hydraulic braking system
– 850 kPa in the case of pneumatic braking system

1.2.3.4. With the exception of cases according to points 1.2.3.5 and 1.2.3.6, it is necessary for the determination of the braking rate of the towed vehicle to measure the braking rate of the towing vehicle plus the towed vehicle and the thrust on the coupling. The towing vehicle shall meet the requirements laid down in the diagram 1, 3, 4 or 6 with regard to the relation between the ratio TM/PM and the pressure pm,

where:
- TM = sum of braking forces at the periphery of wheels of towing vehicles
- PM = total vertical static load between the road surface and the wheels of the towing vehicle
- pm = pressure at coupling head of control line

The braking rate of the towed vehicle shall be calculated according to the following formula:

\[ Z_R = Z_{R+M} + D/PR \]

Where:
- \( Z_R \) = braking rate of the towed vehicle
- \( Z_{R+M} \) = braking rate of the towing vehicle plus the towed vehicle
- \( D \) = thrust on the coupling (tractive force \( D > 0 \); compressive force \( D < 0 \))
- \( PR \) = total vertical static reaction between the road surface and the wheels of the towed vehicle.

1.2.3.5. If a towed vehicle has a continuous or semi-continuous braking system where the pressure in the brake actuators does not change during braking despite the dynamic axle load shifting, the towed vehicle alone may be braked. The braking rate of the towed vehicle shall be calculated according to the following formula:

\[ Z_R = (Z_{R+M} - R) \times \frac{PM + PR}{PR} + R \]

Where:
- \( R \) = rolling resistance value (0.02)
- \( P_M \) = total vertical static load between the road surface and the wheels of the towing vehicle.

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

1.3. Type-I braking test (fade test)

This test type shall be performed according to the requirements of either 1.3.1 or 1.3.2

1.3.1. With repeated braking

1.3.1.1 The service braking system of all vehicles covered by this Regulation shall be tested by successively applying and releasing the brakes a number of times. The vehicle shall be fully laden and tested in accordance with the conditions shown in the following table:

<table>
<thead>
<tr>
<th>Vehicle category</th>
<th>Conditions</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>( v_1 ) [km/h]</td>
</tr>
<tr>
<td>T, C, R2, R3, R4, S2</td>
<td>80 % ( v_{\text{max}} )</td>
</tr>
</tbody>
</table>

Where

\[ v_1 = \text{speed at start of braking} \]
\[ v_2 = \text{speed at end of braking} \]
\[ v_{\text{max}} = \text{maximum design speed of vehicle} \]
\[ n = \text{number of brake applications} \]
\[ \Delta t = \text{duration of the braking cycle (time elapsing between the initiation of one brake application and the initiation of the next).} \]

1.3.1.2 If the characteristics of the vehicle do not allow for the period of time prescribed for \( \Delta t \), 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 shall be allowed in each cycle for stabilising the speed \( v_1 \).

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

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

1.3.1.5 For regaining speed after braking, the gearbox shall 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 The service braking system of vehicles of categories R2, R3, R4 and S2 shall be tested in such a manner that, the vehicle being laden, the energy input to the brakes shall be equivalent to that recorded in the same period of time with a laden vehicle driven at a steady speed (80 +/- 5 %) of the prescribed speed for the Type-0 test on a 7 % down gradient for a distance of 1.7 km.

The test may be carried out on a level road, the trailed vehicle being towed by a agricultural vehicle; during the test, the force applied to the control shall be adjusted so as to keep the resistance of the towed vehicle constant (7 % of the maximum stationary axle load of the towed vehicle). 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:

<table>
<thead>
<tr>
<th>Speed</th>
<th>distance (in m)</th>
</tr>
</thead>
<tbody>
<tr>
<td>80 % of the prescribed speed for the Type-0 test</td>
<td>1700</td>
</tr>
<tr>
<td>60 % of the prescribed speed for the Type-0 test</td>
<td>1950</td>
</tr>
<tr>
<td>40 % of the prescribed speed for the Type-0 test</td>
<td>2500</td>
</tr>
<tr>
<td>30 % of the prescribed speed for the Type-0 test</td>
<td>3100</td>
</tr>
</tbody>
</table>

1.3.3. At the end of the test the hot performance of the service braking device shall be measured under the same conditions as for the Type-0 test with the exception of the temperature conditions.

2. PERFORMANCES OF THE BRAKING DEVICES

2.1. Vehicles of category T and C

2.1.1. Service braking systems

2.1.1.1. Under Type-0 conditions, the service braking system shall be tested under the conditions shown in the following table

<table>
<thead>
<tr>
<th>condition</th>
<th>v_{max} \leq 30 \text{ km/h}</th>
<th>v_{max} &gt; 30 \text{ km/h}</th>
</tr>
</thead>
<tbody>
<tr>
<td>v</td>
<td>v = v_{max}</td>
<td>v = v_{max}</td>
</tr>
<tr>
<td>s (metres)</td>
<td>\leq 0.15 v + v^2/116</td>
<td>\leq 0.15 v + v^2/130</td>
</tr>
<tr>
<td>d_M</td>
<td>\geq 5 m/s^2</td>
<td></td>
</tr>
<tr>
<td>F (foot operated control)</td>
<td>\leq 600 N</td>
<td>\leq 600 N</td>
</tr>
<tr>
<td>F (hand operated control)</td>
<td>\leq 400 N</td>
<td>\leq 400 N</td>
</tr>
</tbody>
</table>
where:

- \( v_{\text{max}} \) = maximum design speed of the vehicle
- \( v \) = prescribed test speed
- \( s \) = Stopping distance
- \( d_M \) = mean fully developed deceleration
- \( F \) = force applied to the control

2.1.1.2. In case of a vehicle of categories T or C authorised to tow an un-braked vehicle of categories R or S, the maximum mass of the combination of the tractor and the un-braked towed vehicle shall not exceed the maximum mass of the laden tractor, multiplied by the ratio between the prescribed stopping distance according to 2.1.1.1 and the achieved stopping distance measured during the type-0 test.

\[
PC \leq PM \left( \frac{s_p}{s_a} \right)
\]

where:

PC = maximum mass of the combination of the tractor and the un-braked towed vehicle, as declared by the agricultural vehicle manufacturer

PM = maximum mass of the laden tractor

\( s_p \) = prescribed stopping distance according to 2.1.1.1

\( s_a \) = achieved stopping distance measured during Type-0 test (tractor laden to its maximum mass PM)

In any case, the sum of axle loads of the un-braked towed vehicle shall not exceed 3.5 tons

2.1.1.3. After Type-I test, the service braking system shall produce a hot performance not less than 75 % of that prescribed, and not less than 60 % of the value recorded during the Type-0 test.

2.1.2. Secondary braking system

It shall be possible to slow the tractor to halt with a deceleration equal to at least 1.5 m/s\(^2\) when \( v_{\text{max}} \leq 30 \text{ km/h} \) and 2.2 m/s\(^2\) when \( v_{\text{max}} > 30 \text{ km/h} \). The secondary braking effectiveness test shall be conducted by simulating the actual failure conditions in the service braking system.

The prescribed performance shall be obtained by applying to the control a force not exceeding 600 N on a foot or 400 N on a hand operated control. The control shall be so placed that it can be easily and quickly applied by the driver.

2.1.3. Parking braking system
2.1.3.1. The parking braking device shall, even if it is combined with one of the other braking devices, be capable of holding a laden tractor on an 18 % up or down gradient. This requirement shall be fulfilled even during the cooling period. The cooling period is deemed to terminate when the brakes have reached a temperature of 10 °C above ambient.

2.1.3.2 For vehicles of category T4.3, the parking braking device shall, even if it is combined with one of the other braking devices, be capable of holding a laden tractor on a 40 % up or down gradient. This requirement shall be fulfilled even during the cooling period. The cooling period is deemed to terminate when the brakes have reached a temperature of 10 °C above ambient.

2.1.3.3. On tractors to which the coupling of towed vehicles is authorised, the parking braking system of the tractor shall be capable of holding the vehicle combination, at the maximum permissible mass as specified by the tractor manufacturer, stationary on a 12 % up or down gradient. In the case of a tractor authorised to tow a vehicle of category R3, R4 or S2, this requirement shall be fulfilled when tractor and towed vehicle brakes are operated according to paragraph 2.2.1.22 of Annex I.

The requirement above is considered fulfilled when conditions A and B below are met:

(A) With the tractor engine not rotating, the combination at the maximum permissible mass remains stationary on the prescribed gradient when the activation of a single control by the driver, from his driving seat, has applied the tractor parking brake and the towed vehicle service brake, secondary brake or parking brake.

(B) The tractor parking brake can hold the tractor connected to an un-braked trailed vehicle, the combination of which having a mass equal to PC as stated by the tractor manufacturer according to 2.1.1.2 of this Annex.

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

2.2. Vehicles of the categories R and S

2.2.1. Service braking system

2.2.1.1. Requirement relating to tests of category R1 or S1 vehicles

If towed vehicles of category R1 or S1 are fitted with a service braking system, the performance of the system shall meet the requirements laid down for category R2 or S2 vehicles.

2.2.1.2. Requirement relating to tests of category R2 vehicles

If the service braking system is of the continuous or semi-continuous type, the sum of the forces exerted at the periphery of the braked wheels shall be at least 50 % of the maximum stationary wheel load.

Where the towed vehicle is fitted with a compressed-air braking system, the pressure in the control line shall not exceed 650 kPa and the pressure in the supply line shall not exceed 700 kPa during the brake test.
Where the towed vehicle is fitted with a hydraulic braking system, the pressure in the supply line shall not exceed 11.500 kPa during the brake test.

Where the braking system is of the inertia type, it shall comply with the conditions laid down in Annex VIII.

2.2.1.3. Requirement relating to tests of category R3, R4 or S2 vehicles

The sum of the forces exerted at the periphery of the braked wheels shall be at least 50 % of the maximum stationary wheel load.

Where the towed vehicle is fitted with a compressed-air braking system, the pressure in the control line shall not exceed 650 kPa and the pressure in the supply line shall not exceed 700 kPa during the brake test.

Where the towed vehicle is fitted with a hydraulic braking system, the pressure in the supply line shall not exceed 11.500 kPa during the brake test.

2.2.1.4 After Type-I test, the service braking system shall produce a hot performance not less than 75 % of that prescribed, and not less than 60 % of the value recorded during the Type-0 test.

2.2.2. Parking braking system

2.2.2.1. The parking braking system shall be capable of holding a laden towed vehicle stationary on an 18 % up and down gradient.

2.2.2.2. The requirements set out in 2.2.2.1 shall be fulfilled even during the cooling period. The cooling period is deemed to be terminated when the brakes have reached a temperature of 10 °C above ambient.

2.2.3. Automatic braking system

The automatic braking performance in the event of the total pressure loss in the air / braking fluid supply line shall not be less than 50 % of the values stated in 2.2.1.3 Wheel-locking at performance levels above this is permitted.

2.3. Reaction time for vehicles of categories T, C, R and S

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

2.3.1. In an emergency manoeuvre, the time elapsing 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 shall not exceed 0,6 seconds.

2.3.2. The requirements of point 2.3.1 are considered to be satisfied if the vehicle complies with the provisions of Annex III. The performance shall be achieved at braking system temperature as defined by the manufacturer.
2.3.3. In the case of vehicles fitted with hydraulic braking systems, the requirements of point 2.3.1 are considered to be satisfied if, in an emergency manoeuvre, 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.

2.3.4. In case of tractors with a braked rear axle and an automatic engagement of the front drive during braking, the requirements of point 2.3.1 are considered to be satisfied if, the tractor satisfies both the prescribed stopping distance and the prescribed mean fully developed deceleration for the relevant vehicle category according to 2.1.1.1., but in this case it is necessary to actually measure both parameters.
Appendix 1: Distribution of braking effort amongst vehicle axles

Markings

1.1 Vehicles 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 and any further information to enable the setting of the device to be checked

1.1.1 When a load sensing device is controlled via the suspension of the vehicle by any other means, the vehicle shall be marked with information to enable the setting of the device to be checked.

1.2 When the requirements of this Appendix are met by means of a device which modulates the pressure in brake transmission, the vehicle shall be marked to show the axle loads at the ground, the nominal outlet pressures of the device and an inlet pressure of not less than 80 % of the maximum design inlet pressure, as declared by the vehicle manufacturer, for the following states of load:

1.2.1 Technically permissible maximum axle load for the axle(s) which control(s) the device.

1.2.2 Axle load(s) corresponding to the mass of the vehicle in running order as defined in point 2.6 of Annex I to Directive 70/156/EEC.

1.2.3 The axle load(s) designated by the manufacturer to enable the setting of the device to be checked in service if this is (these are) different from the loads specified in points 1.2.1 and 1.2.2.

1.3 [Type approval documentation] shall include information to enable compliance with the requirements of points 1.1 and 1.2 to be checked.

1.4 The markings referred to under points 1.1 and 1.2 shall be affixed in a visible position in indelible form. An example of the markings for a mechanically controlled device in a vehicle fitted with compressed-air braking is shown in Diagram 7.

2 Pressure test connections

2.1 Braking systems incorporating the devices referred to in point 1.2 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 point 4.1 of Annex III.

2.2 The pressure test connections shall comply with clause 4 of ISO standard 3583-1984.
Diagram 1
Permissible relationship between braking rate $\frac{TM}{PM}$ and the coupling head pressure $p_m$ for
towing vehicles of categories T1-T4 and C with compressed air braking systems

$TM = \text{sum of braking forces at the periphery of wheels of towing vehicles}$

$PM = \text{total normal static reaction between road surface and wheels of towing vehicles}$

$p_m = \text{pressure at coupling head of control line}$

$\textbf{Tractor max}$ and $\textbf{Tractor min}$ as defined in 2003/37/EC, Annex I, 2.1.1

It is understood that, between the values $\frac{TM}{PM} = 0$ and $\frac{TM}{PM} = 0.1$ it is not necessary that
there should be proportionality between the braking rate $\frac{TM}{PM}$ and the control line pressure $p_m$
as measured at the coupling head.
Diagram 2
Permissible relationship between braking rate TR/PR and the coupling head pressure $p_m$ for towed vehicles of categories S2, R3 and R4 with compressed air braking systems

$TR = \text{sum of braking forces at periphery of all wheels of towed vehicles}$

$PR = \text{total normal static reaction between road surface and wheels of towed vehicles}$

$p_m = \text{pressure at coupling head of control line}$

It is understood that between the values $TR/PR = 0$ and $TR/PR = 0.1$ it is not necessary that there should be proportionality between the braking rate TR/PR and the control line pressure $p_m$ as measured at the coupling head.
Diagram 3
Permissible relationship between braking rate $\frac{TM}{PM}$ and the coupling head pressure $p_m$ for towing vehicles of category T5 with compressed air braking systems

$TM = \text{sum of braking forces at the periphery of wheels of towing vehicles}$

$PM = \text{total normal static reaction between road surface and wheels of towing vehicles}$

$p_m = \text{pressure at coupling head of control line}$

$\text{Tractor max}$ and $\text{Tractor min}$ as defined in 2003/37/EC, Annex I, 2.1.1

It is understood that, between the values $\frac{TM}{PM} = 0$ and $\frac{TM}{PM} = 0.1$ it is not necessary that there should be proportionality between the braking rate $\frac{TM}{PM}$ and the control line pressure $p_m$ as measured at the coupling head.
Hydraulic braking systems

Permissible relationship between braking rate $\frac{TM}{PM}$ and the coupling head pressure $p_m$ for towing vehicles of categories T1-T4 and C with hydraulic braking systems.

Diagram 4

$TM = \text{sum of braking forces at the periphery of wheels of towing vehicles}$

$PM = \text{total normal static reaction between road surface and wheels of towing vehicles}$

$p_m = \text{pressure at coupling head of control line}$

Tractor max and Tractor min as defined in 2003/37/EC, Annex I, 2.1.1

It is understood that, between the values $TM/PM = 0$ and $TM/PM = 0.1$ it is not necessary that there should be proportionality between the braking rate $TM/PM$ and the control line pressure $p_m$ as measured at the coupling head.
Diagram 5
Permissible relationship between braking rate $TR/PR$ and the coupling head pressure $p_m$ for towed vehicles of categories S2, R3 and R4 with hydraulic braking systems.

$TR = \text{sum of braking forces at periphery of all wheels of towed vehicles}$

$PR = \text{total normal static reaction between road surface and wheels of towed vehicles}$

$p_m = \text{pressure at coupling head of control line}$

It is understood that, between the values $TR/PR = 0$ and $TR/PR = 0,1$ it is not necessary that there should be proportionality between the braking rate $TR/PR$ and the control line pressure $p_m$ as measured at the coupling head.
Permissible relationship between braking rate $\frac{TM}{PM}$ and the coupling head pressure $p_m$ for towing vehicles of category T5 with hydraulic braking systems.

$TM = \text{sum of braking forces at the periphery of wheels of towing vehicles}$

$PM = \text{total normal static reaction between road surface and wheels of towing vehicles}$

$p_m = \text{pressure at coupling head of control line}$

$\textbf{Tractor max}$ and $\textbf{Tractor min}$ as defined in 2003/37/EC, Annex I, 2.1.1

It is understood that, between the values $\frac{TM}{PM} = 0$ and $\frac{TM}{PM} = 0,1$ it is not necessary that there should be proportionality between the braking rate $\frac{TM}{PM}$ and the control line pressure $p_m$ as measured at the coupling head.
## Load sensing device

*Diagram 7*

(see point 1.4)

<table>
<thead>
<tr>
<th>Control data</th>
<th>Vehicle loading</th>
<th>Axle No. 2 load at the ground [daN]</th>
<th>Inlet pressure [kPa]</th>
<th>Nominal outlet pressure [kPa]</th>
</tr>
</thead>
<tbody>
<tr>
<td>Laden</td>
<td>10 000</td>
<td>600</td>
<td>600</td>
<td>600</td>
</tr>
<tr>
<td>Unladen</td>
<td>1 500</td>
<td>600</td>
<td>240</td>
<td></td>
</tr>
</tbody>
</table>

Diagram showing forces and distances:
- F = 100 mm
- L = 150 mm

-NL-
ANNEX III

MEASUREMENT OF THE REACTION TIME

1. GENERAL REQUIREMENTS

1.1. The reaction time for the braking devices shall be determined with the vehicle stationary, the pressure being measured at the opening of the least efficient brake cylinder. In the case of vehicles equipped with combined compressed air/hydraulic systems, the pressure may be measured at the opening of the least efficient pneumatic unit. In the case of vehicles equipped with load-dependent correctors, these devices must be on the "loaded" position.

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.

1.3. Reaction times obtained in conformance with this Annex shall be rounded to the nearest tenth of second. If the figure representing the hundredth units is 5 or more, the reaction time is rounded to the upper tenth.

2. METHOD FOR TOWED VEHICLES EQUIPPED WITH A COMPRSSED AIR BRAKING DEVICE

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

2.2. The pressure in the feed pipe must be 650 kPa.

2.3. The simulator must have the following features:

2.3.1. It must have a thirty litre reservoir filled to a pressure of 650 kPa before each test, and it must not be refilled during the tests. The simulator must include at the end of the control device an opening with a diameter of 4 mm to 4.3 mm. The volume of the pipe measured from the opening to and including the coupling head must reach 385 ± 5 cm³ (corresponding to the volume of a tube with a length of 2.5 m and an internal diameter of 13 mm for a pressure of 650 kPa. Pressures must be measured directly after the opening.

2.3.2. The control device must be designed in such a way that the efficiency during the operation is not influenced by the person conducting the test.

2.3.3. The simulator must be adjusted, for instance by the choice of the opening, in such a way that, if it is connected to a reservoir of 385 ± 5 cm³, the time taken for the pressure to increase from 65 kPa to 490 kPa (i.e. from 10 % to 75 % of the nominal pressure which is 650 kPa) is equal to 0.2 ± 0.01 s. When it is connected to a reservoir of 1.155 ± 15 cm³ instead of the abovementioned reservoir, the time taken for the pressure to increase from 65 kPa to 490 kPa without a new adjustment must be equal to 0.38 ± 0.02 s. Between these two values, the pressure must increase in an approximately linear way. These reservoirs must be connected to the coupling head without using flexible pipes, and their internal diameter must not be less than 10 mm.
2.4. The time elapsing between when the pressure produced in the control pipe by the simulator reaches 65 kPa and the moment when the pressure in the brake cylinder of the towed vehicle reaches 75 % of its asymptotic value must not exceed 0.4 seconds.

3. **METHOD FOR TOWED VEHICLES EQUIPPED WITH AN HYDRAULIC BRAKING DEVICE**

3.1. The reaction times of the towed vehicle shall be measured without a towing vehicle. To simulate the towing vehicle, it is necessary to provide a simulator to which the coupling head of the towed vehicle brake pipe is to be connected.

3.2. The pressure in the feed pipe must be 12,000 kPa.

3.3. The simulator must have the following features:

3.3.1. The pressure delivered to the coupling head by the simulator of the towing vehicle must be adjustable between 0 kPa and 12,000 kPa.

3.3.2. The maximum pressure delivered by the simulator must be 12,000 kPa and capable of being maintained.

3.3.3. The control device must be designed in such a way that its operation does not depend on the testing personnel.

3.3.4. The simulator’s flow must be calibrated in such a way that when connected to a cylinder of 90 cm³ for a single axle towed vehicles (respectively 180 cm³ for two axles and 270 cm³ for three axles) according to Appendix fig II.1 and II.2 the pressure measured near the coupling shall reach 11,500 kPa in 0.4 seconds.

3.4. The time elapsing between the moment when the pressure delivered at the coupling head is 1,000 kPa higher than the pressure delivered to the coupling head when the brake control is not actuated, and the moment when the pressure in the brake cylinder of the towed vehicle furthest from the coupling reaches 11,500 kPa (75 % of the prescribed maximum value) must not exceed 0.4 seconds.

3.5. No leakage or incident must be noted after the pipe has been maintained 1 minute at the maximum permissible pressure.
Appendix

EXAMPLES OF SIMULATORS

I Air brakes (see Annex III.2)

1. Setting the Simulator

2. Testing the towed vehicle braking system via the simulator

A = supply connection with shut-off valve
C1 = pressure switch in the simulator, set at 65 kPa and at 490 kPa

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

CF = brake cylinder

L = line from orifice O up to and including its coupling head TC, having an inner volume of $385 \pm 5 \text{ cm}^3$ under a pressure of 650 kPa

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 $385 \pm 5 \text{ cm}^3$

R3 = calibrating reservoir, including its coupling head TC, to be $1155 \pm 15 \text{ cm}^3$

RA = shut-off valve

TA = coupling head, supply line

V = braking system control device

TC = coupling head, control line

VRU = emergency relay valve
II. Hydraulic brakes (see Annex III.3)

1. Towed vehicle simulator for calibrating towing vehicle simulator

2. Towing vehicle simulator calibration
TOWING VEHICLE SIMULATOR

Couplings ISO 5676

Pressure Sensor

to PTO

DATA PRINTER

DATA RECORDER

DOUBLE SWITCH
Start ramp up and trigger for data recorder

TOWED VEHICLE SIMULATOR
90cc, 180cc OR 270cc
3. Towed vehicle
ANNEX IV

Energy reservoirs and sources of energy

A. Compressed-air braking systems

1. CAPACITY OF RESERVOIRS

1.1. General requirements

1.1.1. Vehicles on which the operation of the braking system depends on the use of compressed air shall be fitted with reservoirs of a capacity meeting the requirements of points 1.2 and 1.3.

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. When verifying compliance with the requirements of points 1.2 and 1.3 the brakes shall be adjusted as closely as possible.

1.2. Vehicles of category T

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

1.2.2. During the test, the following requirements shall be satisfied:

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

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

1.2.2.3. In the case of vehicles authorised to tow a vehicle, the supply line shall be blocked off and a reservoir of 0,5 litre capacity shall be connected to the control line. The pressure in this reservoir shall be exhausted before each actuation of the brakes. After the test referred to in point 1.2.1 the pressure in the control line shall not be less than one half of the pressure obtained at the first brake application.

If the vehicle incorporates auxiliary systems e.g. a regenerative air dryer in the system, a volume of air required in the auxiliary/regeneration process must also be connected to the control line and exhausted for one brake application. The volume required for this process to be stated by the vehicle manufacturer.

1.3. Vehicles of categories R and S


7 The initial energy level shall be stated in the information document
1.3.1. Reservoirs fitted to towed vehicles shall be such that after eight full-stroke actuations of the towing vehicle's service braking system, the pressure supplied to the operating parts using it does not fall below a level equivalent to one-half of the figure obtained at the first brake application and without actuating either the automatic or the parking braking system of the towed vehicle.

1.3.2. During the test, the following requirements shall be satisfied:

1.3.2.1. The pressure in the reservoirs at the beginning of the test shall be 850 kPa.

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

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

1.3.2.4. For each brake application, the pressure in the control line shall be 750 kPa.

2. CAPACITY OF ENERGY SOURCES

2.1. General provisions

Compressors shall satisfy the requirements laid down in the following points:

2.2. Definitions

2.2.1. \( p_1 \) the pressure corresponding to 65 % of the pressure \( p_2 \) defined in point 2.2.2.

2.2.2. \( p_2 \) is the value specified by the manufacturer and referred to in point 1.2.2.1.

2.2.3. \( t_1 \) is the time required for the relative pressure to rise from 0 to \( p_1 \); \( t_2 \) is the time required for the relative pressure to rise from 0 to \( p_2 \).

2.3. Conditions of measurement

2.3.1. In all cases the 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 governor.

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 vehicles constructed to tow vehicles, the towed vehicle shall be represented by a reservoir whose maximum relative pressure \( p \) (expressed in kPa) is that which can be supplied through the feed circuit of the towing vehicle and whose volume \( V \) (expressed in litres) is given by the formula \( p \times V = 2R \) (\( R \) being the permissible maximum load, expressed in metric tonnes, on the axles of the towed vehicle or semi-mounted towed vehicle).

2.4. Interpretation of results

2.4.1. The time \( t_1 \) for the least efficient reservoir shall not exceed:
– three minutes in the case of vehicles to which the coupling of a towed vehicle is not authorised
– six minutes in the case of vehicles to which the coupling of a towed vehicle is authorised.

2.4.2. The time $t_2$ for the least efficient reservoir shall not exceed:
– six minutes in the case of vehicles to which the coupling of a towed vehicle is not authorised
– nine minutes in the case of vehicles to which the coupling of a towed vehicle 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 shall be carried out during the course of which there shall be no interference with the functioning of the valves controlling the filling of the auxiliary equipment reservoir(s). A check shall 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 0 to $p_2$ is less than:
– eight minutes in the case of vehicles to which the coupling of a towed vehicle is not authorised
– eleven minutes in the case of vehicles to which the coupling of a towed vehicle is authorised.

2.5.2. The test shall be performed in the conditions prescribed in points 2.3.1 and 2.3.3.

2.6. Towing vehicles

2.6.1. Vehicles to which the coupling of a towed vehicle is authorised shall also comply with the above requirements for vehicles not so authorised. In that case, the tests in points 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.

3. PRESSURE TEST CONNECTIONS

3.1. A pressure test connection shall be fitted at the closest readily accessible position to the least efficient reservoir within the meaning of point 2.4 of this Annex.

3.2. The pressure test connections shall comply with clause 4 of ISO standard 3583-1984.

B. VACUUM BRAKING SYSTEMS

1. CAPACITY OF RESERVOIRS

1.1. General
1.1.1. Vehicles on which the operation of the braking system requires the use of a vacuum shall be equipped with reservoirs of a capacity meeting the requirements of points 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 points 1.2 and 1.3 below, the brakes shall be adjusted as closely as possible.

1.2. Vehicles of category T and C

1.2.1. The reservoirs of agricultural vehicles shall be such that it is still possible to achieve the performance prescribed for the secondary braking system

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

1.2.1.2. after four full-stroke actuations of the service braking system 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 ⁸;

1.2.2.2. The reservoir(s) shall not be fed; in addition, any reservoir(s) for auxiliary equipment shall be isolated.

1.2.2.3. In the case of agricultural vehicles authorised to tow a towed vehicle, the supply line shall be blocked off and a reservoir of 0.5 litre capacity shall be connected to the control line. After the test referred to in point 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. Vehicles of categories R1, R2 and S1

1.3.1. The reservoir(s) with which towed vehicles 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 towed vehicle's service braking system.

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

1.3.2.1. The initial energy level in the reservoir(s) shall be that specified by the manufacturer. It shall be such as to enable the prescribed service braking performance to be achieved ⁹.

---

⁸ The initial energy level shall be stated in the information document
⁹ The initial energy level shall be stated in the information document
1.3.2.2. The reservoir(s) shall not be fed; in addition, any reservoir(s) for auxiliary equipment 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 point 1.2.2.1. In the case of a vehicle to which the coupling of a towed vehicle is authorised, the time taken to achieve that level in the conditions specified in point 2.2 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 vehicle a towed vehicle whose service braking system is vacuum-operated, the towed vehicle 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 metric tonnes, on the axles of the towed vehicle.

C. HYDRAULIC BRAKING SYSTEMS WITH STORED ENERGY

1. CAPACITY OF STORAGE DEVICES (ENERGY ACCUMULATORS)

1.1. General

1.1.1. Vehicles on which the operation of the braking system 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 point 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 braking system 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 points 1.2.1, 1.2.2 and 2.1 below, the brakes shall be adjusted as closely as possible and, for point 1.2.1, the rate of full-stroke actuations shall be such as to provide an interval of at least one minute between each actuation.

1.2. Vehicles of category T and C

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

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

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

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

1.2.1.2.2. The accumulator(s) shall not be fed; in addition, any accumulator(s) for auxiliary equipment shall be isolated.

1.2.2. Vehicles equipped with a hydraulic braking system with stored energy which cannot meet the requirements of point 2.2.1.4.1 of Annex I shall be deemed to satisfy that point 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 system 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 point 2.1.2 of Annex II

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

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

2.1. Definitions

2.1.1. ‘p₁’ represents the maximum system operational pressure (cut-out pressure) in the accumulator(s) specified by the manufacturer.
2.1.2. ‘p₂’ represents the pressure after four full-stroke actuations with the service braking system control, starting at p₁, without having fed the accumulator(s).

2.1.3. ‘t’ represents the time required for the pressure to rise from p₂ to p₁ in the accumulator(s) without application of the service braking system control.

2.2. Conditions of measurement

2.2.1. 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 governor.

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

2.3. Interpretation of results

The time t shall not exceed 30 seconds.

3. CHARACTERISTICS OF ALARM DEVICES

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

SPRING BRAKES

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.

1.1.1. The energy necessary to compress the spring in order to release the brake shall be supplied and controlled by the “control” actuated by the driver (see definition in point 1.4 of Annex I).

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.

2. GENERAL REQUIREMENTS

2.1. A spring brake shall not be used as a service brake. A spring brake can be part of a secondary braking system as defined in 2.1.2.2 of Annex I.

In the case of agricultural vehicles, with the exception of towing vehicles for semi-mounted towed vehicles meeting the requirements specified in point 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 towed vehicles.

2.2. However, vehicles, including towed vehicles, whose speed is lower than 25 km/h may use spring brakes for the service braking, provided that these brakes can be gradually actuated by means of the brake control. Those brakes shall meet the following requirements:

2.1.1 of Annex II (Braking capacity)

2.3. of Annex II (Reaction time)

– it shall be possible to release and re-apply the brake 10 times per minute with engine at idle speed.

– it shall be possible to perform 6 braking actions with reservoirs at the minimum recharge pressure and power source in off position

– the whole system must be reliable, and in particular springs shall be designed in such a way that they are not subject to failure under fatigue.
2.3 A small variation in any of the pressure limits which may occur in the spring compression chamber feed circuit shall not cause a significant variation in the braking force.

2.4 In the case of agricultural 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, shall not be greater than 80% of the minimum level of the normal available pressure. In the case of towed vehicles, the pressure in the spring compression chamber beyond which the springs begin to actuate the brakes shall not be greater than that obtained after four full-stroke actuations of the service braking system in accordance with Annex IV, point 1.3.

2.5 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 shall be actuated. Provided this requirement is met, the warning device may be that specified in point 2.2.1.11.2 of Annex I. This provision does not apply to towed vehicles.

2.6 On vehicles fitted with spring brakes and authorised to tow trailers or interchangeable machinery with continuous or semi-continuous brakes, automatic application of the spring brakes shall cause the towed vehicle brakes to be applied.

3. RELEASE SYSTEM

3.1 A spring braking system shall 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 shall draw their energy from an energy reserve which is independent from the energy reserve normally used for the spring braking system.

3.1.1 For the purposes of the requirement of point 3.1, components of the braking system transmission shall not be regarded as subject to failure if under the terms of point 2.2.1.2.7 of Annex I they are not regarded as liable to breakage, provided that they are made of metal or of a material having similar characteristics and do not undergo significant distortion in normal braking.

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

2. REQUIREMENTS

2.1. 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.

2.2. When the pressure in the locking chamber approaches the level corresponding to mechanical locking, an optical or audible warning system shall be actuated. This provision does not apply to towed vehicles. In the case of towed vehicles the pressure corresponding to mechanical locking shall not exceed 4 kPa. It shall be possible to achieve parking brake performance after any single failure of the towed vehicle service braking system. In addition, it shall be possible to release the brakes at least three times after the towed vehicle has been uncoupled, the pressure in the supply line being 650 kPa before the uncoupling. These conditions shall be satisfied when the brakes are adjusted as closely as possible. It shall also be possible to apply and release the parking braking system as specified in Annex I, point 2.2.2.10, when the towed vehicle is coupled to the towing vehicle.

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

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

2.5. 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, shall be provided.

2.6. The control shall 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.
Annex VII

CASES IN WHICH TYPE-I TEST DOES NOT HAVE TO BE CARRIED OUT

1. Type-I test does not need to be performed on a vehicle submitted for approval in the following cases:

1.1. The vehicle concerned is a power-driven vehicle or a towed vehicle which, as regards tyres, braking energy absorbed per axle, and mode of tyre fitting and brake assembly, is identical with respect to braking with a power-driven vehicle or a towed vehicle which:

1.1.1. has passed the Type-I test and

1.1.2. has been approved, with regard to the braking energy absorbed, for mass per axle not lower than that of the vehicle concerned.

1.2. The vehicle concerned is a power-driven vehicle or a towed vehicle whose axle or axles are, as regards tyres, braking energy absorbed per axle, and mode of tyre fitting and brake assembly, identical with respect to braking with an axle or axles which have individually passed the Type-I test for masses per axle not lower than that of the vehicle concerned, provided that the braking energy absorbed per axle does not exceed the energy absorbed per axle in the reference test or tests carried out on the individual axle.

1.3. The vehicle concerned is a towed vehicle equipped with brakes which satisfy the verification requirements of Appendix 2 to this Annex relative to the control of characteristics compared to the characteristics given in a report of a reference axle test as shown in Appendix 3 to this Annex.

1.4. The vehicle is equipped with hydrostatic drive which incorporates the main braking function and the vehicle is defined as class I or class II in Annex IX.

2. The term "identical", as used in paragraphs 1.1., 1.2. and 1.3. above, means identical as regards the geometric and mechanical characteristics and the materials used for the components of the vehicle referred to in those paragraphs.

3. Where the foregoing requirements are applied, the communication concerning the type approval (Annex X to this Regulation) shall include the following particulars:

3.1. In the case under paragraph 1.1., the approval number of the vehicle subjected to the Type-I test of reference shall be entered.

3.2. In the case under paragraph 1.2., Table I in Appendix 1 to this Annex shall be completed;

3.3. If paragraph 1.3. is applicable, Table II in Appendix 1 to this Annex shall be completed.

4. When a person applying for type-approval in a Member State refers to a type-approval granted in another Member State, that person shall produce the documents relating to such approval.
Appendix 1

Table I

<table>
<thead>
<tr>
<th>Axles of the vehicle</th>
<th>Reference axles</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Mass per axle</td>
</tr>
<tr>
<td></td>
<td>kg</td>
</tr>
</tbody>
</table>

Axle 1

Axle 2

Axle 3

Axle 4

---

\(^{10}\) Technically permissible maximum mass per axle.
### Table II

<table>
<thead>
<tr>
<th>Reference axle</th>
<th>Report No.</th>
<th>Date</th>
<th>(copy attached)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th></th>
<th>Type-I</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Brake force per axle (N)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(see paragraph 4.2.1., Appendix 2)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Axle 1</td>
<td>$T_1 = \ldots % P_e$</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Axle 2</td>
<td>$T_2 = \ldots % P_e$</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Axle 3</td>
<td>$T_3 = \ldots % P_e$</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

| Predicted actuator stroke (mm) |            |      |                |
| (see paragraph 4.3.1.1., Appendix 2) |            |      |                |
| Axle 1              | $s_1 = \ldots$ |      |                |
| Axle 2              | $s_2 = \ldots$ |      |                |
| Axle 3              | $s_3 = \ldots$ |      |                |

| Average output thrust (N) |            |      |                |
| (see paragraph 4.3.1.2, Appendix 2) |            |      |                |
| Axle 1              | $\text{Th}_{A1} = \ldots$ |      |                |
| Axle 2              | $\text{Th}_{A2} = \ldots$ |      |                |
| Axle 3              | $\text{Th}_{A3} = \ldots$ |      |                |

| Braking performance (N) |            |      |                |
| (see paragraph 4.3.1.4, Appendix 2) |            |      |                |
| Axle 1              | $T_1 = \ldots$ |      |                |
| Axle 2              | $T_2 = \ldots$ |      |                |
| Axle 3              | $T_3 = \ldots$ |      |                |

<p>| Result Type-0 | Result Type-I test |      |                |</p>
<table>
<thead>
<tr>
<th>Test for towed vehicle (E)</th>
<th>Hot (predicted)</th>
</tr>
</thead>
</table>
| Braking performance of vehicle  
(see paragraph 4.3.2., Appendix 2) |                |
| Hot braking requirements  
(see paragraph 2.2.1.4 of Annex II) |                |
Appendix 2

ALTERNATIVE PROCEDURES FOR TYPE-I TEST
FOR TOWED VEHICLE BRAKES

1. GENERAL

1.1. In accordance with paragraph 1.3. of this Annex, Type-I test 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 braking performance meets the requirements of this Regulation 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

Note: The reference brake symbols shall have the suffix "e"

\( P \) = normal reaction of road surface on the axle under static conditions

\( C \) = brake input torque

\( C_{\text{max}} \) = maximum permissible brake input torque

\( C_0 \) = threshold brake input torque, i.e., minimum input torque necessary to produce a measurable output torque

\( R \) = tyre rolling radius (dynamic)

\( T \) = brake force at tyre/road interface

\( M \) = brake torque = T.R

\( z \) = braking rate = T/P or M/RP

\( s \) = actuator stroke (working stroke plus free stroke)

\( s_{\text{p}} \) = effective stroke (the stroke at which the output thrust is 90 % of the average thrust \( T_{\text{A}} \))

\( T_{\text{A}} \) = average thrust (the average thrust is determined by integrating the values between 1/3 and 2/3 of the total stroke \( s_{\text{max}} \));

\( l \) = lever length
\( r \) = radius of brake drums
\( p \) = brake actuation pressure

TYPICAL CURVE FOR PNEUMATIC ACTUATOR ONLY
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 paragraph 1.1. of this Annex provided that each axle contributes equal braking energy input during the drag and hot brake tests.

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

3.1.2.2. The documented result for a combination of axles will be the average for the number of axles, as though a single axle had been used.

3.1.3. The axle(s) should preferably be loaded with the maximum static axle load, though this is not essential provided that due allowance is made during the tests for the difference in rolling resistance caused by a different load 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 that prescribed. The final speed shall be calculated by the following formula:

\[ v_2 = v_1 \sqrt{\frac{P_o + P_1}{P_o + P_1 + P_2}} \]

where

- \( v_1 \) = initial speed (km/h)
- \( v_2 \) = final speed (km/h)
- \( P_o \) = mass of the towing vehicle (kg) under test conditions
- \( P_1 \) = part of the mass of the towed vehicle borne by the unbraked axle(s) (kg)
- \( P_2 \) = part of the mass of the towed vehicle borne by the braked axle(s) (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 hot performance tests, and capable of being operated at constant speed for the purpose of the tests described in paragraphs 3.5.1 and 3.5.2. of this Appendix.
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 the air flow being

\[ v_{\text{air}} = 0,33 \, v \]

where:

\[ v = \text{vehicle test speed at initiation of braking.} \]

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 0,02

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 the air flow being

\[ v_{\text{air}} = 0,33 \, v \]

where:

\[ v = \text{vehicle test speed at initiation of braking.} \]

The temperature of the cooling air shall be the ambient temperature.

3.3.3. The braking time shall be 1 second after a maximum build-up time of 0,6 second.

3.4. Test conditions

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

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

3.4.1.2. A continuous recording of fluid pressure in the brake actuator.

3.4.1.3. Vehicle speed during the test.

3.4.1.4. Initial temperature on the outside of the brake drum or brake disc.
3.4.1.5. Brake actuator stroke used during Type-0 and Type-I tests.

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 80 % of test 0 prescribed speed in the case of Type-I test in order to evaluate the hot braking performance at the end of Type-I test.

3.5.1.2. Three brake applications are made at the same pressure (p) and at an initial speed equivalent to 80 % of test 0 prescribed speed in the case of Type-I test, with an approximately equal initial brake temperature not exceeding 100 °C, measured at the outside surface of the drums or discs. 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 50 %. The brake actuator pressure shall not exceed 650 kPa for air brake and 11,500 kPa for hydraulic brake and the brake input torque (C) shall not exceed the maximum permissible brake input torque (Cmax). The average of the three results shall be taken as the cold performance.

3.5.2. Fade test (Type-I test)

3.5.2.1. This test is carried out at a speed equivalent to 80 % of test 0 prescribed speed with an initial brake temperature not exceeding 100 °C, measured at the outside surface of the drum or brake disc.

3.5.2.2. A braking rate is maintained at 7 %, including the rolling resistance (see paragraph 3.2.4. of this Appendix).

3.5.2.3. The test is made during 1.7 km at a vehicle speed equivalent to 80 % of test 0 prescribed speed. If the test velocity cannot be achieved, then the duration of the test can be lengthened according to paragraph 1.3.2. of Annex II.

3.5.2.4. Not later than 60 seconds after the end of the Type-I test, a hot performance test is carried out in accordance with paragraph 1.3. of Annex II at an initial speed equivalent to 80 % of test 0 prescribed speed. The brake actuator pressure shall be that used during the Type-0 test.

3.6. Test report

3.6.1. The result of tests carried out in accordance with paragraph 3.5. of this Appendix shall be reported on a form, a model of which is shown in Appendix 3 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 Appendix 3 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:

<table>
<thead>
<tr>
<th>Item</th>
<th>Criteria</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>4.1.1.</strong> a) Brake drum cylindrical section</td>
<td>No change allowed</td>
</tr>
<tr>
<td>b) Brake drum or brake disc material</td>
<td>No change allowed</td>
</tr>
<tr>
<td>c) Brake drum or brake disc mass</td>
<td>May increase up to $+20%$ from the reference drum or disc mass</td>
</tr>
<tr>
<td><strong>4.1.2.</strong> a) Proximity of wheel to outside surface of brake drum or outside diameter of brake disc (dimension E)</td>
<td>Tolerances to be determined by the Technical Service conducting the tests.</td>
</tr>
<tr>
<td>b) Part of brake drum or brake disc not covered by wheel (dimension F)</td>
<td></td>
</tr>
<tr>
<td><strong>4.1.3.</strong> a) Brake lining or brake pad material</td>
<td></td>
</tr>
<tr>
<td>b) Brake lining or brake pad width</td>
<td>No change allowed</td>
</tr>
<tr>
<td>c) Brake lining or brake pad thickness</td>
<td></td>
</tr>
<tr>
<td>d) Brake lining or brake pad actual surface area</td>
<td></td>
</tr>
<tr>
<td>e) Brake lining or brake pad method of attachment</td>
<td></td>
</tr>
<tr>
<td><strong>4.1.4.</strong> Brake geometry (As in Fig.2A or 2B of Appendix 3 as appropriate)</td>
<td>No change allowed</td>
</tr>
<tr>
<td><strong>4.1.5.</strong> Tyre rolling radius (R)</td>
<td>May change subject to the requirements of paragraph 4.3.1.4 of this Appendix</td>
</tr>
<tr>
<td><strong>4.1.6.</strong> a) Average thrust ($TH_a$)</td>
<td>May change provided that the predicted performance meets the requirements of paragraph 4.3. of this Appendix</td>
</tr>
<tr>
<td>b) Actuation stroke ($s$)</td>
<td></td>
</tr>
<tr>
<td>c) Actuation lever length ($l$)</td>
<td></td>
</tr>
<tr>
<td>d) Actuation pressure ($p$)</td>
<td></td>
</tr>
</tbody>
</table>
4.1.7. Static mass (P)  
P shall not exceed P_e

4.2. Verification of brake energy absorbed

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 Type-I test conditions must not exceed the values T_e as stated in Annex XI Appendix 3, paragraphs 2.1. and 2.2., which were taken as a basis for the test of the reference brake.

4.3. Verification of hot performance

4.3.1. The brake force (T) for each subject brake for a specified pressure (p) in the actuators and for a control line pressure (p_m) used during the Type-0 test of the subject towed vehicle is determined as follows:

4.3.1.1. The predicted actuator stroke (s) of the subject brake is calculated as follows:

\[ s = 1. \frac{s_e}{l_e} \]

This value shall not exceed s_p. Where s_p has been verified and reported in accordance with the procedure defined in item 2 of Annex IX to this Regulation and may only be applied within the pressure range recorded in paragraph 3.3.1. of the test report defined in Appendix 1 of Annex IX.

4.3.1.2. The average thrust output (Th_A) of the actuator fitted to the subject brake at the pressure specified in paragraph 4.3.1. above is measured.

4.3.1.3. The brake input torque (C) is then calculated as follows:

\[ C = Th_A \cdot 1 \]

C shall not exceed C_{max}.

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

\[ T = (T_e - 0.02 P_e) \frac{(C - C_o)(C_e - C_{o_e})}{R} + 0.02 \ P \]

R shall not be less than 0.8 R_e.

4.3.2. The predicted brake performance for the subject towed vehicle is given by:
\[ \frac{T_R}{P_R} = \frac{\Sigma T}{\Sigma P} \]

4.3.3. The hot performances following the Type-I test shall be determined in accordance with paragraphs 4.3.1.1. to 4.3.1.4. The resulting predictions given by paragraph 4.3.2. above must satisfy the requirements of this regulation for the subject towed vehicle. The value used for the figure recorded in the Type-0 test as prescribed in paragraph 2.2.1.4 of Annex II, shall be the figure recorded in the Type-0 test of the subject towed vehicle.
Appendix 3

MODEL TEST REPORT FORM AS PRESCRIBED IN PARAGRAPHS 3.6.1. AND 3.6.2. OF APPENDIX 2 TO THIS ANNEX

TEST REPORT NO...................

1. IDENTIFICATION

1.1. Axle:

Manufacturer (name and address)

Make ....................................................................................................................................... 

Type ........................................................................................................................................ 

Model ...................................................................................................................................... 

Technically permissible axle load \( P_e \)................................................................................ daN

1.2. Brake:

Manufacturer (name and address)...........................................................................................

Make ....................................................................................................................................... 

Type ........................................................................................................................................ 

Model ...................................................................................................................................... 

Technically permissible brake input torque \( C_{\text{max}} \)......................................................... 

Automatic brake adjustment drive: integrated/non-integrated \(^1\) / 

Brake drum or brake disc \(^1\) / 

Internal diameter of drum or outside diameter of disc \(^1\) / ........................................................ 

Effective radius .................................................................................................................... 

Thickness \(^{11}\) ...................................................................................................................... 

Mass ....................................................................................................................................... 

Material...................................................................................................................................

\(^{11}\) Delete as appropriate 
\(^1\) Applies to disc brakes only
Brake lining or pad 1:

Manufacturer..............................................................................................................................................

Type ............................................................................................................................................................

Identification (must be visible when the lining / pad is mounted on the brake shoe / backing plate) ..................................................................................................................................................................................

Width .............................................................................................................................................................

Thickness ......................................................................................................................................................

Surface area....................................................................................................................................................

Method of attachment ......................................................................................................................................

Brake geometry, attach dimension drawing as follows:

Drum brakes see fig. 2A of this Appendix

Disc brakes see fig. 2B of this Appendix

1.3. Wheel(s):

Single/Twin 1/

Rim diameter (D) ..............................................................................................................................................

(Attach dimensioned drawing as in fig. 1A or fig. 1B of this Appendix, as appropriate)

1.4. Tyres:

Reference rolling radius \((R_e)\) at reference reaction \((P_e)\)

1.5. Actuator:

Manufacturer......................................................................................................................................................

Type (cylinder/diaphragm) 1/

Model ..............................................................................................................................................................

Lever length \((l_e)\) ..............................................................................................................................................

1.6 12 Automatic brake adjustment device (not applicable in the case of integrated automatic brake adjustment device)

Manufacturer (name and address): ....................................................................................................................

12 Only to be completed when an automatic brake wear adjustment device is installed.
Make: ......................................................................................................................................
Type: ....................................................................................................................................... 
Version:...................................................................................................................................

2. RECORD OF TEST RESULTS  
   (corrected to take account of rolling resistance of 0,02 P_e)

<table>
<thead>
<tr>
<th>Test type:</th>
<th>0</th>
<th>1</th>
</tr>
</thead>
<tbody>
<tr>
<td>Annex VII, Appendix 2, paragraph:</td>
<td>3.5.1.2.</td>
<td>3.5.2.2./3.5.2.3.</td>
</tr>
<tr>
<td>Test speed</td>
<td>km/h</td>
<td></td>
</tr>
<tr>
<td>Brake actuator pressure p_e</td>
<td>kPa</td>
<td>-</td>
</tr>
<tr>
<td>Braking time</td>
<td>min</td>
<td>-</td>
</tr>
<tr>
<td>Brake force developed T_e</td>
<td>N</td>
<td></td>
</tr>
<tr>
<td>Brake efficiency T_e/9,81P_e</td>
<td>-</td>
<td></td>
</tr>
<tr>
<td>Actuator stroke s_e</td>
<td>mm</td>
<td>-</td>
</tr>
<tr>
<td>Brake input torque C_e</td>
<td>Nm</td>
<td>-</td>
</tr>
<tr>
<td>C_o,e</td>
<td>Nm</td>
<td>-</td>
</tr>
</tbody>
</table>

3. THIS TEST HAS BEEN CARRIED OUT AND THE RESULTS REPORTED IN ACCORDANCE WITH APPENDIX 2 TO ANNEX VII

   Technical Service 11 carrying out the test

   Signed: ........................................ Date: ........................................

4. APPROVAL AUTHORITY 11

   Signed: ........................................ Date: ........................................

   Signed: ........................................ Date: ........................................

13 To be signed by different persons even when the Technical Service and Approval Authority are the same or alternatively, a separate Approval Authority authorisation issued with the report.
Figure 1A

<table>
<thead>
<tr>
<th>Drum width ( (X_e) )</th>
<th>Reaction ( (P_e) )</th>
<th>Tyre</th>
<th>Rim</th>
<th>( B_e ) (mm)</th>
<th>( R_e ) (mm)</th>
<th>( D_e ) (mm)</th>
<th>( E_e ) (mm)</th>
<th>( F_e ) (mm)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Figure 2A

**BRAKE GEOMETRY**

All dimensions in mm except $\alpha_{oe}$, $\alpha_{1e}$ and $F_e$.

$F_e = \text{useful braking surface per brake (cm}^2\text{).}$

<table>
<thead>
<tr>
<th>Type of brake</th>
<th>$a_e$</th>
<th>$h_e$</th>
<th>$c_e$</th>
<th>$d_e$</th>
<th>$e_e$</th>
<th>$\alpha_{oe}$</th>
<th>$\alpha_{1e}$</th>
<th>$b_e$</th>
<th>$r_e$</th>
<th>$F_e$</th>
<th>$S_{1e}$</th>
<th>$S_{2e}$</th>
<th>$S_{3e}$</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Figure 2B

<table>
<thead>
<tr>
<th>l_e</th>
<th>c_e</th>
<th>d_e</th>
<th>x_e</th>
<th>r_e</th>
<th>b_e</th>
<th>F_e</th>
</tr>
</thead>
<tbody>
<tr>
<td>(mm)</td>
<td>(mm)</td>
<td>(mm)</td>
<td>(mm)</td>
<td>(mm)</td>
<td>(mm)</td>
<td>(cm²)</td>
</tr>
</tbody>
</table>
ANNEX VIII

Conditions governing the testing of vehicles with inertia (overrun) braking systems

1. GENERAL PROVISIONS

1.1. The ‘inertia (overrun) braking system’ of a towed vehicle comprises the control device, the transmission and the brake, as defined in point 1.4.

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 systems in which accumulated energy (for instance, electric, pneumatic or hydraulic) is transmitted to the towed vehicle by the towing vehicle and is only controlled by the force at the coupling shall not be deemed to be inertia braking systems within the meaning of this Regulation.

1.6. Tests

1.6.1. Determination of the main characteristics of the brake.

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

1.6.3. 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. Masses: kg

2.1.2. Forces: N

2.1.3. Torques and moments: Nm

2.1.4. Areas: cm²

2.1.5. Pressures: kPa

2.1.6. Lengths: units specified in each case.
2.1.7. Acceleration due to gravity: \( g = 9.81 \, \text{m/s}^2 \).

2.2. *Symbols valid for all types of braking systems* (see diagram 1 in Appendix 1)

2.2.1. \( G_A \): ‘maximum mass’ of the towed vehicle declared to be technically permissible by the manufacturer.

2.2.2. \( G'_A \): ‘maximum mass’ of the towed vehicle which, according to the manufacturer’s declaration, can be braked by the control device.

2.2.3. \( G_B \): ‘maximum mass’ of the towed vehicle which can be braked by the joint operation of all the towed vehicle brakes.

\[
G_B = n \times G_{Bo}
\]

2.2.4. \( G_{Bo} \): fraction of the permissible ‘maximum mass’ which, according to the manufacturer’s declaration, can be braked by one brake.

2.2.5. \( B^* \): braking force required.

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 diagrams 2 and 3 in Appendix 1).

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 \( s \, \text{mm/s} \pm 10 \% \), 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 \( s \, \text{mm/s} \pm 10 \% \) from its rearmost position, the transmission being uncoupled.

2.2.14. \( \eta_{H0} \): efficiency of the inertia control device.

2.2.15. \( \eta_{H1} \): efficiency of the transmission system.

2.2.16. \( \eta_H \): total efficiency of the control device and of the transmission.

\[
\eta_H = \eta_{H0} \times \eta_{H1}
\]
2.2.17. \( s \): travel of control (expressed in mm)

2.2.18. \( s' \): effective travel of control (expressed in mm) fixed in accordance with the requirements of point 9.4.1

2.2.19. \( s'' \): spare travel of the master cylinder actuator, measured in mm at the coupling head

2.2.20. \( s_0 \): loss of travel, that is to say the travel, measured in mm, 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. \( 2s_0 \): brake-shoe lift measured on the diameter parallel to the operating mechanism and without the brakes being adjusted during the test (expressed in mm)

2.2.22. \( 2s_B^* \): minimum brake shoe centre lift (minimum brake shoe application travel), in mm, for wheel brakes with drum brakes:

\[
2s_B^* = 2,4 + \frac{4}{1000} \times 2r
\]

\( 2r \) being the diameter of the brake drum expressed in mm (see diagram 4 in Appendix 1) for wheel brakes with disc brakes with hydraulic transmission:

\[
2s_B^* = 1,1 \left( \frac{10 \times V_{60}}{F_{RZ}} + \frac{1}{1000} \times 2r_A \right)
\]

where:

\( V_{60} \) = fluid volume absorption of one wheel brake at a pressure corresponding to a braking force of \( 1,2 \times B^* = 0,6 \times G_{B0} \) and a maximum tire radius,

\( 2r_A \) = outer diameter of brake disc (\( V_{60} \) in cm\(^3\), \( F_{RZ} \) in cm\(^2\) and \( r_A \) in mm)

2.2.23. \( M \): braking moment

2.2.24. \( R \): dynamic tire rolling radius in meters, rounded to the nearest centimetre

2.2.25. \( n \): number of brakes

2.2.26. \( D_A \): application force at input side of the control device, at which the overload protector is activated

2.2.27. \( M_A \): braking torque at which the overload protector is activated

2.3. Symbols for mechanical transmission braking systems (see diagram 5 in Appendix 1)

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
2.3.2. \( i_{H1} \): 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

\[
i_{H} = i_{Ho} \times i_{H1}
\]

2.3.4. \( i_{g} \): reduction ratio between travel of the brake lever and the brake-shoe centre lift (see diagram 4 in Appendix 1)

2.3.5. \( P \): force applied to the brake control lever

2.3.6. \( P_0 \): 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 diagram 6 in Appendix 1)

2.3.7. \( \rho \): characteristic of the brake defined by:

\[
M = \rho \times (P - P_0)
\]

2.4. Symbols for hydraulic-transmission braking systems (see diagram 8 in Appendix 1)

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 of one wheel cylinder for drum brake(s); for disc brake(s), sum of the surface area of the caliper piston(s) on one side of the disc

2.4.4. \( F_{HZ} \): surface area of piston in master cylinder

2.4.5. \( p \): hydraulic pressure in brake cylinder

2.4.6. \( p_0 \): 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 extrapolation of this function with the abscissa (see diagram 7 in Appendix 1)

2.4.7. \( \rho' \): characteristic of the brake defined by:

\[
M = \rho' \times (p - p_0)
\]

3. GENERAL REQUIREMENTS

3.1. The transmission of braking power from the coupling head to the towed vehicle’s brakes shall 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 shall be as short as possible.
3.2. All pins at joints shall be adequately protected. In addition, these joints shall be either self-lubricating or easily accessible for lubrication.

3.3. Inertia braking systems shall 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 shall be checked after uncoupling the first element of the transmission from the brake control levers.

3.4. The inertia braking system shall allow the towed vehicle to be reversed with the towing vehicle without imposing a sustained drag force exceeding $0.08 \times g \times G_A$. Devices used for this purpose shall act automatically and disengage automatically when the towed vehicle moves forward.

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

3.6. Only inertia braking systems with disc brakes may incorporate overload protectors. They may not be activated at a force of less than $1.2 P$ or a pressure less than $1.2 p$ corresponding to a braking force of $B^* = 0.5 \times g \times G_{B0}$ (when fitted at the wheel brake) or at a thrust on the coupling less than $1.2 D^*$ (when fitted at the control device).

4. REQUIREMENTS FOR CONTROL DEVICES

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

4.2. The sliding members shall be protected by a bellows or some equivalent device. They shall either be lubricated or be constructed of self-lubricating materials. The surface in frictional contact shall be made of a material such that there is neither electrochemical torque nor any mechanical incompatibility liable to cause the sliding members to seize.

4.3. The threshold force of the control equipment ($K_A$) shall be not less than $0.02 \times g \times G'_{A}$, and not more than $0.04 \times g \times G'_{A}$.

4.4. The maximum damping force $D_1$ may not exceed $0.10 \times g \times G'_{A}$ in the case of towed vehicles with rigid drawbars and $0.067 \times g \times G'_{A}$ in the case of multi-axled towed vehicles with pivoted drawbars.

4.5. The maximum towing force $D_2$ shall be between $0.1 \times g \times G'_{A}$ and $0.5 \times g \times G'_{A}$.

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

5.1. Compliance with the requirements of points 3 and 4 shall 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 braking systems:

5.2.1. The travel $s$ and the effective 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 braking systems, the following shall be determined:

5.3.1. The reduction ratio $i_{Ho}$ measured at the mid-travel position 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 shall be derived from the representative curve obtained from these measurements.

\[
\eta_{Ho} = \frac{1}{i_{Ho}} \times \frac{P'}{D - K}
\]

(see diagram 2 in Appendix 1).

5.4. In the case of hydraulic-transmission inertia braking systems, 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 $F_{HZ}$ of the master cylinder piston, as specified by the manufacturer. The supplementary force $K$ and the efficiency shall be derived from the representative curve obtained from these measurements.

\[
\eta_{Ho} = \frac{1}{i_h} \times \frac{p \times F_{HZ}}{D - K}
\]

(see diagram 3 in Appendix 1).

5.4.3. The spare travel of the master cylinder actuators s" mentioned in point 2.2.19.

5.5. In the case of inertia braking systems on multi-axled towed vehicles with pivoted drawbars, the loss of travel $s_0$ mentioned in point 9.4.1 shall be measured.

6. REQUIREMENTS FOR BRAKES

6.1. The manufacturer shall make available to the technical service responsible for the tests, in addition to the brakes to be tested, drawings of the brakes showing the type, dimensions and material of the main parts, and the make and type of the linings. These drawings shall
indicate the surface area $F_{RZ}$ of the brake cylinders in the case of hydraulic brakes. The manufacturer shall also indicate the maximum braking torque $M_{\text{max}}$ which is allowed, as well as the mass $G_{\text{BO}}$ mentioned in point 2.2.4.

6.2. The braking torque $M_{\text{max}}$ specified by the manufacturer shall be not less than that braking torque corresponding to 1.2 times the force $P$ or 1.2 times the pressure $p$, required to give a braking force of $B^* = 0.5 \times g \times G_{\text{BO}}$.

6.2.1. In the case when no overload protector is either fitted or intended to be fitted within the inertia (overrun) braking system, the wheel brake shall be tested at 1.8 times the force $P$ or at 1.8 times the pressure $p$, which is required to give a braking force of $B^* = 0.5 \times g \times G_{\text{BO}}$.

6.2.2. In the case when an overload protector is fitted or intended to be fitted within the inertia (overrun) braking system, the wheel brake shall be tested at 1.1 times the force $P_{\text{max}}$ or $P'_{\text{max}}$ or at 1.1 times the pressure $p_{\text{max}}$ or $p'_{\text{max}}$ of the overload protector including all tolerances (specified by the manufacturer).

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 shall be tested to check whether they conform to the requirements of point 6.

7.2. The following shall be determined:

7.2.1. The minimum shoe centre lift $2sB^*$.

7.2.2. The shoe centre lift $2sB$ (which shall be greater than $2sB^*$).

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.

The speed at which the braking surfaces rotate shall correspond to an initial vehicle speed equal to its maximum design speed and not exceeding 60 km/h. The following is deduced from the curve obtained from these measurements:

7.2.3.1. The retraction force $P_{O}$ and the characteristic $\rho$ in the case of mechanically actuated brakes (see diagram 6 in Appendix 1).

7.2.3.2. The retraction pressure $p_{0}$ and the characteristic $\rho'$ in the case of hydraulically actuated brakes (see diagram 7 in Appendix 1).

8. TEST REPORTS

Where applications are made for type-approval of towed vehicles fitted with inertia braking systems, 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 towed vehicle; 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 BRAKES OF A VEHICLE

9.1. A check shall 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 towed vehicle characteristics mentioned in point 4 of Appendix 4, as to whether the inertia braking system of the towed vehicle 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 shall be tested on the vehicle. The results of the test shall be entered in Appendix 4 (for example $i_{H1}$ and $\eta_{H1}$).

9.2.2. Mass

9.2.2.1. The maximum mass of the towed vehicle $G_A$ shall not exceed the maximum mass $G'_A$ for which the control device is authorized.

9.2.2.2. The maximum mass of the towed vehicle $G_A$ shall not exceed the maximum mass $G_B$ which can be braked by the joint operation of all the towed vehicle brakes.

9.2.3. Forces

9.2.3.1. The threshold force $K_A$ shall not be less than $0.02 \times g \times G_A$ nor greater than $0.04 \times g \times G_A$.

9.2.3.2. The maximum damping force $D_1$ shall not exceed $0.10 \times g \times G_A$ in the case of towed vehicles with rigid drawbars, nor $0.067 \times g \times G_A$ in the case of multi-axled towed vehicles with pivoted drawbars.

9.2.3.3. The maximum towing force $D_2$ shall be between $0.1 \times g \times G_A$ and $0.5 \times g \times G_A$.

9.3. Test of braking efficiency

9.3.1. The sum of the braking forces exerted on the circumference of the towed vehicle wheels shall be at least $B^* = 0.5 \times g \times G_A$ including a rolling resistance of $0.01 \times g \times G_A$. This represents a braking force of $B = 0.49 \times g \times G_A$. In this case, the maximum permitted thrust on the coupling is:

\[
D^* = 0.067 \times g \times G_A \quad \text{in the case of multi-axled towed vehicles with pivoting drawbars, and}
\]

\[
D^* = 0.10 \times g \times G_A \quad \text{in the case of towed vehicles with rigid drawbars.}
\]

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

9.3.1.1. In the case of inertia braking systems with mechanical transmission

\[
\left[\frac{B \times R}{Q} + nP_o\right] \cdot \frac{1}{(D^* - K) \times \eta_H} \leq i_{H1}
\]
9.3.1.2. In the case of inertia braking systems with hydraulic transmission

\[
\frac{B \times R}{n \times Q'} + p_o \leq \frac{1}{(D^* - K) \times \eta_H} \leq \frac{i_h}{F_{HZ}}
\]

9.4. **Control travel test**

9.4.1. In the case of control devices for multi-axle towed vehicles with pivoted drawbar, of which the brake rod system is dependent upon the position of the towing device, the travel of the control \( s \) shall be greater than the effective travel of the control \( s' \); the difference in length shall be at least equivalent to the loss of travel \( s_o \). The travel \( s_o \) shall not exceed 10% of the effective travel \( s' \).

9.4.2. The effective 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:

9.4.3.1. In the case of inertia braking systems with mechanical transmission:

\[ i_H \leq \frac{s'}{s_{B'} \times i_g} \]

9.4.3.2. In the case of inertia braking systems with hydraulic transmission:

\[ \frac{i_h}{F_{HZ}} \leq \frac{s'}{2s_{B'} \times nF_{RZ} \times i_g} \]

9.5. **Additional tests**

9.5.1. In the case of inertia braking systems 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 braking systems 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 shall not be permitted.

9.5.3. The general behaviour of the vehicle when braking shall be the subject of a road test carried out at different speeds, with different levels of brake effort and rates of application; self-excited undamped oscillations shall not be permitted.

10. GENERAL COMMENTS

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

When testing special models, the above requirements shall be adapted.
Appendix 1
Explanatory diagrams
Diagram 1

Symbols valid for all types of braking systems
(see point 2.2)
Diagram 2

Mechanical transmission
(see points 2.2.10 and 5.3.2)

\[ \eta_{H0} = \frac{P'_x}{D_x - K} \times \frac{1}{i_{H0}} \]

Diagram 3

Hydraulic transmission
(see points 2.2.10 and 5.4.2)

\[ \eta_{H0} = \frac{P_x}{D_x - K} \times \frac{F_{HZ}}{i_h} \]
Diagram 4

Brake checks
(see points 2.2.22 and 2.3.4)

Connecting rod and cam

Brake-shoe centre lift
Brake-shoe lift
(application travel)  (travel)

\[ i_a = \frac{a}{2b} \quad i_2 = \frac{a \times d}{b \times c} \]

Brake-shoe centre lift: \( S_B^* = 1,2 \text{ mm} + 0,2 \% \times 2r \)

Retractor

Direction of cable pull

Retractor:
\[ i_a = \frac{a}{b} \quad i_g = \frac{a \times d}{b \times c} \]

Diagram 5

Brakes with mechanical transmission
(see point 2.3)

1.2. Control device 1.3. Transmission 1.4. Brakes

\[ i_{10} = \frac{1 - 1'}{2 - 2'} \quad i_{11} = \frac{2 - 2'}{3 - 3'} \]
Diagram 6

Mechanical brake
(see points 2.3.6 and 7.2.3.1)

\[ q = \frac{M_x}{P_x - P_o} \]
Diagram 7

Hydraulic brake
(see points 2.4. 6 and 7.2.3.2)

\[ \theta' = \frac{M_s}{P_x - P_o} \]
Hydraulic transmission braking system

1.2. Control device

1.4. Brakes

\[ l_h = \frac{1 - 1'}{2 - 2'} \]

\[ l_g = r_{eff} = \frac{3 - 3'}{4 - 4'} = 1 \]

\[ i_g = \frac{r_{eff}}{r_{eff}} = \frac{3 - 3'}{2 \cdot (4 - 4')} = 1 \]
Appendix 2

Test report on the control device

1. Manufacturer ................................................................................................................................
2. Make ...........................................................................................................................................
3. Type ..............................................................................................................................................
4. Characteristics of the towed vehicles for which the control device is intended by the manufacturer:
   4.1. mass \( G'_A \) = …………..kg
   4.2. permissible vertical static force at the head of the towing device…………..N
   4.3. towed vehicle with rigid drawbar \(^{(1)}\) or multi-axled towed vehicle with pivoted drawbar \(^{(1)}\)
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 \(^{(1)}\)
      \( i_{H_0} = \) from \( \) to \( \) \(^{(2)}\)
   8.2. in the case of a device with hydraulic transmission \(^{(1)}\)
      \( i_{h} = \) from \( \) to \( \) \(^{(2)}\)
      \( F_{HZ} = \) ………..cm\(^2\)
      travel of the master cylinder actuator ………..mm
9. Test results:
9.1. Efficiency
      in the case of a device with mechanical transmission \( \eta_H = \) ………..
      in the case of a device with hydraulic transmission \( \eta_H = \) ………..
9.2. Complementary force \( K = \) ………..N
(1) Delete as appropriate
(2) Indicate the lengths whose ratio was used to determine \( i_{ho} \) or \( i_h \).
9.3. Maximum damping force $D_1 = \ldots \ldots \text{N}$

9.4. Maximum towing force $D_2 = \ldots \ldots \text{N}$

9.5. Threshold force $K_A = \ldots \ldots \text{N}$

9.6. Loss of travel and spare travel:
where the position of the towing device has an effect $s_0 (1) = \ldots \ldots$
in the case of a device with hydraulic transmission $s'' (1) = \ldots \ldots$

9.7. Effective travel of the control $s' = \ldots \ldots$

9.8. An overload protector according to point 3.6 of this Annex is provided/not provided (1)

9.8.1. If the overload protector is fitted before the transmission lever of the control device

9.8.1.1. Threshold force of the overload protector

$$D_A = \ldots \ldots \text{N}$$

9.8.1.2. where the overload protector is mechanical (1)

maximum force $P'_{\text{max}}$ which the inertia control device can develop

$$P'_{\max}/i_{Ho} = \ldots \ldots \text{N}$$

9.8.1.3. where the overload protector is hydraulic (1)

maximum hydraulic pressure which the inertia control device can develop

$$p'_{\max}/i_H = \ldots \ldots \text{N/cm}^2$$

9.8.2. If the overload protector is fitted after the transmission lever of the control device

9.8.2.1. Threshold force of the overload protector

where the overload protector is mechanical (1) $D_A i_{Ho} = \ldots \ldots \text{N}$,

where the overload protector is hydraulic (1) $D_A i_h = \ldots \ldots \text{N}$

9.8.2.2. Where the overload protector is mechanical (1)

maximum force $P'_{\text{max}}$ which the inertia control device can develop

$$P'_{\max} = \ldots \ldots \text{N}$$

9.8.2.3. Where the overload protector is hydraulic (1)

maximum hydraulic pressure which the inertia control device can develop

$$p'_{\max} = \ldots \ldots \text{N/cm}^2$$

10. Technical service which carried out the tests
11. The control device described above does/does not (1) comply with the requirements of points 3, 4 and 5 of the testing conditions for vehicles fitted with inertia braking systems.

..............................................................

Signature

(1) Delete as appropriate
**Appendix 3**

Test report on the brake

1. Manufacturer ...........................................................................................................................................................................

2. Make ................................................................................................................................................................................................

3. Type ................................................................................................................................................................................................

4. Technically permissible maximum mass per wheel \( G_{Bo} = \ldots \ldots \ldots \) kg

5. Maximum braking torque \( M_{\text{max}} = \ldots \ldots \ldots \) Nm
   (as specified by the manufacturer according to point 6.2 of this Annex)

5.1. Tested braking torque = \ldots \ldots \ldots \) Nm
   (according to points 6.2.1 and 6.2.2 respectively of this Annex)

6. Dynamic tyre rolling radius
   \( R_{\text{min}} = \ldots \ldots \ldots \) m;
   \( R_{\text{max}} = \ldots \ldots \ldots \) m

7. Brief description
   (List of plans and dimensional drawings)

8. Main diagram of the brake:

9. Test result:
   Mechanical brake \(^{(1)}\)  
   Hydraulic brake \(^{(1)}\)

9.1. Reduction ration

9.1.1. \( i_g = \ldots \ldots \ldots \) \(^{(2)}\)

9.1.1.1. \( I'_g = \ldots \ldots \ldots \) \(^{(2)}\)

9.2. Half shoe centre lift

9.2.1. \( s_B = \ldots \ldots \ldots \) mm

9.2.2. \( s_B = \ldots \ldots \ldots \) mm

9.3. Half minimum shoe centre lift

9.3.1. \( s_B^* = \ldots \ldots \ldots \) mm

9.3.2. \( s_B^* = \ldots \ldots \ldots \) mm

9.4. Retraction force

9.4.1. \( P_0 = \ldots \ldots \ldots \) N

9.4.2. \( p_0 = \ldots \ldots \ldots \) kPa

9.5. Coefficient

9.5.1. \( \ldots \ldots \ldots \) \(^{(1)}\)

9.5.2. \( \ldots \ldots \ldots \) \(^{(2)}\)
\[ \rho = \ldots \text{m} \quad \rho' = \ldots \text{m} \]

9.6. An overload protector according to point 3.6 of this Annex is/is not provided (1)

9.6a. An overload protector according to point 3.6 of this Annex is/is not provided (1)

9.6.1. Braking torque activating the overload protector

\[ M_A = \ldots \text{Nm} \]

9.6.1a. Braking torque activating the overload protector

\[ M_A = \ldots \text{Nm} \]

9.7. Maximum permissible force for \( M_{\text{max}} \)

\[ P_{\text{max}} = \ldots \text{N} \]

9.7a. Maximum permissible pressure for \( M_{\text{max}} \)

\[ p_{\text{max}} = \ldots \text{N/cm}^2 \]

9.8a. Surface area of wheel cylinder

\[ F_{\text{RZ}} = \ldots \text{cm}^2 \]

9.9a. (for disc brakes)

Fluid volume absorption

\[ V_{60} = \ldots \text{cm}^3 \]

10. Technical Service which carried out the test

11. The above brake does/does not (1) conform to the requirements of points 3 and 6 of the testing conditions for vehicles fitted with inertia braking systems described in this Annex. The brake may/may not (1) be used for an inertia braking system without an overload.

...........................................................................................

Signature
Appendix 4

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

1. Control device

described in the attached test report (see Appendix 2)

Reduction ratio selected:
\[ i_{Ho}^{(1)} = \ldots \ldots (2) \text{ or } i_{h}^{(1)} = \ldots \ldots (2) \]
(shall be between the limits specified in Appendix 2, point 8.1 or 8.2)

2. Brakes

described in the attached test report (see Appendix 3)

3. Transmission devices on the towed vehicle

3.1. Brief description with main diagram

3.2. Reduction ratio and efficiency of the mechanical transmission device on the trailer

\[ i_{Hl}^{(2)} = \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \]
\[ \eta_{Hl}^{(2)} = \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \]

4. Towed vehicle

4.1. Manufacturer:

4.2. Make:

4.3. Type:

4.4. Type of drawbar connection:

single-axled towed vehicle with rigid drawbar/multi-axled towed vehicle with pivoted drawbar (1)

4.5. Number of brakes \( n = \ldots \ldots \)

4.6. Technically permissible maximum mass \( G_A = \ldots \ldots \text{kg} \)

4.7. Dynamic tyre rolling radius \( R = \ldots \ldots \text{m} \)

4.8. Permissible force on the coupling

\[ D^* = 0,10 \times g \times G_A = \ldots \ldots \text{N} \]

or

\[ D^* = 0,067 \times g \times G_A = \ldots \ldots \text{N} \]

4.9. Required braking force

\[ B^* = 0,5 \times g \times G_A = \ldots \ldots \text{N} \]

4.10. Braking force

\[ B = 0,49 \times g \times G_A = \ldots \ldots \text{N} \]
5. Compatibility Test results

5.1. Stress threshold $100 \frac{K_A}{g \times G_A} = \ldots$ (shall be between 2 and 4)

5.2. Maximum compressive force $100 \frac{D_1}{(g \times G_A)} = \ldots$ (shall not exceed 10 for towed vehicles with rigid drawbar, or 6.7 for multi-axled towed vehicles with pivoted drawbar)

5.3. Maximum tractive force $100 \frac{D_2}{(g \times G_A)} = \ldots$ (shall be between 10 and 50)

5.4. Technically permissible maximum mass for the inertia control device $G_A' = \ldots$ kg (shall not be less than $G_A$)

5.5. Technically permissible maximum mass for all towed vehicle brakes

$G_B = n \times G_{B_0} = \ldots$ kg (shall not be less than $G_A$)

5.6. Maximum braking torque of the brakes $n \times \frac{M_{\text{max}}}{(B \times R)} = \ldots$ (shall be equal to or greater than 1.2)

5.6.1. An overload protector within the meaning of point 3.6 of this Annex is/is not (1) fitted on the inertia control device/on the brakes (1)

5.6.1.1. Where the overload protector is mechanical on the inertia control device (1)

$n \times \frac{P_{\text{max}}}{(i_{HI} \times \eta_{HI} \times P'_{\text{max}})} = \ldots$ (shall be equal or greater than 1.0)

5.6.1.2. Where the overload protector is hydraulic on the inertia control device (1)

$P_{\text{max}}/P'_{\text{max}} = \ldots$ (shall be equal or greater than 1.0)

5.6.1.3. If the overload protector is on the inertia control device:

threshold force $D_A/D^* = \ldots$ (shall be equal or greater than 1.2)

5.6.1.4. If the overload protector is fitted on the brake:

threshold torque $n \frac{M_A}{(B \times R)} = \ldots$ (shall be equal or greater than 1.2)

5.7. Inertia braking system with mechanical transmission (1)

5.7.1. $i_H = i_{H0} \times i_{HI} = \ldots$

5.7.2. $\eta_H = \eta_{H0} \times \eta_{HI} = \ldots$

$\frac{B \times R}{0} + n \times P_e}{(D^* - R) \times \eta_{HI}} = \ldots$

(shall not be greater than $i_H$).
5.7.4. \[ \frac{s'}{S_{B'} \times i_g} = \ldots \]

5.8. Inertia braking system with hydraulic transmission (1)

5.8.1. \[ i_{h/FHZ} = \ldots \]

5.8.2. \[ \frac{B \times R}{n \times Q' + P_s} \times \frac{1}{(D' - K) \times \eta_H} = \ldots \]

(shall be not greater than \(i_{h/FHZ}\))

5.8.3. \[ \frac{s'}{2S_{B'} \times n \times F_{RZ} \times i_g'} = \ldots \]

(shall be not less than \(i_{h/FHZ}\))

5.8.4. \[ \frac{s'}{i_h} = \ldots \]

(shall be not greater than the travel of the master cylinder actuator as specified in point of Appendix 2)

6. Technical Service which carried out the tests

7. The inertia braking system described above does/does not(1) comply with the requirements of points 3 to 9 of the testing conditions for vehicles fitted with inertia braking systems.

Signature
ANNEX IX

Braking system for vehicles with hydrostatic drive

1. SCOPE.

This Annex applies to vehicles equipped with hydrostatic drive and that meet one of these conditions:

- the hydrostatic drive cannot be disengaged during travel,
- the hydrostatic drive acts as a braking system,

Or

- the hydrostatic drive is part of at least one braking system.

2. GENERAL.

For special duties, some vehicles are equipped with a hydrostatic drive used both to retard and to propel the vehicle. This type of drive can therefore be recognised as a braking system, whether alone or in combination with a friction brake.

3. CLASSIFICATION OF VEHICLES.

3.1. Class I: vehicles with a maximum design speed \( \leq 12 \) km/h.

3.2. Class II: vehicles with a maximum design speed \( > 12 \) km/h and \( \leq 30 \) km/h.

3.3. Class III: vehicles with a maximum design speed \( > 30 \) km/h and \( \leq 40 \) km/h.

4. DEFINITIONS.

4.1 ‘Hydrostatic drive’

means that the propulsion of the vehicle uses a hydrostatic transmission, with open or closed circuit, in which fluid circulates as the energy medium between one or more hydraulic pumps and one or more hydraulic motors.

Torque can be generated and transmitted with this system.

4.2 ‘Hydrostatic braking system’

means a braking system that only uses the braking power of the hydrostatic drive.
4.3. ‘Combination braking system’

is a system that combines one hydrostatic brake with one or more friction brake(s) activated simultaneously or consecutively. The proportion of the friction brake on the braking effect has to meet the requirements set out in point 7.1.1.1.2.

4.4. ‘Friction braking system’.

A braking system with a predominant proportion (see point 7.1.1.1.3.) of the braking effect generated by friction brakes.

4.5. ‘Graduated hydrostatic braking systems’.

Systems are considered as graduated when the driver is able to modify the vehicle speed at any time by a progressive action on the control.

4.6. ‘Hydrostatic drive control’.

A device, such as a lever or pedal, used to vary the vehicle speed. It can be the same as the service brake control device.

4.7. "Inch" device.

This device affects the speed of the vehicle independently of the hydrostatic drive control.

4.8. ‘Cold brake’.

A brake is considered to be cold in accordance with the definition set out in Annex II, point 1.2.1.1.

4.9. "Non-disengaged" transmission system.

This term means that pressure, force and torque are continuously transmitted during a journey on the road of the vehicle:

- In the drive train between the vehicle engine and the wheels,

and

- In the hydrostatic braking system between the control and the wheels.

5. REQUIREMENTS.

5.1. General.

5.1.1. Requirements for braking equipment mentioned in Annex I, point 2.1.1.
5.1.2. The drive control must be constructed in such a way that accidental reversing is prevented during a journey on the road.

5.1.3. To facilitate vehicle recovery, a device is required disengaging the connection between engine and drive wheels.

It must be impossible to operate this device from the driving position during the journey on the road.

If a tool is needed to operate this device, it must be carried on the vehicle.

5.2. Design requirements for the braking systems.

5.2.1. Service brake.

5.2.1.1. The service braking system shall 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 shall be possible to graduate this braking action. The driver must be able to apply the service brake from his seat and retain control of the steering device on the tractor with at least one hand.

5.2.1.2. The performance of the service braking system required under the regulation must be obtained by the actuation of a single control.

5.2.1.2.1. This requirement is also deemed to be satisfied:

- When the foot is moved from the drive pedal to the brake pedal,

or

- When at the start of the braking sequence, the drive control is released or moved to neutral position by hand or foot.

5.2.1.2.2. The control of the service braking system must be designed to return to the initial position automatically when released.

This does not apply to the hydrostatic section of the brake device when the release of the hydrostatic drive control creates the braking effect.

5.2.1.3. The service brake must be capable of controlling the movement of the vehicle in a safe, rapid and efficient way, whatever the conditions of speed, loading or gradient. The effect of the service brake must be progressive.

14 This means, for example, that in a power-shift transmission at least one clutch is engaged.
These conditions are satisfied when the braking requirements are met and the vehicle can be stopped with the control of the service braking system, including on a gradient.

5.2.1.4. It is acceptable that a braking system (secondary or parking braking system) additional to the service brake is used to stop the vehicle when there is a residual creep speed.

5.2.2. Secondary braking system

5.2.2.1. Requirements mentioned in Annex I, point 2.1.2.2.

5.2.2.2. If, in the case of a hydrostatic drive, the vehicle cannot be stopped on a gradient, then it is permissible to operate the parking braking system to stop the machine from residual creep speed to standstill. For this purpose the parking brake has to be designed such that it is possible for it to be actuated during driving.

5.2.3. Parking braking system

Requirements mentioned in Annex I, point 2.1.2.3.

5.3. Characteristics of the braking systems

5.3.1. Requirements mentioned in Annex I, point 2.2.1.

5.3.2. Any failure of a part, except the wheel brakes, or any other fault in the service braking system, must not prevent the secondary braking system, or the parts of the service brake that are not affected by the fault, from stopping the vehicle in the conditions required of the secondary braking system;

5.3.2.1. In particular, when the secondary braking system and the service braking system share a common control and a common transmission.

For example, when the braking effect is dependant on the operation of the power transmission i.e. converter, hydraulic pumps, pressure pipes, hydraulic motors or comparable components.

5.3.2.2. Differing from point 5.3.2., in the event of a fault in the pump control of the hydrostatic drive, it must be possible to stop the vehicle in the conditions provided for the secondary brake, in which case an additional device may be actuated that can always be easily operated from the driving position (for example a system acting on the engine speed).

5.3.3. In the case of an "inch" device, or other comparable device, which can be operated on the road, provisions must be taken to ensure that the prescribed requirements (especially the braking performance) are still complied with when this type of device is actuated (the "inch" device cancels the braking effect of the hydrostatic drive).

6. BRAKE TESTING

6.1. General
6.1.1. Requirements mentioned in Annex II, point 1.1.

6.1.2. To assess the effectiveness of a braking system, the braking power of the hydrostatic propulsion drive must be considered in combination with a friction brake device.

6.1.3. During the brake test the drivability is to be assessed (e.g. tendency for lifting the rear axle due to the braking action of the service brake)

6.1.3.1. Lifting off the ground of an axle is permissible for vehicles of Class III at a deceleration exceeding 5.0 m/s², however the driving stability must be preserved.

6.1.3.2. Lifting of an axle is permissible for vehicles of Class I and Class II at a deceleration exceeding 4.5 m/ s², however the driving stability must be preserved.

6.2. Brake test Type O

6.2.1. The service brake test is carried out in accordance with Annex II, point 1.2.2.

6.2.1.1. In the case of manually operated drive control, the performance of the service brake is assessed by moving the drive lever to neutral just before operating the service brake in order to ensure not to brake against the hydrostatic system.

6.2.1.2. The service brake has to meet the requirements in point 7.1.1.1. Combination braking systems have to meet the requirements in point 7.1.1.2; in addition the friction brake as part of the combination braking system has to meet the requirements in point 7.1.1.1.3.

The performance of the friction brake must also be determined. In this type of test, the effect of the hydrostatic transmission must be neutralised to assess the friction brake and rolling resistance.

If the hydrostatic brake cannot be disconnected for technical reasons, the proportion of the friction brake may be determined by another method, e.g.

6.2.1.2.1. Successive brake tests are performed with the combination braking system and with the friction brake effect less and the hydrostatic brake solitary; then this formula is used:

\[ Z_F = Z_{Hy} + F - Z_{Hy} + R \]

\( Z_F \): braking rate of the friction braking system including rolling resistance.

\( Z_{Hy} \): braking rate of the hydrostatic transmission including rolling resistance.

\( Z_{Hy} + F \): total braking rate of the combination braking system.

\( R \): rolling resistance = 0.02

6.2.1.3. Friction braking systems have to meet the requirements in point 7.1.1.1, in addition the friction brake as part of the friction braking system has to meet the in point 7.1.1.1.3.
6.2.2. Secondary braking system.

6.2.2.1. The system must be tested with the appropriate control device. If it forms part of the service brake, then the latter must be modified and separated from the auxiliary brake, so that it can be operated alone.

6.2.2.2. The secondary brake must satisfy the requirements in Annex II.

6.3. Brake test Type-I (fade)

6.3.1. These tests, in accordance with the procedure of Annex II, include running the laden vehicle and absorbing the energy equal to that emitted from this vehicle on a 7 % downward gradient over a distance of 1,7 km. The speed must not exceed $30 \pm 5$ km/h.

Note: the following procedure can be used for this test: a tractor pulls the vehicle over 1,7 km, while it is retarded by the hydrostatic drive in such a way that the drawbar pull be equal to 7 % the mass of the vehicle.

During the test, the vehicle must not drive the engine at a speed above that specified by the manufacturer.

6.3.2. In addition to the tests under point 6.3.1., the hot braking effect of the service brake is determined according to the Type-0 procedure at a different temperature. With an operating force that does not exceed 600 N.

6.3.3. Type-I Test can be omitted if the manufacturer can verify that overheating of the brakes in case of permanent operation is prevented.

6.4. Parking braking system.

6.4.1. The tests are performed according to the procedure of Annex II.

6.4.2. Where the service and the secondary braking systems have the same control, the parking braking system shall be so designed that it can be actuated when the vehicle is in motion. The actuation includes the releasing of the brake. To verify the compliance with this requirement, a Type-0 test must be carried out with a laden vehicle with an initial speed of $v \geq 0.8 \, v_{\text{max}}$ but not more than 30 km/h, with the operating force described in Annex II.
7. PERFORMANCE OF BRAKING SYSTEMS

7.1. Service brake.

7.1.1. For Type-0 tests (v in km/h; s in m; dm in m/s²)

<table>
<thead>
<tr>
<th></th>
<th>Laden &amp; Unladen</th>
<th>Class I</th>
<th>Class II</th>
<th>Class III</th>
</tr>
</thead>
<tbody>
<tr>
<td>7.1.1.1 Service brake</td>
<td></td>
<td>v ≤ 12</td>
<td>≤ 30</td>
<td>≤ 40</td>
</tr>
<tr>
<td>7.1.1.1.1 Hydrostatic braking system only</td>
<td></td>
<td>s ≤ 0.15v + v²/78</td>
<td>≤ 0.15v + v²/116</td>
<td>≤ 0.15v + v²/130</td>
</tr>
<tr>
<td>7.1.1.1.2 Minimum component of friction brake(s) in a combination service braking system</td>
<td>dm</td>
<td>≥ 1,0</td>
<td>≥ 1,5</td>
<td>≥ 1,5</td>
</tr>
<tr>
<td>7.1.1.1.3 Minimum component of mechanical braking effect within friction braking system</td>
<td>s</td>
<td>≤ 0.15v + v²/52</td>
<td>≤ 0.15v + v²/52</td>
<td>≤ 0.15v + v²/78</td>
</tr>
<tr>
<td>7.1.1.4 Parking braking system - dynamic so far as required by 6.4.2</td>
<td>dm</td>
<td>≥ 1,5</td>
<td>≥ 1,5</td>
<td>≥ 1,5</td>
</tr>
</tbody>
</table>

7.1.2. For Type-I tests

<table>
<thead>
<tr>
<th>Service braking system</th>
<th>Hot performance as % of the prescribed value</th>
<th>Hot performance as % of the value recorded during Type-0 test</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hydrostatic braking system</td>
<td>75</td>
<td>60</td>
</tr>
<tr>
<td>Friction braking system</td>
<td>75</td>
<td>60</td>
</tr>
<tr>
<td>Combination braking system</td>
<td>75</td>
<td>60</td>
</tr>
</tbody>
</table>

7.2. Secondary brake

The performance of the secondary brake must be identical to the requirement of Annex II.

7.3. Parking brake

7.3.1. The performance of the parking brake must be identical to the requirements set out in Annex I, point 2.1.3.
ANNEX X

Type-approval documentation

Appendix 1

MODEL

(maximum format: A4 (210 × 297 mm))

EC TYPE-APPROVAL CERTIFICATE

Communication concerning the
— type approval (1)
— extension of type approval (1)
— refusal of type approval (1)
— withdrawal of type approval (1)

of a type of a vehicle/component/separate technical unit (1) with regard to Regulation [new No.],

Type-approval number: ...........................................................................................................

Reason for extension: ...........................................................................................................

SECTION I

0.1. Make (trade name of manufacturer):

0.2. Type:

0.3. Means of identification of type if marked on the vehicle/component/separate technical unit (1) (2):

0.3.1. Location of that marking:

0.4. Category of vehicle (3):

0.5. Name and address of manufacturer:

0.7. In the case of components and separate technical units, location and method of affixing of the EC approval mark:
0.8. Address(es) of assembly plant(s):

SECTION II

1. Additional information (where applicable): See Addendum

2. Technical service responsible for carrying out the tests:

3. Date of test report:

4. Number of test report:

5. Remarks (if any): See Addendum

6. Place:

7. Date:

8. Signature:

9. The index to the information package lodged with the approval authority, which may be obtained on request, is attached.

(1) Delete where not applicable.

(2) If the means of identification of type contains characters not relevant to describe the vehicle, component or separate technical unit types covered by this type-approval certificate such characters shall be represented in the documentation by the symbol ‘?’ (e. g. ABC?123?).

(3) As defined in Annex II (A) to Directive 2003/37/EC.
1. ADDITIONAL INFORMATION

1.1. Mass of vehicle
1.1.1. Maximum mass of vehicle: .................................................................
1.1.2. Minimum mass of vehicle: .................................................................
1.1.3. Distribution of the mass on each axle (maximum value): .................

1.2. Make and type of brake linings: .............................................................
1.2.1. Alternative brake linings: .................................................................

1.3. In the case of an agricultural tractor

1.3.1. Engine type: ....................................................................................
1.3.2. If applicable (1), maximum mass of towed vehicle which may be coupled: ........
1.3.2.1. full trailer (interchangeable towed machinery): ............................
1.3.2.2. semi-mounted towed vehicle (interchangeable towed machinery): ........
1.3.2.3. centre-axle towed vehicle: indicate also the maximum ratio of the coupling overhang (2) to the wheelbase:
1.3.2.4. maximum mass of the combination:
1.3.2.5. R1/S1 towed vehicle: braked/unbraked (1)

1.4. Tyre dimensions:

1.5. Number and arrangement of axles:
1.6. Brief description of the braking equipment:

1.7. Distribution of braking among the axles of a vehicle:

2. Remarks:

__________

(1) Delete as appropriate.

(2) ‘Coupling overhang’ is the horizontal difference between the coupling for centre-axle towed vehicles and the centre-line of the rear axle(s).
Appendix 2

Test report

1. Mass of vehicle at the time of testing on the following:

<table>
<thead>
<tr>
<th></th>
<th>unladen (kg)</th>
<th>laden (kg)</th>
</tr>
</thead>
<tbody>
<tr>
<td>King pin supporting load (^{(15)})</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Axle N° 1 (^{(16)})</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Axle N° 2</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Axle N° 3</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Axle N° 4</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

2. Result of the tests:

<table>
<thead>
<tr>
<th>Test</th>
<th>Test speed (km/h)</th>
<th>Measured performance</th>
<th>Measured force applied to the control (N)</th>
</tr>
</thead>
<tbody>
<tr>
<td>2.1. Type-0 test, engine disconnected</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>service braking</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>secondary braking</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2.2. Type-0 test, engine connected and service braking in accordance with Annex II, point 2.1.1.1</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2.3. Type-I tests with repeated braking applies only to tractors with continuous braking</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

\(^{(15)}\) In the case of a semi-trailer or a centre-axle trailer, enter the mass corresponding to the load on the coupling device

\(^{(16)}\) Delete as appropriate
2.4. Reaction time and dimensions of flexible pipes

2.4.1. Reaction time at the brake actuator ...... sec.

2.4.2. Reaction time at the control line coupling head ...... sec.

2.5. Cases in which Type-I tests do not have to be carried out (Annex VII):

2.5.1. Type-approval number of the reference vehicle

2.5.2.

<table>
<thead>
<tr>
<th>Vehicle’s axles</th>
<th>Reference axles</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mass per axle (*)</td>
<td>Required braking force to the wheels</td>
</tr>
<tr>
<td>kg</td>
<td>N</td>
</tr>
</tbody>
</table>

Axle 1

Axle 2

Axle 3

Axle 4

(*) This is the technically permissible maximum mass per axle.
2.5.3.

<table>
<thead>
<tr>
<th>Reference axle …</th>
<th>Report N° …</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Type-I</td>
</tr>
</tbody>
</table>

**Brake forces per axle (N)**  
(see point 4.2, Appendix 2 of Annex VII)

<table>
<thead>
<tr>
<th>Axle 1</th>
<th>Axle 2</th>
<th>Axle 3</th>
</tr>
</thead>
<tbody>
<tr>
<td>$T_1 = \ldots % P_e$</td>
<td>$T_2 = \ldots % P_e$</td>
<td>$T_3 = \ldots % P_e$</td>
</tr>
</tbody>
</table>

**Predicted actuator stroke (mm)**  
(see point 4.3.1.1, Appendix 2 of Annex VII)

<table>
<thead>
<tr>
<th>Axle 1</th>
<th>Axle 2</th>
<th>Axle 3</th>
</tr>
</thead>
<tbody>
<tr>
<td>$S_1 = \ldots$</td>
<td>$S_2 = \ldots$</td>
<td>$S_3 = \ldots$</td>
</tr>
</tbody>
</table>

**Average output thrust (N)**  
(see point 4.3.1.2, Appendix 2 of Annex VII)

<table>
<thead>
<tr>
<th>Axle 1</th>
<th>Axle 2</th>
<th>Axle 3</th>
</tr>
</thead>
<tbody>
<tr>
<td>$Th_{A1} = \ldots$</td>
<td>$Th_{A2} = \ldots$</td>
<td>$Th_{A3} = \ldots$</td>
</tr>
</tbody>
</table>

**Braking performance (N)**  
(see point 4.3.1.4, Appendix 2 of Annex VII)

<table>
<thead>
<tr>
<th>Axle 1</th>
<th>Axle 2</th>
<th>Axle 3</th>
</tr>
</thead>
<tbody>
<tr>
<td>$T_1 = \ldots$</td>
<td>$T_2 = \ldots$</td>
<td>$T_3 = \ldots$</td>
</tr>
</tbody>
</table>
Braking performance of vehicle
(see point 4.3.2, Appendix 2 of Annex VII)

Hot braking requirements
(see point 2.2.1.4 of Annex II)

3. Reservoirs and energy sources using compressed-air:

3.1. Total volume of the brake reservoirs .................................................................

3.2. Value \( p_2 \) declared by manufacturer ..............................................................

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

3.4. Charging time \( t_1 \) ...........................................................................................

3.5. Charging time \( t_2 \) ...........................................................................................

3.6. Total volume of the reservoirs of auxiliary systems ............................................

3.7. Charging time \( t_3 \) ...........................................................................................

4. Automatic braking on towed vehicles with compressed-air braking system

4.1. Braking rate achieved .........................................................................................
ANNEX XI
INFORMATION DOCUMENT No . . .

pursuant to Annex I of Directive 2003/37/EC of the European Parliament and of the Council (†) relating to EC type-approval of a tractor with respect to the braking equipment of tractors

(Regulation [new No.]).

The following information, if applicable, shall be supplied in triplicate and include a list of contents. Any drawings shall be supplied in appropriate scale and in sufficient detail on size A4 format. Photographs, if any, shall show sufficient detail.

If the systems, components or separate technical units have electronic controls, information concerning their performance shall be supplied.

0. GENERAL

0.1. Make (trade mark registered by the manufacturer):

0.2. Type: (specify any variants and versions):

0.3. Means of identification of type, if marked on the vehicle:

0.3.1. Manufacturer’s plate (location and method of affixing):

0.4. Category of vehicle (†):

0.5. Name and address of manufacturer:

0.8. Name(s) and address(es) of assembly plant(s):

1. GENERAL CONSTRUCTION CHARACTERISTICS OF THE VEHICLE

(Attach 3/4 front and 3/4 rear photographs or drawings of a representative version, and a dimensioned drawing of the entire vehicle)

1.1. Number of axles and wheels:

1.1.1. Number and position of axles with twinned wheels (if applicable):

(†) The point numbers and footnotes used in this information document correspond to those set out in Annex I to Directive 2003/37/EC. Points not relevant for the purpose of this Regulation are omitted.
1.1.3. Powered axles (number, position, interconnection):

1.1.4. Braked axles (number, position):

1.6. Vehicle designed for on-road use on the: right/left (1)
2. MASSES AND DIMENSIONS (\(^5\)) (in kg and mm) (Refer to drawing where applicable)

2.1.1. Unladen mass(es) in running order (\(^{16}\)) (serving as a reference point for the various separate directives or regulations) (including the roll-over protection structure, excluding optional accessories, but with coolant, lubricants, fuel, tools and driver) (\(^6\)):

- maximum: ................
- minimum: ..............

2.1.1.1. Distribution of this (these) mass(es) among the axles and, in the case of a semi-mounted towed vehicle (or interchangeable towed machinery) or a centre-axle trailer (or interchangeable towed machinery), the load on the coupling point: ............

2.2.1. Technically permissible maximum laden mass(es) of vehicle according to the tyre specification: ........................................................................................................................................

2.2.2. Distribution of this (these) mass(es) among the axles and, in the case of a semi-mounted towed vehicle (or interchangeable towed machinery) or a centre-axle trailer (or interchangeable towed machinery), the load on the coupling point: ............

2.2.3. Limits on the distribution of this (these) mass(es) among the axles (specify the minimum limits in percentages on the front axle and on the rear axle) and, in the case of a semi-mounted towed vehicle (or interchangeable towed machinery) or a centre-axle trailer (or interchangeable towed machinery), the load on the coupling point: ........................................................................................................................................

2.4. Technically permissible towable mass(es) (according to type of coupling)

2.4.1. Maximum mass of the combination of towing vehicle and un-braked towed vehicle (PC): ....

2.4.2. Inertia-braked towable mass: ........

2.4.3. Towable mass when fitted with hydraulic or pneumatic braking: ...........

2.4.4. Total technically permissible mass(es) of the tractor-trailer combination (interchangeable towed machinery) (for each configuration of trailer (interchangeable towed machinery): ........

2.4.6. Position of coupling point

2.4.6.1. Height above ground:
2.4.6.1.1. Maximum: …

2.4.6.1.2. Minimum: ….

2.4.6.2. Distance from the vertical plane passing through the axis of the rear axle: ……

2.4.6.3. Maximum static vertical load/technically permissible mass on the coupling point:

2.4.6.3.1. — of the tractor: ……

2.6. Maximum and minimum width of track of each axle (measured between the symmetry planes of the single or twin tyres normally fitted) (to be stated by the manufacturer) (8): …………………………………………………

3. ENGINE

3.1. Parent engine/engine type (1) (3) (21)

3.1.1. Make(s) (trade name of manufacturer): ……………………………..

3.1.2. Type and commercial description of the parent engine and (if applicable) of the family of engine(s) (1): …………………………………………………

3.1.6. Operating principle:

– spark/compression ignition (1)

– direct/indirect injection (1)

– two/four-stroke (1)

3.2.1.8. Rated speed: …….. r/min

3.8. Other traction engines or motors (spark ignition, etc.), or combinations thereof (characteristics of components): …………………………………………………

3.11. Electrical system:

3.11.1. Rated voltage, positive/negative earth (1): ……… V

3.11.2. Generator:

3.11.2.1. Type: …………………………………………………

4. TRANSMISSION (16)

4.1. Diagram of the transmission system: …………………………………………………
4.2. Type (mechanical, hydraulic, electric, etc.): .......................................................

4.6. Gear ratios (if any), with or without transfer box (17)

<table>
<thead>
<tr>
<th>Gear</th>
<th>Gearbox ratio</th>
<th>Transfer-box ratio(s)</th>
<th>Final drive ratio</th>
<th>Overall gear ratio</th>
</tr>
</thead>
<tbody>
<tr>
<td>Maximum for speed-changing mechanism (1)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Minimum for speed-changing mechanism (1)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Reverse</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>...</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

(1) Continuously variable transmission (CVT).

4.7. Calculated maximum tractor design speed in top gear (show factors used in calculation) (17): ......... km/h

6. SUSPENSION (where appropriate)

6.1. Extreme (maximum-minimum) tyre/wheel combinations (if any) (dimensions, characteristics, inflation pressure for road use, maximum permissible load, wheel dimensions and front/rear combinations): ..............................................

6.2. Type of suspension (if fitted) for each axle or wheel: ...........................................

8. BRAKES (overall sketch and operating sketch) (19)

8.1. Service braking system: .................................................................

8.2. Secondary braking system (if fitted): .....................................................

8.3. Parking brake: .....................................................................................
8.4. Any additional braking device(s) (and especially retarders): ..........................

8.5. For vehicles with anti-lock braking systems, description of system operation (including any electronic parts), electric block diagram, hydraulic or pneumatic circuit plan: .................................................................

8.8. Calculation for the braking system (determination of the ratio of the total braking forces at the circumference of the wheels to the force applied to the braking control): .................................................................

8.9. Locking of left and right braking controls: ...................................................

8.10. External energy source(s) (if any) (characteristics, capacity of energy reservoirs, maximum and minimum pressure, pressure gauge and minimum-pressure warning device on the dashboard, vacuum reservoirs and supply valve, supply compressors, compliance with provisions regarding pressure equipment): .................................................................

8.11. Vehicles fitted with trailer braking devices

8.11.1. Trailer-brake actuating device (description, characteristics): ......................

8.11.2. Mechanical/hydraulic/pneumatic/electric coupling (1)

8.11.3. Connectors, couplings, safety devices (description, drawing, sketch): .........

8.11.4. Single- or two-line connections (1)

8.11.4.1. Supply overpressure (1 line): ........ kPa

8.11.4.2. Supply overpressure (2 line): ........ kPa

8.12. Brief description of the braking systems (according to point 1.6. of the Addendum of Appendix 1 of Annex X, to this Regulation:

8.13. If claiming exemptions from the Type-I tests, state the number of the report in accordance with Annex VII to this Regulation:

Date: ............................................. File: .....................................................
ANNEX XII

INFORMATION DOCUMENT No . . .

pursuant to Annex I of Directive 2003/37/EC of the European Parliament and of the Council (*) relating to EC type-approval of a vehicle with respect to the braking equipment of towed vehicles with other than inertia (overrun) brakes

(Regulation [new No.]).

The following information, if applicable, shall be supplied in triplicate and include a list of contents. Any drawings shall be supplied in appropriate scale and in sufficient detail on size A4 format. Photographs, if any, shall show sufficient detail.

If the systems, components or separate technical units have electronic controls, information concerning their performance shall be supplied.

0. GENERAL

0.1. Make (trade mark registered by the manufacturer): .........................

0.2. Type: (specify any variants and versions): .................................

0.3. Means of identification of type, if marked on the vehicle: .............

0.3.1. Manufacturer’s plate (location and method of affixing): ............

0.4. Category of vehicle (†): ...................

0.5. Name and address of manufacturer: .........................................

0.8. Name(s) and address(es) of assembly plant(s): ........................

1. GENERAL CONSTRUCTION CHARACTERISTICS OF THE VEHICLE

It shall be attached 3/4 front and 3/4 rear photographs or drawings of a representative version, and a dimensioned drawing of the entire vehicle.

1.1. Number of axles and wheels: ...........

1.1.1. Number and position of axles with twinned wheels (if applicable): ........

1.1.4. Braked axles (number, position): ........

(*) The point numbers and footnotes used in this information document correspond to those set out in Annex I to Directive 2003/37/EC. Points not relevant for the purpose of this Regulation are omitted.
2. MASSES AND DIMENSIONS (IN KG AND MM) (Refer to drawing where applicable)

2.1.1. Unladen mass(es) in running order (serving as a reference point for the various separate directives or Regulations) (including the roll-over protection structure, excluding optional accessories, but with coolant, lubricants, fuel, tools and driver):

- maximum: ..............
- minimum: ..............

2.1.1.1. Distribution of this (these) mass(es) among the axles and, in the case of a semi-mounted towed vehicle (or interchangeable towed machinery) or a centre-axle trailer (or interchangeable towed machinery), the load on the coupling point: ..............

2.2.1. Technically permissible maximum laden mass(es) of vehicle according to the tyre specification: .................................................................

2.2.2. Distribution of this (these) mass(es) among the axles and, in the case of a semi-mounted towed vehicle (or interchangeable towed machinery) or a centre-axle trailer (or interchangeable towed machinery), the load on the coupling point: ..............

Limits on the distribution of this (these) mass(es) among the axles (specify the minimum limits in percentages on the front axle and on the rear axle) and, in the case of a semi-mounted towed vehicle (or interchangeable towed machinery) or a centre-axle trailer (or interchangeable towed machinery), the load on the coupling point: .................................

2.4. Technically permissible towable mass(es) (according to type of coupling)

2.4.1. Unbraked towable mass:

2.4.2. Inertia-braked towable mass:

2.4.3. Towable mass when fitted with hydraulic or pneumatic braking:

2.4.6.3. Maximum static vertical load/technically permissible mass on the coupling point:

2.4.6.3.2. of the semi-mounted towed vehicle (interchangeable towed machinery) or the centre-axle trailer (interchangeable towed machinery):
......................................................

2.5. Wheelbase ():

2.5.1. For semi-mounted towed vehicles (interchangeable towed machinery):

2.5.1.1. distance between the coupling pin and the first rear axle: .........................

2.5.1.2. distance between the coupling pin and the rear of the semi-mounted towed vehicle (interchangeable towed machinery): .................................
2.6. Maximum and minimum width of track of each axle (measured between the symmetry planes of the single or twin tyres normally fitted) (to be stated by the manufacturer) (9): .................................................................

6. SUSPENSION (where appropriate)

6.1. Extreme (maximum-minimum) tyre/wheel combinations (if any) (dimensions, characteristics, inflation pressure for road use, maximum permissible load, wheel dimensions and front/rear combinations): .........................

6.2. Type of suspension (if fitted) for each axle or wheel: ..................................

8. BRAKES (overall sketch and operating sketch) (19)

8.1. Service braking system:

8.2. Secondary braking system (if fitted): ..........................................................

8.3. Parking brake: ..........................................................................................

8.4. Any additional braking device(s) (and especially retarders): ......................

8.5. For vehicles with anti-lock braking systems, description of system operation (including any electronic parts), electric block diagram, hydraulic or pneumatic circuit plan: .................................................................

8.8. Calculation for the braking system (determination of the ratio of the total braking forces at the circumference of the wheels to the force applied to the braking control): .................................................................

8.11.2. Mechanical/hydraulic/pneumatic/electric coupling (1)

8.11.3. Connectors, couplings, safety devices (description, drawing, sketch): .......

8.11.4. Single- or two-line connections (1)

8.11.4.1. Supply overpressure (1 line): ........ kPa

8.11.4.2. Supply overpressure (2 line): ........ kPa”

8.12. Brief description of the braking systems (according to point 1.6. of the Addendum of Appendix 1 of Annex IX, to this Regulation:

8.13. If claiming exemptions from the Type-I tests, state the number of the report in accordance with Annex VII to this Regulation:

Date: .................................................. File:.................................................................
ANNEX XIII
SPECIAL REQUIREMENTS TO BE APPLIED TO THE SAFETY ASPECTS OF COMPLEX ELECTRONIC TRACTOR CONTROL SYSTEMS

1. GENERAL

This Annex defines the special requirements for documentation, fault strategy and verification with respect to the safety aspects of complex electronic tractor control systems (Clause 2.3 below).

This Annex may also be called, by special clauses in this standard, for safety related functions which are controlled by electronic system(s).

This Annex does not specify the performance criteria for “The System” but covers the methodology applied to the design process and the information.

This information shall show that “The System” respects, under normal and fault conditions, all the appropriate performance requirements specified elsewhere in this standard. When a single fault occurs in "The System" the prescribed function shall always be performed.

This Annex only applies to complex electronic tractor controls that are used in tractors having a maximum design speed of more than 12 km/h.

2. DEFINITIONS

For the purposes of this Annex the following definitions apply:

2.1 “Safety concept” is a description of the measures designed into the system, for example within the electronic units, so as to address system integrity and thereby ensure safe operation even in the event of an electrical failure.

The possibility of a fall-back to partial operation or even to a back-up system for vital tractor functions may be a part of the safety concept.

2.2 “Electronic control system” means a combination of units, designed to co-operate in the production of the stated tractor control function by electronic data processing.

Such systems, often controlled by software, are built from discrete functional components such as sensors, electronic control units and actuators and connected by transmission links. They may include mechanical, electro-pneumatic or electro-hydraulic elements.

“The System” referred to herein, is one for which type approval is being sought.

2.3 “Complex electronic vehicle control systems” are those electronic control systems which are subject to a hierarchy of control in which a controlled function may be over-ridden by a higher level electronic control system/function. A function which is over-ridden becomes part of the complex system.
2.4 “Higher level control” systems/functions are those which employ additional processing and/or sensing provisions to modify tractor behaviour by commanding variations in the normal function(s) of the tractor control system. This allows complex systems to automatically change their objectives with a priority which depends on the sensed circumstances.

2.5 “Units” are the smallest divisions of system components which will be considered in this Annex, since these combinations of components will be treated as single entities for purposes of identification, analysis or replacement.

2.6 “Transmission links” are the means used for inter-connecting distributed units for the purpose of conveying signals, operating data or an energy supply. This equipment is generally electrical but may, in some part, be mechanical, pneumatic or hydraulic.

2.7 “Range of control” refers to an output variable and defines the range over which the system is likely to exercise control.

2.8 “Boundary of function operation” defines the boundaries of the external physical limits within which the system is able to maintain control.

3. DOCUMENTATION

3.1 Requirements

The manufacturer shall develop and maintain a documentation package which gives access to the basic design of “The System” and the means by which it is linked to other tractor systems or by which it directly controls output variables. The function(s) of “The System” and the safety concept, as laid down by the manufacturer, shall be explained.

Documentation shall be brief, yet provide evidence that the design and development has had the benefit of expertise from all the system fields which are involved.

For technical inspections, care and maintenance the documentation shall describe how the current operational status of “The System” can be checked.

3.1.1 Documentation shall be made available in two parts:

(a) The formal documentation package, containing the material listed in Clause 3 (with the exception of that of Clause 3.4.4). This will be taken as the basic reference for the verification process set out in Clause 4 of this Annex.

(b) Additional material and analysis data of Clause 3.4.4, which shall be retained by the manufacturer, but made open for inspection.

3.2 Description of the functions of “The System”

A description shall be developed and maintained which gives a simple explanation of all the control functions of “The System” and the methods employed to achieve the objectives, including a statement of the mechanism(s) by which control is exercised.
3.2.1 A list of all input and sensed variables shall be developed and maintained and the working range of these defined.

3.2.2 A list of all output variables which are controlled by “The System” shall be developed and maintained and an indication given, in each case, of whether the control is direct or via another tractor system. The range of control (clause A.2.7) exercised on each such variable shall be defined.

3.2.3 Limits defining the boundaries of functional operation (clause A.2.8) shall be stated where appropriate to system performance.

3.3 System layout and schematics

3.3.1 Inventory of components

A list shall be developed and maintained, collating all the units of “The System” and mentioning the other tractor systems which are needed to achieve the control function in question.

An outline schematic showing these units in combination shall be developed and maintained with both the equipment distribution and the interconnections made clear.

3.3.2 Functions of the unit

The function of each unit of “The System” shall be outlined and the signals linking it with other units or with other tractor systems shall be shown. This may be provided by a labelled block diagram or other schematic, or by a description aided by such a diagram.

3.3.3 Interconnections

Interconnections within “The System” shall be shown by a circuit diagram for the electric transmission links, by a piping diagram for pneumatic or hydraulic transmission equipment and by a simplified diagrammatic layout for mechanical linkages.

3.3.4 Signal flow and priorities

There shall be a clear correspondence between these transmission links and the signals carried between units. Priorities of signals on multiplexed data paths shall be stated, wherever priority may be an issue affecting performance or safety as far as this Annex is concerned.

3.3.5 Identification of units

Each unit shall be clearly and unambiguously identifiable (e.g. by marking for hardware and marking or software output for software content) to provide corresponding hardware and documentation association.

Where functions are combined within a single unit or indeed within a single computer, but shown in multiple blocks in the block diagram for clarity and ease of explanation, only a single hardware identification marking shall be used.
The manufacturer shall, by the use of this identification, affirm that the equipment supplied conforms to the corresponding document.

3.3.5.1 The identification defines the hardware and software version and, where the latter changes such as to alter the function of the unit as far as this Annex is concerned, this identification shall also be changed.

3.4 Safety concept of the manufacturer

3.4.1 The strategy chosen by the manufacturer to achieve “The System” objectives shall not, under non-fault conditions, prejudice the safe operation of systems which are subject to the prescriptions of this Annex.

3.4.2 In respect of software employed in “The System”, the outline architecture shall be explained and the design methods and tools used shall be identified.

3.4.3 The Manufacturer shall develop and maintain an explanation of the design provisions built into “The System” so as to generate safe operation under fault conditions as determined in Clause 1. In case of a failure, the driver shall be warned for example by warning signal or message display. When the system is not deactivated by the driver, e.g. by turning the ignition (run) switch to “off”, or by switching off that particular function if a special switch is provided for that purpose, the warning shall be present as long as the fault condition persists.

Possible design provisions for failure in ‘The System’ are for example:

a) Fall-back to operation using a partial system.

(b) Change-over to a separate back-up system.

(c) Removal of the high level functions.

3.4.3.1 If the chosen provision selects a partial performance mode of operation under certain fault conditions, then these conditions shall be stated and the resulting limits of effectiveness defined.

3.4.3.2 If the chosen provision selects a second (back-up) means to realise the tractor control system objective, the principles of the change-over mechanism, the logic and level of redundancy and any built in back-up checking features shall be explained and the resulting limits of back-up effectiveness defined.

3.4.3.3 If the chosen provision selects the removal of the Higher Level Function, all the corresponding output control signals associated with this function shall be inhibited, and in such a manner as to limit the transition disturbance.

3.4.4 The documentation shall be supported, by an analysis which shows, in overall terms, how the system will behave on the occurrence of any one of those specified faults which will have a bearing on tractor control performance or safety.

The chosen analytical approach(es) shall be established and maintained by the Manufacturer and shall be made open for inspection. This may be based on a
Failure Mode and Effect Analysis (FMEA), a Fault Tree Analysis (FTA) or any similar process appropriate to system safety considerations.

3.4.4.1 This documentation shall itemise the parameters being monitored and shall set out, for each fault condition of the type defined in Clause 3.4.4 above, the warning signal to be given to the driver and/or to service/technical inspection personnel.

4 VERIFICATION AND TEST

4.1 The functional operation of “The System”, as laid out in the documents required in clause A.3, shall be tested as follows:

4.1.1 Verification of the function of “The System”

As the means of establishing the normal operational levels, verification of the performance of the tractor system under non-fault conditions shall be conducted against the manufacturer's basic benchmark specification unless this is subject to a specified performance test as part of this or another standard related to "The System".

4.1.2 Verification of the safety concept of Clause 3.4

The reaction of “The System” shall be checked under the influence of a failure in any individual unit by applying corresponding output signals to electrical units or mechanical elements in order to simulate the effects of internal faults within the unit.

4.1.2.1 The verification results shall correspond with the documented summary of the failure analysis, to a level of overall effect such that the safety concept and execution are confirmed as being adequate.
1. GENERAL

1.1. This Annex defines the required braking performance for agricultural vehicles fitted with anti-lock braking systems. In addition, agricultural vehicles which are authorised to tow a trailer, and trailers equipped with compressed-air braking systems, shall, when the vehicles are laden, meet the requirements for compatibility set out in Diagrams 1 to 6 of appendix 1 to Annex II.

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

2. DEFINITIONS

2.1. An ‘anti-lock braking system’ is part 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 (17).

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)17.

3. TYPES OF ANTI-LOCK BRAKING SYSTEMS

3.1. A tractor shall be deemed to be equipped with an anti-lock braking system if one of the following systems is fitted:

3.1.1. Category 1 anti-lock braking system:

17 Anti-lock braking systems with ‘select-high’ control are deemed to include both directly and indirectly controlled wheels; in systems with ‘select-low’ control, all sensed wheels are deemed to be directly controlled wheels.
A vehicle equipped with a category 1 anti-lock braking system shall meet all the relevant requirements of this Annex.

3.1.2. Category 2 anti-lock braking system:

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

3.1.3. Category 3 anti-lock braking system:

A vehicle equipped with a category 3 anti-lock braking system shall meet all the relevant requirements of this Annex except those of points 5.3.4 and 5.3.5.

3.2. A trailer shall be deemed to be equipped with an anti-lock braking system when at least two wheels on opposite sides of the vehicle are directly controlled and all remaining wheels are either directly or indirectly controlled by the anti-lock braking system. In the case of full trailers, at least two wheels on one front axle and two wheels on one rear axle shall be directly controlled with each of these axles having at least one independent modulator and all remaining wheels are either directly or indirectly controlled. In addition, the anti-lock equipped trailer shall meet one of the following conditions:

3.2.1. Category A anti-lock braking system:

A trailer equipped with a category A anti-lock braking system shall meet all the relevant requirements of this Annex.

3.2.2. Category B anti-lock braking system:

A trailer equipped with a category B anti-lock braking system shall meet all the relevant requirements of this Annex, except point 6.3.2.

4. GENERAL REQUIREMENTS

4.1. Any electrical failure or sensor anomaly that affects the system with respect to the functional and performance requirements in this Annex, including those in the supply of electricity, the external wiring to the controller(s), the controller(s) and the modulator(s) shall be signalled to the driver by a specific optical warning signal.

4.1.1. The warning signal shall light up when the anti-lock braking system is energised and, with the vehicle stationary, it shall be verified that none of the above-mentioned defects are present before extinguishing the signal.

4.1.2. The static sensor check may verify that a sensor was not functioning the last time that the vehicle was at a speed greater than 10 km/h

---

18 Until uniform test procedures have been agreed, the manufacturer shall provide the technical service with an analysis of potential failures within the controller(s) and their effects. This information shall be subject to discussion and agreement between the technical service and the vehicle manufacturer.

19 The warning signal may light up again while the vehicle is stationary, provided that it is extinguished before the vehicle speed reaches 10 km/h when no defect is present.
phase, the electrically controlled pneumatic modulator valve(s) shall cycle at least once.

4.2. Tractors equipped with an anti-lock braking system and authorised to tow a trailer equipped with such a system shall be fitted with a separate optical warning signal for the anti-lock braking system of the trailer, meeting the requirements of point 4.1 of this Annex.

4.2.1. This warning signal shall not light up when a trailer without an anti-lock braking system is coupled or when no trailer is coupled. This function shall be automatic.

4.3. The above mentioned optical warning signal(s) shall be visible even in daylight and it shall be easy for the driver to check that they are in working order.

4.4. The electrical connections used for the anti-lock braking systems of towing vehicles and trailers shall be affected by a special connector conforming to ISO Standard 7638-1985 or ISO/DIS Standard 7638-1996.\(^{20}\)

4.5. In the event of a failure of the anti-lock braking system, the residual braking performance shall be at least that prescribed for the secondary braking system (see point 2.1.2 of Annex II for tractors and 2.2.3 of Annex II for trailers).

4.6. The operation of the system shall not be adversely affected by magnetic or electrical fields.\(^{21}\)

\(^{20}\) The wiring specification of point 6.2 of ISO 7638-1985 or point 5.4 of ISO/DIS standard 7638-1996 for the trailer may only be reduced if the trailer is equipped with its own independent fuse. The rating of the fuse shall be such that the current rating of the conductors is not exceeded.

With the exception of vehicles of categories N3 and O4, and until a uniform international standard has been agreed, the electrical connection between towing vehicles and trailers equipped with a 12 volt electrical system shall conform with DIN standard 72570, Part 4.

4.7. A manual device may not be provided to disconnect or change the control mode \(^{22}\) of the anti-lock braking system, except on tractors of category T or C. Where a device is fitted to tractors of category T or C, the following conditions shall be met:

4.7.1. the vehicle with the anti-lock braking system disconnected or the control mode changed by the device referred to in point 4.7 above shall satisfy all the other relevant requirements in Annex II;

4.7.2. an optical warning signal shall inform the driver that the anti-lock braking system has been disconnected or the control mode changed; the anti-lock failure warning signal may be used for this purpose;

4.7.3. the anti-lock braking system shall automatically be reconnected/returned to on-road mode when the ignition (start) device is again set to the ‘on’ (run) position or the vehicle speed exceeds 40 km/h;

4.7.4. the vehicle user's handbook provided by the manufacturer should warn the driver of the consequences of manual disconnection or mode change of the anti-lock braking system;

4.7.5. the device referred to in point 4.7 above may, in conjunction with the towing vehicle, disconnect/change the control mode of the anti-lock braking system of the trailer; a separate device for the trailer alone is not permitted.

5. SPECIAL PROVISIONS CONCERNING AGRICULTURAL VEHICLES

5.1. Energy consumption

Braking systems equipped with anti-lock braking systems shall maintain their performance when the service braking control device is fully applied for long periods. Compliance with the 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 energy storage device(s) for pneumatic auxiliary equipment shall be isolated.

5.1.1.2. From an initial speed of not less than 50 km/h (or \(v_{\text{max}}\), whichever is lower), on a surface with a coefficient of adhesion of 0.3 \(^{23}\) or less, the brakes of the laden vehicle

---

\(^{22}\) It is understood that devices changing the control mode of the anti-lock braking system are not subject to point 4.7 if in the changed control mode condition all requirements for the category of anti-lock braking system, with which the vehicle is equipped, are fulfilled. However, in this case points 4.7.2, 4.7.3 and 4.7.4 shall be met.

\(^{23}\) 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 service. The actual value obtained and the type of tyres and surface shall be recorded.
shall be fully applied for a time \( t \), during which time the energy consumed by the
indirectly controlled wheels shall be taken into consideration and all directly
controlled wheels shall remain under control of the anti-lock braking system
throughout that time.

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

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

5.1.1.5. When the control is applied for the fifth time, it shall 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 vehicle authorised to tow a trailer equipped with a
compressed-air braking system, the supply line shall be blocked off and an energy
storage device of 0.5 litre capacity shall be connected to the control line (in
accordance with point 1.2.2.3 of Annex IV, section A). When the brakes are applied
for the fifth time, as provided in point 5.1.1.5, the energy level supplied to the control
line shall 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 is measured with the vehicle in
question, by the method described in point 1.1 of Appendix 2 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:

\[
    t = \frac{v_{\text{max}}}{7} \quad \text{(but not less than 15 seconds)}
\]

where \( t \) is expressed in seconds and \( v_{\text{max}} \) represents the maximum design speed of the
vehicle expressed in km/h, with an upper limit of 90 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. From the second phase, the energy consumption corresponding
to the initial brake application may be taken into account, by subtracting one full
brake application from the four full applications prescribed in point 5.1.1.4 (and
5.1.1.5, 5.1.1.6 and 5.1.2.6) of this Annex for each of the second, third and fourth
phases used in the test prescribed in point 5.1.1 of this Annex as applicable.

5.1.2.6. The performance prescribed in point 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. Utilisation of adhesion

5.2.1. The utilisation of adhesion by the anti-lock braking system takes into account the actual increase in braking distance beyond the theoretical minimum. The anti-lock braking system shall be deemed to be satisfactory when the condition

\[ \varepsilon \geq 0.75 \]

is satisfied, where \( \varepsilon \) represents the adhesion utilised, as defined in point 1.2 of Appendix 2 to this Annex.

5.2.2. The adhesion utilisation (\( \varepsilon \)) shall be measured on road surfaces with a coefficient of adhesion of 0.3 \(^{24}\) or less, and of about 0.8 (dry road), with an initial speed of 50 km/h or \( v_{\text{max}} \), whichever is the lower. To eliminate the effects of differential brake temperatures it is recommended that \( Z_{\text{AL}} \) be determined prior to the determination of \( k \).

5.2.3. The test procedure to determine the coefficient of adhesion (\( k \)) and the formulae for calculation of the adhesion utilisation (\( \varepsilon \)) shall be those laid down in Appendix 2 to this Annex.

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

5.2.5. The condition \( \varepsilon \geq 0.75 \) shall be checked with the vehicle laden and unladen. The laden test on the high-adhesion surface may be omitted if the prescribed force on the control device does not achieve full cycling of the anti-lock braking system. For the unladen test, the control force may be increased up to 1.000 N if no cycling is achieved with its full force value \(^{25}\). If 1.000 N is insufficient to make the system cycle, then this test may be omitted. For air braking systems, the air pressure may not be increased above the cut-out pressure for the purpose of this test.

5.3. Additional checks

The following additional checks shall be carried out with the engine disconnected, with the vehicle laden and unladen:

5.3.1. The wheels directly controlled by an anti-lock braking system shall not lock when the full force\(^{1}\) is suddenly applied on the control device, on the road surfaces specified in point 5.2.2 of this Annex, at an initial speed of 40 km/h and at a high initial speed as indicated in the table below \(^{26}\):

---

\(^{24}\) 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 service. The actual value obtained and the type of tyres and surface shall be recorded.

\(^{25}\) ‘Full force’ means the maximum force laid down in Annex II for the category of vehicle: a higher force may be used if required to activate the anti-lock braking system.

\(^{26}\) The purpose of these tests is to check that the wheels do not lock and that the vehicle remains stable; it is not necessary, therefore, to make complete stops and bring the vehicle to a complete halt on the low-adhesion surface.
### Table: Condition vs. Maximum Test Speed

<table>
<thead>
<tr>
<th>Condition</th>
<th>Maximum test speed</th>
</tr>
</thead>
<tbody>
<tr>
<td>High adhesion surface</td>
<td>$0.8 , v_{\text{max}} \leq 80 , \text{km/h}$</td>
</tr>
<tr>
<td>Low adhesion surface</td>
<td>$0.8 , v_{\text{max}} \leq 70 , \text{km/h}$</td>
</tr>
</tbody>
</table>

5.3.2. When an axle passes from a high-adhesion surface ($k_H$) to a low adhesion ($k_L$) where $k_H \geq 0.5$ and $k_H / k_L \geq 2$ \(^{27}\), with the full force \(^{28}\) applied on the control device, the directly controlled wheels shall not lock. The running speed and the instant of applying the brakes shall be so calculated that, with the anti-lock braking system 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 point 5.3.1 above \(^2\).

5.3.3. When a vehicle passes from a low-adhesion surface ($k_L$) to a high-adhesion ($k_H$) where $k_L \geq 0.5$ and $k_H / k_L \geq 2$, with the full force \(^3\) applied on the control device, the deceleration of the vehicle shall rise to the appropriate high value within a reasonable time and the vehicle shall not deviate from its initial course. The running speed and the instant of applying the brakes shall be so calculated that, with the anti-lock braking system fully cycling on the low-adhesion surface, the passage from one surface to the other occurs at approximately 50 km/h, or $0.8 \, v_{\text{max}}$, whichever is the lower.

5.3.4. In the case of vehicles equipped with anti-lock braking systems of categories 1 and 2, when the right and left wheels of the vehicle are situated on surfaces with differing coefficients of adhesion ($k_H$ and $k_L$) where $k_H \geq 0.5$ and $k_H / k_L \geq 2$, the directly controlled wheels shall not lock when the full force \(^{29}\) is suddenly applied on the control device at a speed of 50 km/h or $0.8 \, v_{\text{max}}$, whichever is the lower.

5.3.5. Furthermore, laden vehicles equipped with anti-lock braking systems of category 1 shall, under the conditions of point 5.3.4 above, satisfy the prescribed braking rate in Appendix 3 to this Annex.

5.3.6. However, in the tests provided for in points 5.3.1, 5.3.2, 5.3.3, 5.3.4 and 5.3.5 above, brief periods of wheel-locking are 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 shall not be affected.

---

\(^{27}\) $k_H$ is the high-adhesion surface coefficient; $k_L$ is the low-adhesion surface coefficient. $k_H$ and $k_L$ are measured as laid down in Appendix 2 to this Annex.

\(^{28}\) ‘Full force’ means the maximum force laid down in Annex II for the category of vehicle: a higher force may be used if required to activate the anti-lock braking system.

\(^{29}\) ‘Full force’ means the maximum force laid down in Annex II for the category of vehicle: a higher force may be used if required to activate the anti-lock braking system.
5.3.7. During the tests provided for in points 5.3.4 and 5.3.5 above, steering correction is permitted if the angular rotation of the steering control is within 120° during the initial 2 seconds and not more than 240° in all. Furthermore, at the beginning of these tests the longitudinal median plane of the vehicle shall pass over the boundary between the high- and low-adhesion surfaces and during these tests no part of the (outer) tyres shall cross this boundary.

6. SPECIAL PROVISIONS CONCERNING TRAILERS

6.1. Energy consumption

Trailers equipped with anti-lock braking systems shall be so designed that, even after the service braking control device 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\(^{30}\), and with the brakes adjusted as closely as possible and with the brake load sensing device (if fitted) held in the 'laden' position throughout the test.

6.1.2. In the case of compressed-air braking systems, the initial energy level in the energy storage device(s) shall be equivalent to a pressure of 0,8 MPa at the coupling head of the trailer's supply line.

6.1.3. With an initial vehicle speed of at least 30 km/h, the brakes shall be fully applied for a time \(t = 15\) s, during which time the energy consumed by the indirectly controlled wheels shall be taken into consideration and all directly controlled wheels shall remain under control of the anti-lock braking system. During this test, the supply to the energy storage device(s) shall be cut off. If the time \(t = 15\) s cannot be completed in a single braking phase, further phases may be used. During these phases, no fresh energy shall be supplied to the energy storage device(s) and, as from the second phase, the additional energy consumption for filling the actuators is to be taken into account, e.g. by the following test procedure. The pressure in the reservoir(s) when starting the first phase is to be that stated in point 6.1.2 above. At the beginning of the following phase(s), the pressure in the reservoir(s) after application of the brakes shall be not less than the pressure in the reservoir(s) at the end of the preceding phase. At the subsequent phase(s), the only time to be taken into account is from the point at which the pressure in the reservoir(s) is equal to that at the end of the preceding phase.

6.1.4. At the end of the braking, with the vehicle stationary, the service braking control device shall be fully actuated four times. During the fifth application, the pressure in the operating circuits shall be sufficient to provide a total braking force at the periphery of the wheels equal to not less than 22,5 % of the maximum stationary wheel load and without causing an automatic application of any braking system not being under the control of the anti-lock braking system.  

\(^{30}\) If the coefficient of adhesion of the test track is too high, preventing the anti-lock braking system from cycling then the test may be carried out on a surface with a lower coefficient of adhesion.
6.2. Utilisation of adhesion

6.2.1. Trailers equipped with an anti-lock braking system shall be deemed acceptable when the condition $\varepsilon \geq 0.75$ is satisfied, where $\varepsilon$ represents the adhesion utilised, as defined in point 2 of Appendix 2 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.\(^{31}\)\(^{32}\)

6.2.2. To eliminate the effects of differential brake temperatures, it is recommended that $Z_{RAL}$ be determined prior to the determination of $k_R$.

6.3. Additional checks

6.3.1. At speeds exceeding 15 km/h, the wheels directly controlled by an anti-lock braking system shall not lock when the full force\(^{33}\) is suddenly applied on the control device of the towing vehicle. This shall be checked, under the conditions prescribed in point 6.2 of this Annex, at initial speeds of 40 km/h and 60 km/h.

6.3.2. The provisions of this point shall only apply to trailers equipped with an anti-lock braking system of category A. When the right and left wheels are situated on surfaces which produce differing maximum braking rates ($Z_{RALH}$ and $Z_{RALL}$), where

$$\frac{Z_{RALH}}{E_H} \geq 0.5 \text{ and } \frac{Z_{RALH}}{Z_{RALL}} \geq 2$$

the directly controlled wheels shall not lock when the full force (3) is suddenly applied on the control device of the towing vehicle at a speed of 50 km/h. The ratio $Z_{RALH}/Z_{RALL}$ may be ascertained by the procedure in point 2 of Appendix 2 or by calculating the ratio $Z_{RALH}/Z_{RALL}$. Under this condition, the unladen vehicle shall satisfy the prescribed braking rate in Appendix 3.

6.3.3. At vehicle speeds $\geq 15$ km/h, the directly controlled wheels are permitted to lock for brief periods, but at speeds < 15 km/h, any locking is permissible. Indirectly controlled wheels are permitted to lock at any speed. In all cases, stability must not be affected.

---

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

32 In the case of trailers fitted with a brake load sensing device the pressure setting may be increased to ensure full cycling.

33 'Full force' means the maximum force laid down in Annex II for the category of vehicle; a higher force may be used if required to activate the anti-lock braking system.
Appendix 1

Symbols and definitions

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>E</td>
<td>wheelbase</td>
</tr>
<tr>
<td>$E_R$</td>
<td>distance between king-pin and centre of axle of semi-mounted towed vehicle (or distance between drawbar coupling and centre of axle or axles of centre-axle trailer)</td>
</tr>
<tr>
<td>$\varepsilon$</td>
<td>the adhesion utilised by the vehicle: quotient of the maximum braking rate with the anti-lock braking system operative ($z_{AL}$) and the coefficient of adhesion ($k$)</td>
</tr>
<tr>
<td>$\varepsilon_i$</td>
<td>the $\varepsilon$-value measured on axle $i$ (in the case of an agricultural vehicle with a category 3 anti-lock system)</td>
</tr>
<tr>
<td>$\varepsilon_H$</td>
<td>the $\varepsilon$-value on the high-friction surface</td>
</tr>
<tr>
<td>$\varepsilon_L$</td>
<td>the $\varepsilon$-value on the low-friction surface</td>
</tr>
<tr>
<td>F</td>
<td>force [N]</td>
</tr>
<tr>
<td>$F_{br}$</td>
<td>braking force of the trailer with the anti-lock braking system inoperative</td>
</tr>
<tr>
<td>$F_{brmax}$</td>
<td>maximum value of $F_{br}$</td>
</tr>
<tr>
<td>$F_{brmax,i}$</td>
<td>value of $F_{brmax}$ with only axle $i$ of the trailer braked</td>
</tr>
<tr>
<td>$F_{brAL}$</td>
<td>braking force of the trailer with the anti-lock braking system operative</td>
</tr>
<tr>
<td>$F_{Cnd}$</td>
<td>total normal reaction of road surface on the un-braked and non-driven axles of the vehicle combination under static conditions</td>
</tr>
<tr>
<td>$F_{Cd}$</td>
<td>total normal reaction of road surface on the un-braked and driven axles of the vehicle combination under static conditions</td>
</tr>
<tr>
<td>$F_{dyn}$</td>
<td>normal reaction of road under dynamic conditions with the anti-lock braking system operative</td>
</tr>
<tr>
<td>$F_{dyn,i}$</td>
<td>$F_{dyn}$ on axle $i$ in case of agricultural vehicles or full trailers</td>
</tr>
<tr>
<td>$F_{Cnd}$</td>
<td>normal reaction of road surface on axle $i$ under static conditions</td>
</tr>
<tr>
<td>$F_{M}$</td>
<td>total normal static reaction of road surface on all wheels of motor (towing) vehicle</td>
</tr>
<tr>
<td>$F_{Mnd}$</td>
<td>total normal static reaction of road surface on the un-braked and non-driven axles of the agricultural vehicle</td>
</tr>
<tr>
<td>$F_{Md}$</td>
<td>total normal static reaction of road surface on the un-braked and driven axles of the agricultural vehicle</td>
</tr>
<tr>
<td>$F_R$</td>
<td>total normal static reaction of road surface on all wheels of trailer</td>
</tr>
<tr>
<td>$F_{Rdyn}$</td>
<td>total normal dynamic reaction of road surface on the axle(s) of semi-mounted towed vehicle or centre-axle trailer</td>
</tr>
<tr>
<td>$F_{wM}$</td>
<td>$0,01 F_{Mnd} + 0,015 F_{Md}$</td>
</tr>
<tr>
<td>$g$</td>
<td>acceleration due to gravity (9,81 m/s²)</td>
</tr>
</tbody>
</table>

$^34$ $F_{Mnd}$ and $F_{Md}$: in case of two-axle agricultural vehicles: these symbols may be simplified to corresponding $F_i$ symbols.
<table>
<thead>
<tr>
<th>Symbol</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>h</td>
<td>height of centre of gravity specified by the manufacturer and agreed by the technical service conducting the approval test</td>
</tr>
<tr>
<td>hD</td>
<td>height of drawbar (hinge point on trailer)</td>
</tr>
<tr>
<td>hK</td>
<td>height of fifth wheel coupling (king pin)</td>
</tr>
<tr>
<td>hR</td>
<td>height of centre of gravity of the trailer</td>
</tr>
<tr>
<td>k</td>
<td>coefficient of adhesion between tyre and road</td>
</tr>
<tr>
<td>k_f</td>
<td>k-factor of one front axle</td>
</tr>
<tr>
<td>k_H</td>
<td>k-value determined on the high-friction surface</td>
</tr>
<tr>
<td>k_i</td>
<td>k-value determined on axle i for a vehicle with a category 3 anti-lock braking system</td>
</tr>
<tr>
<td>k_L</td>
<td>k-value determined on the low-friction surface</td>
</tr>
<tr>
<td>k_lock</td>
<td>value of adhesion for 100 % slip</td>
</tr>
<tr>
<td>k_M</td>
<td>k-factor of the agricultural vehicle</td>
</tr>
<tr>
<td>k_peak</td>
<td>maximum value of the curve ‘adhesion versus slip’</td>
</tr>
<tr>
<td>k_r</td>
<td>k-factor of one rear axle</td>
</tr>
<tr>
<td>k_R</td>
<td>k-factor of the trailer</td>
</tr>
<tr>
<td>P</td>
<td>mass of individual vehicle [kg]</td>
</tr>
<tr>
<td>R</td>
<td>ratio of $k_{\text{peak}}$ to $k_{\text{lock}}$</td>
</tr>
<tr>
<td>t</td>
<td>time interval [s]</td>
</tr>
<tr>
<td>$t_m$</td>
<td>mean value of t</td>
</tr>
<tr>
<td>$t_{\text{min}}$</td>
<td>minimum value of t</td>
</tr>
<tr>
<td>z</td>
<td>braking rate [m/s$^2$]</td>
</tr>
<tr>
<td>$z_{\text{AL}}$</td>
<td>braking rate z of the vehicle with the anti-lock braking system operative</td>
</tr>
<tr>
<td>$z_C$</td>
<td>braking rate z of the vehicle combination, with the trailer only braked and the anti-lock braking system inoperative</td>
</tr>
<tr>
<td>$z_{\text{CAL}}$</td>
<td>braking rate z of the vehicle combination, with the trailer only braked and the anti-lock braking system operative</td>
</tr>
<tr>
<td>$z_{\text{Cmax}}$</td>
<td>maximum value of $z_C$</td>
</tr>
<tr>
<td>$z_{\text{Cmax,i}}$</td>
<td>maximum value of $z_C$, with only axle i of the trailer braked</td>
</tr>
<tr>
<td>$z_{\text{m}}$</td>
<td>mean braking rate</td>
</tr>
<tr>
<td>$z_{\text{max}}$</td>
<td>maximum value of z</td>
</tr>
<tr>
<td>$z_{\text{MALS}}$</td>
<td>$z_{\text{AL}}$ of the agricultural vehicle on a ‘split surface’</td>
</tr>
<tr>
<td>$z_R$</td>
<td>braking rate z of the trailer with the anti-lock braking system inoperative</td>
</tr>
<tr>
<td>$z_{\text{RAL}}$</td>
<td>$z_{\text{AL}}$ of the trailer obtained by braking all the axles, the towing vehicle un-braked and its engine disconnected</td>
</tr>
<tr>
<td>$z_{\text{RAL,H}}$</td>
<td>$z_{\text{RAL}}$ on the surface with the high coefficient of adhesion</td>
</tr>
<tr>
<td>$z_{\text{RAL,L}}$</td>
<td>$z_{\text{RAL}}$ on the surface with the low coefficient of adhesion</td>
</tr>
<tr>
<td>$z_{\text{RAL,S}}$</td>
<td>$z_{\text{RAL}}$ on the split surface</td>
</tr>
<tr>
<td>Symbol</td>
<td>Description</td>
</tr>
<tr>
<td>--------</td>
<td>-------------</td>
</tr>
<tr>
<td>$Z_{RH}$</td>
<td>$z_R$ on the surface with the high coefficient of adhesion</td>
</tr>
<tr>
<td>$Z_{RL}$</td>
<td>$z_R$ on the surface with the low coefficient of adhesion</td>
</tr>
<tr>
<td>$Z_{RH_{\text{max}}}$</td>
<td>maximum value of $Z_{RH}$</td>
</tr>
<tr>
<td>$Z_{RL_{\text{max}}}$</td>
<td>maximum value of $Z_{RL}$</td>
</tr>
<tr>
<td>$Z_{R_{\text{max}}}$</td>
<td>maximum value of $Z_{R}$</td>
</tr>
</tbody>
</table>
Appendix 2

Utilisation of adhesion

1. METHOD OF MEASUREMENT FOR TRACTORS

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 only on one axle of the vehicle under test, at an initial speed of 50 km/h. The braking forces shall be distributed between the wheels of the axle to reach maximum performance. The anti-lock braking system shall be disconnected, or inoperative, between 40 km/h and 20 km/h.

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

$$z = \frac{0.566}{t}$$

$z_{\text{max}}$ is the maximum value of $z$ in m/s$^2$,

$t$ is in seconds.

1.1.3.1. Wheel-lock may occur below 20 km/h.

1.1.3.2. Starting from the minimum measured value of t, called $t_{\text{min}}$, then select three values of t comprised within $t_{\text{min}}$ and 1.05 $t_{\text{min}}$ and calculate their arithmetical mean value $t_m$, then calculate

$$z_m = \frac{0.566}{t_m}$$

If it is demonstrated that for practical reasons the three values determined above cannot be obtained, then the minimum time $t_{\text{min}}$ may be utilised. However, the requirements of point 1.3 still apply.

1.1.4. The braking forces shall be calculated from the measured braking rate and the rolling resistance of the un-braked 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 calculated from the braking rate, static axle load, wheelbase and centre of gravity height.

1.1.6. The value of k shall be rounded to three decimal places.
1.1.7. Then, the test will be repeated for the other axles(s) as defined in points 1.1.1 to 1.1.6 above (for exemptions, see points 1.4 and 1.5 below).

1.1.8. For example, in the case of a two-axle rear-wheel drive vehicle, with the front axle being braked, the coefficient of adhesion \((k)\) is given by:

\[
k_f = \frac{z_m \times P \times g - 0.015F_z}{F_1 + \frac{h}{E} z_m \times P \times g}
\]

1.1.9. One coefficient will be determined for the front axle \(k_f\) and one for the rear axle \(k_r\).

1.2. Determination of the adhesion utilised (\(\varepsilon\))

1.2.1. The adhesion utilised \((\varepsilon)\) is defined as the quotient of the maximum braking rate with the anti-lock braking system operative \((Z_{AL})\) and the coefficient of adhesion \(K_M\), i.e.,

\[
\varepsilon = \frac{Z_{AL}}{K_M}
\]

1.2.2. From an initial vehicle speed of 55 km/h, or \(v_{max}\) whichever is lower, the maximum value for the braking rate \((Z_{AL})\) shall be measured with the anti-lock braking system operative. This value for \(Z_{AL}\) shall be based on the average value of three tests, as previously described in point 1.1.3 of this Appendix, using the time taken for the speed to reduce from 45 km/h to 15 km/h, according to the following formula:

\[
Z_{AL} = \frac{0.849}{t_m}
\]

1.2.3. The coefficient of adhesion \(K_M\) shall be determined by weighting with the dynamic axle loads:

\[
k_M = k_f \times F_{f_{dyn}} + k_r \times F_{r_{dyn}}
\]

Where:

\[
F_{f_{dyn}} = F_f + \frac{h}{E} \times z_{AL} \times P \times g
\]

\[
F_{r_{dyn}} = F_r - \frac{h}{E} \times z_{AL} \times P \times g
\]

1.2.4. The value of \(\varepsilon\) shall be rounded to two decimal places.

---

\(^{35}\) Anti-lock braking systems with 'select-high' control are deemed to include both directly and indirectly controlled wheels; in systems with 'select-low' control, all sensed wheels are deemed to be directly controlled wheels.
1.2.5. In the case of a vehicle equipped with an anti-lock braking system of category 1 or 2, the value of $z_{AL}$ is based on the whole vehicle, with the anti-lock braking system in operation, and the adhesion utilised ($\varepsilon$) shall be given by the same formula quoted in point 1.2.1 above.

1.2.6. In the case of a vehicle equipped with an anti-lock braking system of category 3, the value of $Z_{AL}$ shall be measured on each axle which has at least one directly controlled wheel.

Example: for a two-axle vehicle with an anti-lock braking system acting only on the rear axle (2), the adhesion utilised ($\varepsilon$) is given by:

$$\varepsilon_2 = \frac{z_{AL} \times P \times g - 0.010 \times F_1}{k_2 \left( F_2 - \frac{h}{E} z_{AL} \times P \times g \right)}$$

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

1.3. If $\varepsilon > 1.00$, the measurements of coefficients of adhesion shall be repeated. A tolerance of 10 % is acceptable.

1.4. For vehicles equipped with three axles, only the axle not associated with a close-coupled bogie shall be used to establish a $k$ value for the vehicle.

1.5. For vehicles with a wheel base less than 3.80 m and with $h/E > 0.25$, the determination of the coefficient of adhesion for the rear axle shall be omitted.

1.5.1. In that case, the adhesion utilised ($\varepsilon$) is defined as the quotient of the maximum braking rate with the anti-lock braking system operative ($z_{AL}$) and the coefficient of adhesion ($k_f$), i.e.

$$\varepsilon = \frac{Z_{AL}}{k_f}$$

2. METHOD OF MEASUREMENT FOR TRAILERS

2.1. General

2.1.1. 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.

2.1.2. The brakes shall be applied on only one axle of the trailer under test, at an initial speed of 50 km/h. The braking forces shall be distributed between the wheels of the axle to reach maximum performance. The anti-lock braking system shall be disconnected or inoperative between 40 km/h and 20 km/h.

---

36 Until a uniform test procedure is agreed, vehicles with more than three axles and special vehicles will be subject to consultation with the technical service.
2.1.3. A number of tests at increments of line pressure shall be carried out to determine the maximum braking rate of the vehicle combination \( z_{C_{\text{max}}} \) with the trailer only braked. During each test, a constant input force shall be maintained and the braking rate shall 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:

\[
z_c = \frac{0.566}{t}
\]

2.1.3.1. Wheel-lock may occur below 20 km/h.

2.1.3.2. Starting from the minimum measured value of \( t \), called \( t_{\text{min}} \), then select three values of \( t \) comprised within \( t_{\text{min}} \) and 1.05 \( t_{\text{min}} \) and calculate their arithmetical mean value \( t_m \), then calculate:

\[
z_{c_{\text{max}}} = \frac{0.566}{t_m}
\]

If it is demonstrated that for practical reasons the three values determined above cannot be obtained, then the minimum time \( t_{\text{min}} \) may be utilised.

2.1.4. The adhesion utilised \( (\varepsilon) \) shall be calculated by means of the formula:

\[
\varepsilon = \frac{Z_{AL}}{k_R}
\]

The \( k \) value shall be determined according to point 2.2.3 for full trailers or point 2.3.1 for semi-mounted towed vehicles, respectively.

2.1.5. If \( \varepsilon > 1.00 \) the measurements of coefficients of adhesion shall be repeated. A tolerance of 10% is accepted.

2.1.6. The maximum braking rate \( (z_{R_{AL}}) \) shall be measured with the antilock braking system operative and the towing vehicle unbraked, based on the average value of three tests, as in point 2.1.3 of this Appendix.

2.2. Full trailers

2.2.1. The measurement of \( k \) (with the anti-lock braking system being disconnected, or inoperative, between 40 km/h and 20 km/h) shall be performed for the front and rear axles.

For one front axle \( i \):

\[
F_{b_{\text{max},i}} = z_{c_{\text{max}}}(F_M + F_R) - 0.01F_{\text{end}} - 0.015F_{\text{ed}}
\]

\[
F_{i_{\text{dyn}}} = F_i + \frac{z_{c_{\text{max}}}(F_M \times h_D + g \times P \times h_R) - F_{wH} \times h_D}{E}
\]
\[ k_r = \frac{F_{br\text{ max}_i}}{F_{dyn}} \]

For one rear axle \( i \):

\[ F_{br\text{ max}_i} = z_{c\text{ max}_i}(F_M + F_R) - 0.01F_{\text{cond}} - 0.015F_{cd} \]

\[ F_{dyn} = F_i - z_{c\text{ max}}(F_M \times h_D + g \times P \times h_R) - F_{wM} \times h_D - \frac{E}{F_R} \]

\[ k_r = \frac{F_{br\text{ max}_i}}{F_{dyn}} \]

2.2.2. The values of \( k_f \) and \( k_r \) shall be rounded to three decimal places.

2.2.3. The coefficient of adhesion \( k_R \) shall be determined proportionally according to the dynamic axle loads.

\[ k_R = \frac{k_f \times F_{dyn} + k_r \times F_{rdyn}}{P \times g} \]

2.2.4. Measurement of \( z_{RA} \) (with the anti-lock braking system operative)

\[ z_{RA} = \frac{z_{CAL} \times (F_M + F_R) - 0.01F_{\text{cond}} - 0.015F_{cd}}{F_R} \]

\( z_{RA} \) shall be determined on a surface with a high coefficient of adhesion and, for vehicles with a category A anti-lock braking system, also on a surface with a low coefficient of adhesion.

2.3. Semi-mounted towed vehicles and centre-axle trailers

2.3.1. The measurement of \( k \) (with the anti-lock braking system being disconnected, or inoperative, between 40 km/h and 20 km/h) shall be carried out with wheels fitted only on one axle, the wheels of the other axle(s) are removed.

\[ F_{br\text{ max}_i} = z_{c\text{ max}_i}(F_M + F_R) - F_{wM} \]

\[ F_{rdyn} = F_R - \frac{F_{br\text{ max}_i} \times h_k + z_c \times g \times P \times (h_R - h_k)}{E_R} \]

\[ k = \frac{F_{br\text{ max}_i}}{F_{rdyn}} \]

2.3.2. The measurement of \( z_{RA} \) (with the anti-lock braking system operative) shall be carried out with all wheels fitted.

\[ F_{br\text{ a}LA} = z_{CAL} \times (F_M + F_R) - F_{wM} \]
\[ F_{rdyn} = F_R - \frac{F_{brAL} \times h_k + z_c \times g \times P \times (h_R - h_k)}{E_R} \]

\[ z_{RAL} = \frac{F_{brAL}}{F_{rdyn}} \]

\( z_{RAL} \) shall be determined on a surface with a high coefficient of adhesion and, for vehicles with a category A anti-lock braking system, also on a surface with a low coefficient of adhesion.
Appendix 3

Performance on differing adhesion surfaces

1. TRACTORS

1.1. The prescribed braking rate referred to in point 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 shall satisfy the conditions prescribed in point 5.3.4 of this Annex.

1.2. The coefficient of adhesion \((k_H \text{ and } k_L)\) of the high- and low adhesion surfaces, respectively, shall be determined in accordance with the provisions in point 1.1 of Appendix 2 to this Annex.

1.3. The braking rate \((z_{MALS})\) for laden agricultural vehicles shall be:

\[
Z_{MALS} \geq 0,75 \frac{4k_L + k_H}{5} \quad \text{and} \quad Z_{MALS} \geq k_L
\]

2. TRAILERS

2.1. The braking rate referred to in point 6.3.2 of this Annex may be calculated by reference to the measured braking rates \(z_{RALH}\) and \(z_{RALL}\) on the two surfaces on which the tests are carried out with the anti-lock braking system operative. These two surfaces shall satisfy the conditions prescribed in point 6.3.2 of this Annex.

2.2. The braking rate \(z_{RALS}\) shall be:

\[
z_{RALS} \geq 0,75 \times \frac{4z_{RALL} + z_{RALH}}{\varepsilon_H} \quad \text{and}
\]

\[
z_{RALS} \geq \frac{z_{RALL}}{\varepsilon_H}
\]

If \(\varepsilon_H > 0,95\) use \(\varepsilon_H = 0,95\).
Appendix 4

Method of selection of the low-adhesion surface

1. Details of the coefficient of adhesion of the surface selected, as determined in point 5.1.1.2 of this Annex, shall be given to the technical service.

1.1. These data shall include a curve of the coefficient of adhesion versus slip (from 0 % to 100 % slip) for a speed of approximately 40 km/h 37.

1.1.1. The maximum value of the curve will represent \( k_{\text{peak}} \) and the value at 100 % slip will represent \( k_{\text{lock}} \).

1.1.2. The ratio \( R \) shall be determined as the quotient of the \( k_{\text{peak}} \) and \( k_{\text{lock}} \).

\[
R = \frac{k_{\text{peak}}}{k_{\text{lock}}}
\]

1.1.3. The value of \( R \) shall be rounded to one decimal place.

1.1.4. The surface to be used shall have a ratio \( R \) between 1,0 and 2,0 38.

2. Prior to the tests, the technical service shall ensure that the selected surface meets the specified requirements and shall be informed of the following:

— test method to determine \( R \),
— type of vehicle (agricultural vehicle, trailer, etc.),
— axle load and tyres (different loads and different tyres have to be tested and the results shown to the technical service which will decide if they are representative for the vehicle to be approved).

2.1. The value of \( R \) shall be mentioned in the test report.

The calibration of the surface has to be carried out at least once a year with a representative vehicle to verify the stability of \( R \).

---

37 Until a uniform test procedure is established for the determination of the adhesion curve for vehicles with a maximum mass exceeding 3,5 tonnes, the curve established for passenger cars may be used. In this case, for vehicles with a maximum mass exceeding 3,5 tonnes, the ratio \( k_{\text{peak}} \) to \( k_{\text{lock}} \) shall be established using a value of \( k_{\text{peak}} \) as defined in Appendix 2 of this Annex. With the consent of the technical service, the coefficient of adhesion described in this item may be determined by another method provided that the equivalence of the values of \( k_{\text{peak}} \) and \( k_{\text{lock}} \) are demonstrated.

38 Until such test surfaces become generally available, a ratio \( R \) up to 2,5 is acceptable, subject to discussion with the technical service.