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Item 3 of the provisional agenda

Regulations Nos. 13 and 13-H (Braking)**Proposal for amendments to Regulation No. 13 (Heavy vehicle braking) and 13-H (Brakes of M₁ and N₁ vehicles)****Submitted by the expert from Germany***

The text reproduced below was prepared by the expert from Germany to introduce a new Annex 23 into UN Regulation No.13 covering special additional requirements for trailers of category O₂ without pneumatic connections and equipped with service braking systems with pneumatic energy storage devices. In consequence of these new braking systems it is necessary to also amend some other braking requirements for trailers and motor vehicles in Regulations Nos. 13 and 13-H respectively. The modifications to the existing text of these two Regulations are marked in bold for new or strikethrough for deleted characters.

* In accordance with the programme of work of the Inland Transport Committee for 2010–2014 (ECE/TRANS/208, para. 106 and ECE/TRANS/2010/8, programme activity 02.4), the World Forum will develop, harmonize and update Regulations in order to enhance the performance of vehicles. The present document is submitted in conformity with that mandate.

I. Proposal for a Supplement to the 11 series of amendments to Regulation No. 13

Paragraph 5.2.1.19., amend to read:

"5.2.1.19. In the case of a power-driven vehicle equipped to draw a trailer with a ~~an electrical~~ braking system, according to ~~paragraph 1.1. of Annex 14~~ **Annexes 14 or 23** to this Regulation, the following requirements shall be met:

Paragraph 5.2.1.19.1., amend to read:

"5.2.1.19.1. The power supply (generator and battery) of the power-driven vehicle shall have a sufficient capacity to provide the current for ~~an electrical~~ **the trailer** braking system. **At the time of type approval, it shall be checked that,** ~~With the engine running at the idling speed recommended by the manufacturer and the all electrical devices required during normal vehicle use supplied by the manufacturer as standard equipment of the vehicle~~ switched on, the voltage in the electrical **energy supply line lines for the electrical braking system of the trailer** shall at maximum current consumption of the electrical braking system (15 A) not fall below the value of **11.1** ~~9.6~~ V measured at the connection. The electrical lines shall not be capable of short circuiting even when overloaded;"

Paragraph 5.2.1.19.2., amend to read:

"5.2.1.19.2. ~~In the event of a failure in the towing vehicle's service braking system, where that system consists of at least two independent parts, the part or parts not affected by the failure should be capable of partially or fully actuating the brakes of the trailers;~~

Deviating from paragraph 5.2.1.19.1., for vehicles intended to tow trailers with a braking system complying with the provisions of Annex 23, the electrical supply line may be temporarily automatically switched off."

Paragraph 5.2.1.19.3., amend to read:

"5.2.1.19.3. The use of the stop-lamp switch and circuit for actuating the ~~electrical~~ braking system **according to Annex 14 or Annex 23** is permissible only if the actuating line is connected in parallel with the stop-lamp and the existing stop-lamp switch and circuit are capable of taking the extra load."

Paragraph 5.2.2.2., amend to read:

"5.2.2.2. Trailers of category O₂ shall be equipped with a service braking system either of the continuous or semi-continuous or of the inertia (overrun) type. The latter type shall be permitted only for centre axle trailers. However, electrical braking systems conforming to the requirements of Annex 14 **and braking systems conforming to the requirements of Annex 23** to this Regulation shall be permitted."

Add new paragraph 5.2.2.24., to read:

- 5.2.2.24. For trailers of category O₂ equipped with an anti-lock system/functions as defined in paragraph 3.2. of Annex 13 to this Regulation the following requirements shall apply:**
- 5.2.2.24.1. At least the requirements of a Category B anti-lock system shall be met.**
- 5.2.2.24.2. For demonstrating the fulfilment of the requirements of paragraph 5.2.2.24.1. a "trailer anti-lock braking system test report" according to Annex 19 - Appendix 6 to this Regulation of the installed anti-lock system/functions may be used which covers the braking configuration (e.g. with regard to the installed disc or drum brake type and number and location of brake actuator and sensed wheels) fitted to the subject trailer.**
- 5.2.2.24.3. In contrast to the requirements of paragraph 5.2.2.17.2. of this Regulation (applicable to trailers of categories O₃ and O₄) the following requirements apply:**
- 5.2.2.24.3.1. if the ISO 7638:2003 power supply is the only available primary power source for the braking system then the requirements of paragraph 5.2.2.17. (including its subparagraph) apply;**
- 5.2.2.24.3.2. in the case that the primary power supply for the anti-lock system/functions may be also available from another electrical connector than the ISO 7638:2003 connector then the following paragraphs 5.2.2.24.3.3. to 5.2.2.24.6. apply;**
- 5.2.2.24.3.3. a failure warning device is required on the trailer for the purposes of providing a warning in the event of failures within the electric control transmission that affects the functional and performance requirements of the anti-lock system/function.**
- 5.2.2.24.4. In the event of failures within the electric control transmission that affect the functional and performance requirements of the anti-lock system/function it is required that:**
- 5.2.2.24.5. these failures shall be signalled to the driver by a specific optical warning device mounted on the trailer at a position in the indirect drivers field of vision.**
- 5.2.2.24.6. When a power supply is used other than via the ISO 7638:2003 electrical connector it shall be possible to verify the operation of the braking system from this power source. This may be done for instance by a short flashing signal after first initialisation of the system or by other means."**

Annex 2

Paragraph 14.9., amend to read:

- "14.9. ~~Vehicle is/is not² equipped to tow a trailer with electrical braking systems~~
Compliance with paragraph 5.2.1.19. of this Regulation**
- 14.9.1. Vehicle is/is not² equipped to tow a trailer with an electrical braking system according to Annex 14.**
- 14.9.2. Vehicle is/is not² equipped to tow a trailer with a compressed-air braking system according to Annex 23."**

Paragraph 14.10., amend to read (addition of the footnote):

"14.10. Vehicle is/is not² equipped with an anti-lock system⁸"

Add new paragraph 17., to read:

- 17. Additional information in the case of trailers of category O₂ equipped with a compressed-air braking system according to Annex 23**
- 17.1. Test results (compatibility band) according to Annex 14 and its Appendix**
- 17.2. Where an Annex 11 (Appendix 3) or Annex 12 (Appendix 3) test report has been utilised, the test report number and the date shall be stated:**
- 17.3. Vehicle is/is not² equipped with an anti-lock system**
Where an Annex 19 anti-lock test report has been utilized, the test report number(s) shall be stated:
- 17.4. Description of the device generating the control pressure according to paragraph 4. of Annex 23**
- 17.5. Data of compressor**
 - **Minimum performance..... W**
 - **Maximum performance W**
 - **Max. cut-out pressure kPa**
 - **Max. cut-in pressure kPa"**

Paragraphs 17. to 26. (former), renumber as paragraphs 18. to 27.

Annex 14

Paragraph 2.5., amend to read:

"2.5. The ~~relay control device~~ **control device** for actuating the ~~braking system~~ **service braking system** ~~braking current in accordance with paragraph 5.2.1.19.2. of this Regulation, which is connected to the actuating line,~~ shall be situated on the trailer."

⁸ In the case trailers of category O₂ according to Annex 23 see paragraph 17.3.

Add a new Annex 23, to read:

"Annex 23

Special additional requirements for trailers of category O₂ without pneumatic connections and equipped with service braking systems with pneumatic energy storage devices

1. Symbols and definitions
 - 1.1. G_A: trailer's technically permissible "maximum mass" as declared by the manufacturer
 - 1.2. "Control pressure" means the input pressure within the pneumatic braking system which regulates the braking force.
 - 1.3. "Control line" means the line where the 'control pressure' is effective.
 - 1.4. "State of energy level" of the trailer battery means the operating condition as declared by the manufacturer for defining the warning level according to paragraph 3.5.6.
 - 1.5. "Backup braking" means braking with the service braking system without the presence of the stop lamp signal (see paragraph 3.3.).
2. Scope

Trailers of category O₂ without pneumatic connections where the electric energy supplied by the towing vehicle is converted into pneumatic energy and stored into pneumatic storage devices providing the energy to actuate the brakes shall comply with the special additional requirements of this Annex.
3. General
 - 3.1. For trailers where the control pressure is generated from the travel of a mechanical control device, the requirements of this Annex apply instead of those of Annex 12.
 - 3.2. With regard to the energy source and energy storage devices the requirements of paragraph 8. of this annex apply instead of the requirements of Annex 7, Part A to this Regulation.
 - 3.3. The actuation of the service braking system shall be ensured when the braking signal is generated to illuminate the stop lamps.
 - 3.4. When the braking signal to illuminate the stop lamps is not generated, no application of the service braking system shall occur when the trailer is reversed.
 - 3.5. Electrical power supply
 - 3.5.1. The maximum current consumption measured in the electrical energy supply line between the towing vehicle and the trailer shall not exceed 15 A, the nominal operating voltage shall be 12 V.
 - 3.5.2. The terminals of the two cables providing the electrical energy supply shall have a nominal cross-sectional area of at least 2.5 mm².
 - 3.5.3. The socket shall have a cover which closes automatically when the plug is disconnected.

- 3.5.4. The connector for the electrical connection to the motor vehicle shall fulfil the relevant requirements of paragraph "5. Tests and requirements" of ISO 4091:2003.
- 3.5.5. The trailer shall be equipped with a battery having a sufficient capacity to provide the current for the correct functioning of the braking system when all electrical devices (compressor, lights, etc.) supplied by the manufacturer as standard equipment of the vehicle are switched on. It is required to indicate the battery (voltage) charge condition on the trailer.
- 3.5.6. [Before the state of energy level of the trailer battery falls below a level at which the prescribed number of service brake applications as defined in paragraph 8.3. are no longer be ensured a warning signal, visible even by daylight, shall illuminate. The satisfactory condition of the signal shall be easily verifiable by the driver when the trailer is at standstill.]
- 3.6. **Wear adjustment**
 In contrast to the requirement of paragraph 5.2.2.8.1. of this Regulation, for trailers of category O₂ coming under the scope of this annex, wear adjustment shall be automatic for the service brakes. Brakes equipped with automatic brake adjustment devices shall, after heating followed by cooling, be capable of free running as defined in paragraph 1.7.3. of Annex 4 following the Type-I or Type-III test also defined in that annex as appropriate.
- 3.7. Instead of the provisions for the periodical technical inspection of Section 5.1.4. of this Regulation the following requirements apply:
- 3.7.1. paragraphs 5.1.4.1. to 5.1.4.3. and 5.1.4.6. of this Regulation;
- 3.7.2. the service braking system shall be equipped with an air pressure test connection which can be used to simulate a control pressure (as defined in paragraph 1.2.) to generate maximum braking forces under static conditions on a rolling road or roller brake tester.
- 3.7.3. **Data for the braking system**
 In addition to the data required by paragraph 5.1.4.5.2. of the Regulation, the following data, if applicable, is required:
- 3.7.3.1. Max. cut-out pressure of compressor =kPa
- 3.7.3.2. Min. cut-in pressure of compressor =kPa
- 3.7.3.3. Adjustment setting of pressure limiting devices (if fitted)
- 3.7.3.4. Markings according to paragraph 7 of Annex 10 (as appropriate)
- 3.8. **Backup braking**
 When the trailer is decelerated by a braking ratio above $[z = 0,2]$, the trailer braking system shall recognise whether the stop lamp signal (see paragraph 3.3.) has been activated and shall, irrespective whether this signal is present or not, produce braking forces which are in compliance with the compatibility band according to Appendix of Annex 14.
 The backup braking shall be indicated to the driver by the warning signal as specified in paragraph 3.5.6. The warning signal shall illuminate until one of the following conditions occurs:
- the stop lamp signal is transmitted to the trailer braking system

- the trailer is electrically disconnected to the towing vehicle
- 4. Control pressure
- 4.1. The vehicle manufacturer shall supply to the Technical Service the information showing the relationship of the input parameter (e.g. travel of a mechanical control device, coupling force, deceleration of the trailer) to the pneumatic control pressure (as defined in paragraph 1.2.).
- 5. Braking tests and braking performance

Instead of the braking performance requirements of paragraphs 3.1., 3.3. and 4. of Annex 4 to this Regulation, the requirements of this section shall apply. However, with regard to the parking braking system, the requirements of paragraph 3.2. of Annex 4 to this Regulation apply.
- 5.1. Cold performance and compatibility between towing vehicle and trailer
- 5.1.1. The performance of the braking system shall comply with the requirements as laid down in paragraphs 3.1. to 3.5. of Annex 14 (including its Appendix) to this Regulation. The compatibility requirements according to Annex 10 (Diagram 2) to this Regulation shall not apply.
- 5.2. Type-I test (fade test)

For the braking system the requirements of paragraphs 1.5.2. and 1.5.3. of Annex 4 to this Regulation shall be fulfilled. Compliance of these requirements shall be either shown by the Type-I test according to Annex 4 to this Regulation, paragraph 1.5. or the alternative procedure for the Type-I test in accordance with the provisions laid down in Annex 11, Appendix 2, paragraph 3.5.2. (e.g. by test reports according to Annex 11, Appendix 3 or Annex 12, Appendix 3).
- 6. Validation of the development of braking force

Instead of the requirements of Annex 10 to this Regulation, paragraph 1.3. the following requirements shall be satisfied.
- 6.1. At the time of type approval it shall be checked that the development of braking on an axle in the laden and unladen condition shall be within the control pressure range 20 to 180 kPa.
- 6.2. With the wheel(s) of the axle(s) raised off the ground and free to rotate, apply an increasing brake demand and measure the control pressure corresponding to when the wheel(s) can no longer be rotated by hand. This condition is defined as the development of the braking force.
- 7. Response time

The response time shall be determined according to Annex 6 to this Regulation with the following differing testing requirements.
- 7.1. The coupling head of the supply line of the simulator (Annex 6, Appendix) shall be joined with a line connected to the line feeding the air reservoir of the service braking system. The initial pressure in the supply line of the simulator (Annex 6, Appendix) shall be 650 kPa.
- 7.2. The coupling head of the control line of the simulator (Annex 6, Appendix) shall be joined with a line connected to the control line of the braking system producing the control pressure according to paragraph 1.2.

- 7.3. During the response time measurement, the air reservoir(s) shall not be fed by the compressor.
- 7.4. The test shall be carried out under worst case conditions (e.g. it shall be ensured that maximum braking forces are generated; compare also paragraph 1.1. of Annex 6 to this Regulation).
- 8. Provisions relating to energy sources and energy storage devices (energy reservoirs)
 - 8.1. Energy storage devices (energy reservoirs)
 - 8.1.1. The energy storage devices (energy reservoirs) with which trailers are equipped shall be such that, after eight full-stroke actuations of the towing vehicle's service braking system, the energy level supplied to the operating members using the energy, 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 trailer.
 - 8.1.2. Testing shall be performed in conformity with the following requirements:
 - 8.1.2.1. The pressure in the energy storage devices at the beginning of the test shall be 850 kPa.
 - 8.1.2.2. The energy storage devices shall not be replenished during the test; in addition, any energy storage device(s) for auxiliary equipment shall be isolated;
 - 8.1.2.3. The test shall be carried out under worst case conditions (e.g. in the case of vehicles equipped with load sensing valves, these devices shall be set in the "laden" position).
 - 8.1.2.4. At each brake application, the maximum available control pressure shall be simulated.
 - 8.1.3. If the pressure in the energy storage devices falls under a level of [50] per cent of the air reservoir pressure where prescribed service braking performance is ensured, the trailer shall automatically apply the brakes or remain braked.
 - 8.1.4. Pressure gauge

In order for the driver to be able to check the actual pressure level in the air reservoir, a pressure gauge shall be mounted on the trailer in a position visible by a person standing on the ground.
 - 8.2. Capacity of energy sources (compressors)
 - 8.2.1. General

The compressors shall meet the requirements set forth in the following paragraphs.
 - 8.2.2. Definitions
 - 8.2.2.1. "p₁" = 423 kPa (the pressure corresponding to 65 per cent of the pressure p₂ defined in paragraph 8.2.2.2. below).
 - 8.2.2.2. "p₂" = 650 kPa; this is the energy level in the energy storage device(s) which shall enable the prescribed performance of the service braking system to be achieved

- 8.2.2.3. "t₁" is the time required for the relative pressure to rise from 0 to p₁, and "t₂" is the time required for the relative pressure to rise from 0 to p₂.
- 8.2.3. Conditions of measurement and test results
- 8.2.3.1. During the tests to determine the time t₁ and the time t₂, the energy storage device(s) for auxiliary equipment shall be isolated.
- 8.2.3.2. The time t₁ recorded for the least-favoured energy storage device shall not exceed three minutes.
- 8.2.3.3. The time t₂ recorded for the least-favoured energy storage device shall not exceed six minutes.
- 8.3. Braking capability in case of loss of electric energy supply by the towing vehicle
- 8.3.1. After the warning signal as specified in paragraph 3.5.6. has been activated, the energy of the battery shall still be sufficient to attain [30] service brake applications where the energy level in the pneumatic storage device(s) ensures that the prescribed service braking performance for the trailer in the laden condition is achieved.
- 8.3.2. Compliance with the above requirement shall be checked by the procedure specified below:
- 8.3.2.1. The trailer is either in the laden condition or in a condition where the axle loads are simulated for the laden condition.
- 8.3.2.2. The battery of the trailer is discharged to an energy level where the warning signal according to paragraph 3.5.6. is illuminated.
- 8.3.2.3. The initial pressure in the pneumatic energy storage devices before carrying out the following service brake applications shall be adjusted to the cut-in pressure of the compressor.
- 8.3.2.4. [30] full service brake applications with the maximum possible control pressure which can be simulated by the available air reservoir pressure.
- 8.3.2.5. During these brake applications the pressure in the energy storage devices shall not fall under a level at which the prescribed service braking performance for the trailer in the laden condition is guaranteed."

II. Proposal for a Supplement to the 00 series of amendments to Regulation No. 13-H

Paragraph 5.2.1.17., amend to read:

"5.2.17. In the case of a motor vehicle equipped to tow a trailer with ~~electric service brakes~~ **a service braking system supplied with electric energy by the motor vehicle**, the following requirements shall be met:"

Paragraph 5.2.1.17.1., amend to read:

"5.2.17.1. The power supply (generator and battery) of the motor vehicle shall have a sufficient capacity to provide the current for ~~the trailer an electric~~ **the trailer** braking system. With the engine running at the idling speed recommended by the manufacturer and all electrical devices supplied by the manufacturer as standard equipment of the vehicle switched on, the voltage in the electrical ~~energy supply line lines~~ **energy supply line** ~~lines~~ **for the electrical braking system of the trailer** shall at maximum current consumption of the electrical braking system (15 A) not fall below the value of ~~11.1~~ **9.6** V measured at the connection. The electrical lines shall not be capable of short circuiting even when overloaded ..."

Paragraph 5.2.17.2., amend to read:

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

Deviating from paragraph 5.2.17.1., for vehicles intended to tow trailers with a braking system complying with the provisions of Annex 23 of UN Regulation No. 13, the electrical supply line may be temporarily automatically switched off."

Paragraph 5.2.17.3., amend to read:

"5.2.17.3. ~~the use of the stop-lamp switch and circuit for actuating the electrical braking system~~ **a service braking system supplied with electric energy by the motor vehicle**, is permissible only if the actuating line is connected in parallel with the stop-lamp and the existing stop-lamp switch and circuit are capable of taking the extra load."

Annex 1,

Paragraph 18., amend to read:

- "18. ~~Vehicle is/is not² equipped to tow a trailer with electrical braking systems~~
Compliance with paragraph 5.2.1.19. of the Regulation
- 18.1 Vehicle is/is not² equipped to tow a trailer with an electrical braking system according to Annex 14 of UN Regulation No. 13.
- 18.2 Vehicle is/is not² equipped to tow a trailer with a compressed-air braking system according to Annex 23 of UN Regulation No. 13."

III. Justification

A. General - Trailers covered by the proposal

1. The main difference of trailers equipped with conventional compressed-air braking systems and trailers covered by this Annex is that the pneumatic braking system is not controlled by the pressure " p_m " but by a **pneumatic control pressure** (see paragraphs 1.2. and 4.1. of Annex 23) which may be generated by the trailer either by the **travel** of the inertia braking system control device or the **coupling force** between the motor vehicle and the trailer or by the **deceleration** of the trailer itself.

Note: With conventional compressed-air braking systems the **control pressure** (p_m) is just **before** the headboard and with Annex 23 trailers the **control pressure** is just **behind** the headboard! This is **principally the main difference** (apart from the supply pressure provided by the trailer compressor) when comparing a conventional compressed-air braking system of category O₂ trailer with an Annex 23 compressed-air braking system of category O₂ trailers.

2. Thus, an Annex 23 braking systems may feature all the components of compressed-air braking systems fitted to O₃ and O₄ trailers (e.g. ABS, park/shunt valve with integrated emergency function, load sensing and pressure regulating devices, etc.).

B. Regulations Nos. 13 and 13-H

Paragraph 5.2.1.19. of Regulation No. 13 and para.5.2.1.17. of Regulation No. 13-H:

3. This amendment takes into account the newly proposed Annex 23 where also electrical current is needed for the operation of the braking system.

Para. 5.2.1.19.1. of Regulation No. 13 and para. 5.2.1.17.1. of Regulation No. 13-H:

4. The reference to "**electrical**" braking system has been removed in order to also include pneumatic braking system according to Annex 23 where also current is needed.

5. To replace the "9.6 V" requirement by the "11.1 V" requirement is proposed to align with the current proposal by the GRRF Annex 14 informal ad hoc Group (see Informal document GRRF-79-24) which argues that the currently specified 9.6 V measured at the connection is unrealistic low and not necessary. Following this proposal, further amendments with regard to the clarification of the energy supply lines and the testing conditions ("electrical devices required during normal vehicle use") have been made (see also Justification in Informal document GRRF-79-24).

Current para. 5.2.1.19.2. of Regulation No. 13 and current para. 5.2.17.2. of Reg. No. 13-H

6. The control of the braking systems according to Annex 14 and Annex 23 depends on the **actual deceleration** of the motor vehicle **independent** whether such a deceleration is caused by a failed or non-failed towing vehicle's service braking system.

7. The wording of paragraph 5.2.1.19.2. in Regulation No. 13 (and 5.2.17.2. in Regulation No. 13-H respectively) is identical with that of paragraph 5.2.1.18.2. of Regulation No. 13 for compressed-air braking systems and therefore comparable.

8. In the case of pneumatic braking systems, on application of the service braking system a full or partial control pressure is transmitted via the trailer brake control valve (ports 41/42) to the trailer according to the control of the non-failed pneumatic service brake circuit.

9. Such analogous electrical control signal - transmitted by the "**parts not affected by the failure**" to the trailer - is not existing.

10. Thus, this requirement seems to be inappropriate for motor vehicle authorized to tow trailers having no comparable connecting lines as trailers of categories O3 or O4 (see paragraph R13/5.2.1.18.2.) and should be deleted.

11. In consequence of this, paragraph 2.5. of Annex 14 of UN Regulation No. 13 has been amended accordingly.

Proposed para. 5.2.1.19.2. (R13) and new proposed para. 5.2.17.2. (R13-H)

12. Trailer service braking systems according to R13/Annex 23 continue to function even when the electrical supply line is temporarily automatically switched off by the towing vehicle; compare also paragraphs 3.5.6. and 8.3. of R13/Annex 23.

Paragraph 5.2.1.19.3. (R13) and new proposed para. 5.2.17.3. (R13-H)

13. The wording "according to Annex 14 or Annex 23" (and "a service braking system supplied with electric energy by the motor vehicle" respectively) is added to make clear that this requirement refers not only to an "electrical" braking system according to R13/Annex 14 but also to a trailer braking system according to an R13/Annex 23 with pneumatic energy storage devices which may use a very low current during braking from the stop-lamp circuit (e.g. 1.4 A).

C. Regulation No. 13

Paragraph 5.2.2.2.

14. The braking system type and service braking performance of an Annex 23 trailer is similar to a trailer of a category O2 with a semi-continuous type compressed-air braking system.

15. This amendment (like the existing clarification in paragraph 5.2.2.2. of this Regulation with regard to an Annex 14 braking system) makes it clear that all O2 trailers are permitted to be equipped with a braking system when they are conform to the proposed requirements of Annex 23.

16. Since an Annex 23 trailer may also have a mechanical control device (see paragraph 1.2.) as an inertia (overrun) braking system, some observations are made with regard to the discussions which lead to the prohibition of inertia (overrun) braking systems for full trailers.

17. Paragraph 5.2.2.2. addresses trailers of category O2 (with a maximum mass exceeding 0.75 tonnes, but not exceeding 3.5 tonnes).

18. Whereas inertia (overrun) braking systems according to Annex 12 on semi-trailers had been always forbidden, they are also now forbidden since 2005 (Supplement 1 to the 10 series of amendments) for full trailers. This prohibition was requested by Denmark in February 2003 during the 53rd GRRF session (see also document TRANS/WP.29/GRRF/2004/10).

19. The main reasons leading to the prohibition of inertia (overrun) braking systems according to Annex 12 had been:

- Although all full trailers with inertia braking systems had been required in the past (before 2005) to comply with paragraph 5.2.2.4.2.: "*shall distribute its action appropriately among the axles*" they were never fitted with a load compensating systems to take care of different load distributions and different frictions on the road. In 2003 Denmark argued that especially this missing load compensating system made full trailers with two or three axles potentially unstable (tendency that the vehicle

combination will jack-knife under braking, especially when braking during cornering). This argument by Denmark will be addressed for a trailer equipped with an Annex 23 compressed-air braking system. In contrast to common inertia braking systems they will (as it was the case in the past with normal conventional pneumatic trailer braking systems without ABS) be fitted with "standard" available load sensing devices in order to comply with the adhesion requirements of Annex 10 (see also commentary "As to paragraph 5.2.2.24. with regard to the exemption from the adhesion requirements of paragraph 5.1. of Annex 10" below).

- "Inertia brakes are very low tech compared to other vehicles" (DK argument)

This argument will be addressed for a trailer equipped with an Annex 23 compressed-air braking system. Apart from the control (p_m pressure before the headboard versus control pressure behind the headboard), the basic braking system will use braking components fitted to O₂ or O₃ compressed-air trailer braking systems and therefore these Annex 23 braking systems will behave similar as those of O₂ and O₃ trailers.

- Another argument brought forward by DK in 2003 was that the tendency to jack-knife under braking is given particular when the towing vehicle braking performance is much higher than the trailer braking performance capacity (especially in the case of passenger cars with a deceleration of often 10 m/s²).

With the new proposed Annex 23, it is required that the compatibility requirements as laid down in paragraphs 3.1. to 3.5. of Annex 14 (including its Appendix) have to be fulfilled ensuring that the difference in braking performance of motor vehicle and trailer is limited.

As long as the legislator is not be willing to require substantial higher braking performance for O₂ trailers (e.g. 80%, which is not at all anticipated and would be out of touch with reality), any trailer (totally independent of the kind of fitted braking system) will always produce high coupling forces when the trailer's braking performance is substantially lower than that of the motor vehicle.

The Danish argument focuses on inertia braked full trailers but not on full trailers with a conventional compressed-air braking system. This is surprising since trailers equipped with these pneumatic braking system are allowed to produce coupling forces which are much higher than allowed for trailers complying with the Annex 12 or Annex 14 requirements.

If one compares a laden motor vehicle with a laden trailer which braking performance is 50% then the allowed coupling forces for a trailer with a compressed-air braking system is 2,65 times greater than the coupling forces allowed for an Annex 23 trailer which has to fulfil the compatibility band of the Appendix of Annex 14. If a vehicle combination is compared where the towing vehicle is unladen and the trailer laden then the coupling forces allowed for a trailer with a compressed-air braking system are much worse (factor ≈ 4 to 5).

Conclusion: Discussing the problem of high coupling forces makes only sense if conventional compressed-air braking system are also included into this discussion since the problem of high coupling forces can be much more severe than with 'Annex 14 and Annex 23 trailers' (which are required to comply with the compatibility band of the Appendix of Annex 14).

Thus, as long as it is allowed that passenger cars are allowed to tow O₂ trailers the problem of coupling forces will exist. And that passenger cars will also be allowed in the future to tow O₂ trailers, nobody will really question.

- "Semi trailers, centre axle trailers and full trailers above 3,500 kg must have Anti-lock Braking Systems (ABS) and then the stability problem is not there anymore." (DK argument)

That ABS enhances stability goes without saying. However, in rule making cost/benefit considerations have also be taken into account.

O₂ Annex 23 trailer can be fitted with ABS as O₃ and O₄ trailers with conventional compressed-air braking system. Thus, if stability arguments are brought forward then all braking systems for O₂ trailers should be considered.

20. Paragraph 5.2.2.9. (R13) stipulates:

"5.2.2.9. The braking systems shall be such that the trailer is stopped automatically if the coupling separates while the trailer is in motion."

In the case of an O₂ trailer equipped with an Annex 23 compressed-air braking system there are additional possibilities to apply the service or parking braking systems (spring brakes) in case of a coupling separation as compared to conventional inertia (overrun) braking systems using a breakaway cable.

Paragraph 5.2.2.24.

21. Paragraph 5.2.2.24. covers the various special requirements if an ABS is fitted voluntarily.

22. An anti-lock braking system for a trailer of category O₃ and O₄ can only fulfil the requirements if the vehicle is fitted with an ISO 7638 connector and with connecting lines.

23. To demand an ISO 7638 connector for the ABS of a light trailer of category O₂ which is usually coupled behind a passenger car would have the consequence that for cost reasons no manufacturer would offer this safety feature of an anti-lock device on e.g. an "Annex 23 trailer".

24. Therefore, this chapter defines under which conditions (with and without an ISO 7638 connector) an ABS can be fitted to a light trailer of category O₂.

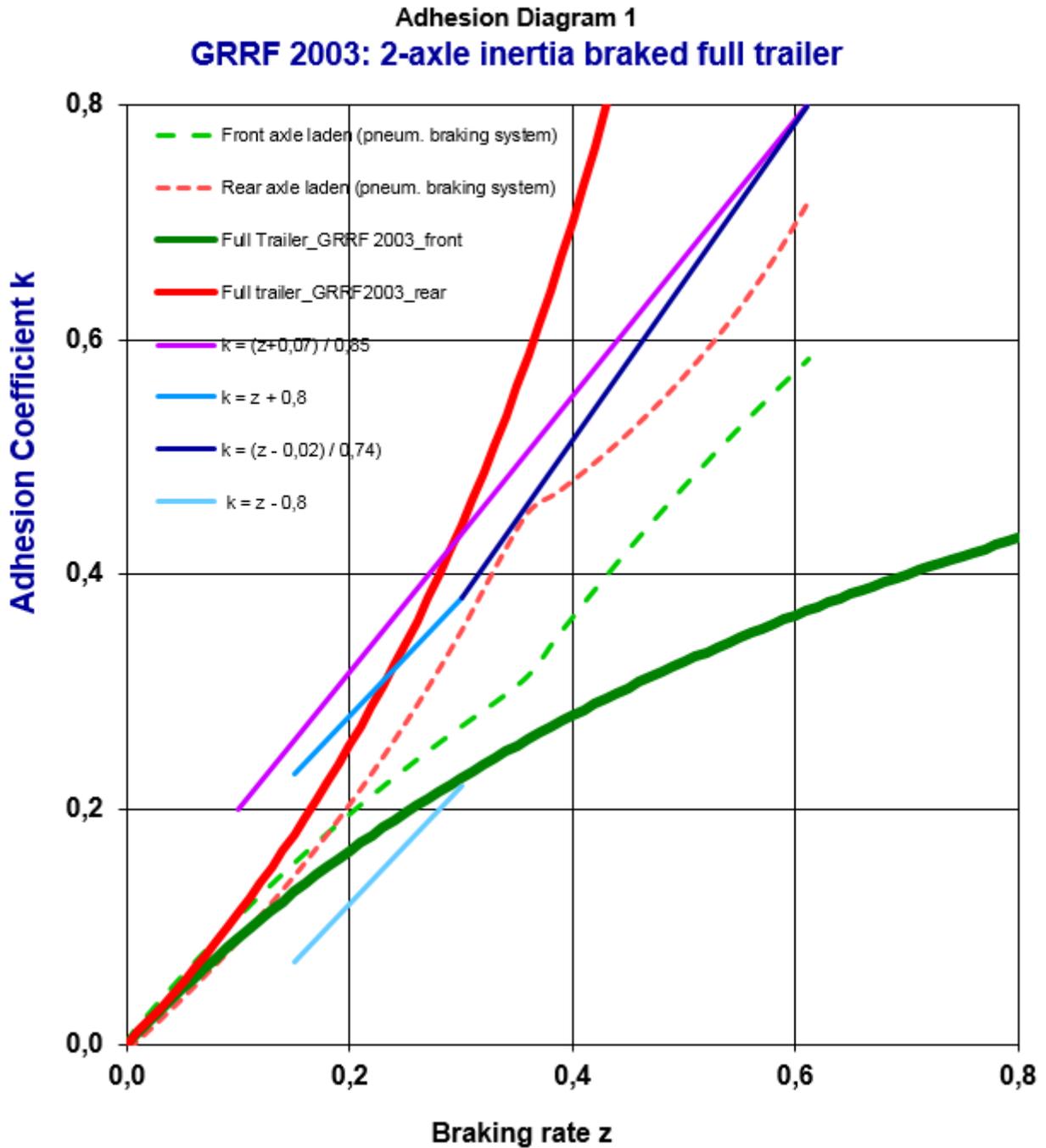
Paragraph 5.2.2.24. with regard to the exemption from the adhesion requirements of paragraph 5.1. of Annex 10:

25. A trailer must either be fitted with an ABS or has to fulfil the **adhesion requirements of paragraph 5.1. of Annex 10**. The bold red (rear axle) and green (front axle) curves of the following diagram are the adhesion utilization curves discussed in February 2003 during the 53rd GRRF session (see also document TRANS/WP.29/GRRF/2003/8).

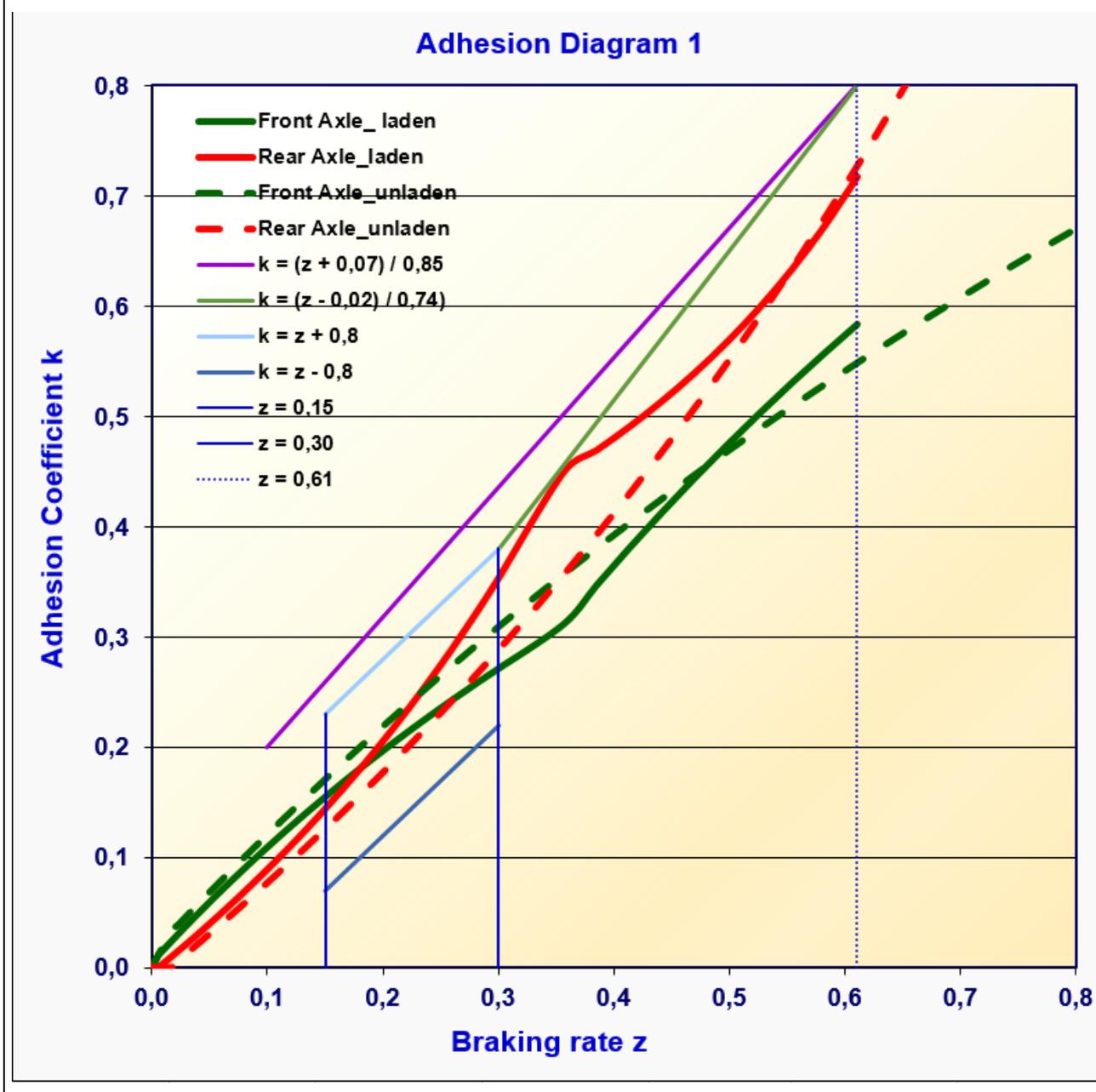
26. These curves have been calculated from an O₂ full trailer (mass 3500 kg - E = 2.80 m - hR = 1.5 m) with a symmetrical brake force distribution. These curves are typical for full trailers with conventional inertia (overrun) braking systems according to Annex 12. The adhesion utilization curve of the rear axle lies (contrary to the philosophy of Annex 10) above that of the front axle over the whole deceleration range.

27. The dotted red (rear axle) and dotted green (front axle) curves are the adhesion utilization curves calculated from the O₂ full trailer (test vehicle data see in this Justification, paragraph "General" of Annex 23) equipped with an Annex 23 compressed-air braking system (according to paragraph 3.1. of Annex 23) fitted with pressure regulating devices. These adhesion utilization curves are complying with the requirements of paragraph 5.1. of Annex 10 (see also the next diagram but one).

Comparison of trailers with a conventional inertia (overrun) braking system and a trailer equipped with an Annex 23 compressed-air braking system



Laden & unladen adhesion curves of a trailer equipped with an Annex 23 compressed-air braking system



Paragraph 5.2.2.24.1.

28. In Directive 71/320/EEC the following requirements exist:

- 2.2.2.13. Trailers of categories O_3 and O_4 shall be equipped with anti-lock systems in accordance with the requirements of Annex X.
- 2.2.2.14. If trailers not mentioned in item 2.2.2.13. above are fitted with anti-lock systems, they shall comply with the requirements of Annex X.

29. In Regulation No. 13, such a requirement as in paragraph 2.2.2.14. does not exist.

30. Therefore, paragraph 5.2.2.24.1. is added to make clear that an ABS, if voluntarily fitted, has at least to comply with the requirements of a Category B anti-lock system.

Paragraph 5.2.2.24.2.

31. This approach is similar as permitted by Annex 20, paragraph 7.4. when it is not possible to carry out the ABS tests in accordance with the testing requirements of Annex 13 or Annex 19.

Paragraphs 5.2.2.24.3., 5.2.2.24.4. and 5.2.2.24.6.

32. According to paragraph R13/5.2.2.17.2., the primary power source for the braking system is that which is available from the ISO 7638:2003 connector. A "stop light powered ABS system" is only allowed for trailers of categories O₃ and O₄ when it is used as a backup in case that the primary power source fails. For trailers of category O₂ no ABS is required. To make use of the safety benefit of an anti-lock braking system it is proposed that a "stop light powered ABS system" is permitted (which - in the past - was for many years the standard ABS type used for trailers).

33. Paragraph 5.2.2.17.2. (d) (Regulation No. 13) stipulates:

"The trailer shall not have any marking or label to indicate that the trailer is equipped with an additional power supply."

34. This requirement was introduced in order not to promote a reliance on the use of the additional power source. The spirit of this requirement is to avoid any encouragement to use the backup when the power supply via the ISO 7638 connector is faulty rather than providing it as for an emergency.

35. Paragraph 5.2.2.17.2. (e) stipulates:

"A failure warning device is not permitted on the trailer for the purposes of providing a warning in the event of a failure within the trailer braking system when the braking system is powered from the additional supply."

36. Thus, it is not allowed to check-out the correct functioning of the trailer braking system using a failure warning device mounted on the trailer. Also, the cab lamp cannot be used by the backup ("stop light powered ABS system") when in operation over-riding the ISO 7638 failure warning signal.

37. Since neither an ABS nor the expensive ISO 7638 connector are required for trailers of category O₂ the requirements of paragraphs R13/5.2.2.17.2. (d) and e) are not applicable for category O₂ trailers not equipped with an ISO 7638 connector.

38. Thus, paragraphs 5.2.2.24.3., 5.2.2.24.4. and 5.2.2.24.6. lay down the requirements when the primary power source for the braking system is not available from the ISO 7638:2003 connector but from another connector (e.g. 13-Pin ISO 11446:2004 connector used today by passenger cars and trailers of category O₂).

39. With paragraph 5.2.2.24.3.1. it is clarified that when the ISO 7638:2003 connector is fitted the requirements applicable to trailers of category O₃ and O₄ have to be complied with.

40. By paragraph 5.2.2.24.3.2. it is clarified that when the ISO 7638:2003 connector is not fitted the requirements of paragraphs 5.2.2.24.3.3. to 5.2.2.24.6. have to be complied with.

Paragraph 5.2.2.24.5.1.

41. In the past, when the "stop light powered ABS system" was used as the standard trailer ABS type for heavy trailers, the warning lamp was either mounted on the top of the

trailer headboard or fitted near to the extreme outer edge of the side of the trailer (similar to the visible position of an "end-outline marker lamp").

Paragraph 5.2.2.24.6.

42. The verification of the operation of the braking system from its power source may be done by checking the operation of the warning signal and checking that enough current is available. This may be accomplished e.g. by a short flashing of a green warning signal and by a short cycling of the pneumatic modulator valve(s) during initialisation of the system.

Annex 2

Paragraph 14.9.

43. Since the newly proposed paragraph 5.2.1.19.2. of the Regulation permits a temporary cut-off of the electrical supply to the trailer in case when a trailer with a compressed-air braking system according to Annex 23 is fitted, the newly amended paragraph 14.9. distinguishes now between an Annex 14 and an Annex 23 braking system.

Amended paragraph 14.10.

44. A new footnote "8" is added.

45. Trailers of categories O₂ according to Annex 23 cannot fulfil the requirements of Annex 13 (paragraph 1) due to their design (pneumatic coupling head of the control line is not existing). In order to avoid confusion, the relevant information for these kind of trailers are put together in the new proposed paragraph 17.

New paragraph 17.

46. This paragraph is inserted to cover the relevant information for the Type Approval Authority with regard to the new and special test requirements for trailers with an Annex 23 compressed-air braking system.

New paragraph 17.2.

47. The standard procedure to show compliance with the Type-I requirements of paragraphs 1.5.2. and 1.5.3. of Annex 4 will be by the test procedure as laid down in Annex 11, Appendix 2, paragraph 3.5.2. This compliance is either shown by the test reports according to Annex 11, Appendix 3 or Annex 12, Appendix 3.

New paragraph 17.4.

48. The basic difference of compressed-air braking system of category O₂ trailers coming under the scope of Annex 23 to conventional compressed-air braking system category O₂ trailers is that the control line pressure 'pm' has to be generated, and that due to the missing supply line the trailer has to be equipped with an energy source (compressor). Therefore, with regard to Annex 23, this information is needed for the Technical Service in order to check compliance with the Regulation; for the Approval Authority this information is needed to define the relevant data for the approval.

49. The remainder of the Annex 23 compressed-air braking system consists more or less of braking components used also for conventional compressed-air braking systems of category O₂ trailers and is not specific to Annex 23.

New paragraphs 17.5. and current paragraph 5.1.4.5.2. of the Regulation

50. Up to now, Regulation No. 13 did not cover a compressed-air braking system which was fed by a compressor fitted on the trailer.

51. It is proposed to require that the data specified in paragraph 17.5. is also included in the type approval documentation. In contrast to a compressor fitted on the motor vehicle, the compressor on a trailer may be changed. Thus, in order to be able to check the

correctness of the performance data as to paragraph 17.5. of the fitted compressor, this information should be available within the approval documentation.

Annex 23

General consideration:

52. This Annex is only applicable to O1 and O2 trailers (see also paragraphs 5.2.2.1. and 5.2.2.3. of this Regulation).

53. For sake of simplicity, clarity and practicality Annex 23 covers all requirements which are specific for trailers without pneumatic connections and equipped with braking systems with pneumatic energy storage devices.

54. Tests had been carried out to verify the practicality of the proposed requirements.

55. These tests had been performed with a full trailer (with drum brakes) according to paragraph 3.1. with the following vehicle data:

Table:

	<i>unladen</i>	<i>laden</i>
GVW	1215 kg	3500 kg
Front	620 kg	1750 kg
Rear	595 kg	1750 kg
h_R (height of CoG)	650 mm	1040 mm (test trailer) 1350 mm (used in calculation)
E (wheelbase)	2803 mm	2803 mm

With:

- (a) Air reservoir volume: 20 l
- (b) Compressor: 600 W
- (c) Type of service brake chamber: 12"
- (d) Number of service brake chamber: 2 (one for each axle)

About the heading of Annex 23:

56. By the wording "Special **additional** requirements" it should be made clear that all other relevant requirements of this Regulation not addressed in this annex are also applicable (e.g. Annex 8 as to spring brakes, etc.)

57. The reference to "trailers of **category O2**" seems important to clarify that this Annex does not apply to "trailers of categories O₃ and O₄" which are required to comply with more severe requirements.

Irrespective how the following paragraph 2.10.2. is interpreted the heading makes it clear that the scope of Annex 23 does not cover trailers of categories O₃ and O₄.

2.10. "Semi-continuous braking" means ...

2.10.2. *The energy used for braking the vehicles constituting the combination is furnished by two different sources (one of which may be the muscular energy of the driver);*

58. That trailers of category O₁ may also fall under the scope of this Annex if they are equipped with a service braking system is made clear by paragraph 5.2.2.1. of this Regulation:

5.2.2.1. Trailers of category O_1 need not be equipped with a service braking system; however, if a trailer of this category is equipped with a service braking system, it shall satisfy the same requirements as a trailer of category O_2 .

Paragraph 1.2.

59. The "control pressure" corresponds to the pressure p_m at the coupling head of the pneumatic control line. The 'control pressure' may be generated from the travel of a mechanical control device, from the measured coupling force between towing and towed vehicle or from the measured deceleration of the trailer.

Paragraph 2.

60. This "Scope"-definition and the new "Scope"-definition proposed by the GRRF ad hoc Annex 14 Group for the Annex 14* clarify unambiguously which annex (14 or 23) is applicable in the case of trailers without pneumatic connections where its braking system is supplied by the towing vehicle with electrical energy.

* *"This Annex defines the special requirements for trailers of category O_2 with a service braking system using electric energy supplied by the towing vehicle. On the trailer this electric energy may be converted into another form of energy which may be stored. If this electric energy is converted into pneumatic energy and stored in pneumatic storage devices annex 23 shall apply"* (Proposal of the ad hoc Annex 14 Group as of 27th May 2015)

Paragraph 3.

61. In this general section 3. general requirements are covered which are specific to the trailers covered by Annex 23.

Paragraph 3.1.

By this paragraph it is made clear that the requirements of Annex 12 are not applicable to the trailers equipped with braking system addressed in this paragraph.

Paragraph 3.2.

62. The requirements with regard to the energy source and energy storage devices of Annex 7, Part A have to be modified since a trailer equipped with an Annex 23 compressed-air braking system has not a pneumatic control line (no p_m -value).

Paragraphs 3.3. and 3.4.

63. By these requirements it is ensured that no unintended actuation of the service braking system occurs, in particular:

- There is no need to stipulate the requirement of paragraph 3.4. of Annex 12 which demands that the trailer when being reversed by the towing vehicle shall not impose a sustained drag force exceeding $0.08 g \cdot G_A$.
- In contrast to mechanical inertia (overrun) braking system according to Annex 12, no braking occurs when driving downhill without brake pedal application by the driver and no unwanted drag force is produced by the braking system when reversing.

Paragraph 3.5.

64. For a trailer equipped with an Annex 23 compressed-air braking system, energy is needed for the operation of the compressor and - in general - to signal the beginning of braking (by the stop lamp signal).

65. In the case that the trailer is equipped with an ABS, electrical energy may be supplied by the ISO 7638 connector or by the standard electrical connector for the lighting system (e.g. 13-Pin ISO 11446:2004 connector); see also paragraph 5.2.2.24.3.2.

Paragraphs 3.5.1. and 3.5.2.

66. Passenger cars are usually fitted with the 13-pole ISO 11446 connector having the two pins 10 and 11 with the nominal cross-sectional area of 2.5 mm² for providing the electrical energy supply for the trailer air compressor. The maximum permissible current for the cross-sectional area of 2.5 mm² is capable to carry a current of 20 A (compare paragraph 5.8.1. of ISO 4091).

67. However, to comply with paragraph 5.2.1.19.1. of the Regulation, the nominal value of 15 A is proposed as the **maximum** permitted value for the current consumption of the trailer.

Paragraph 3.5.3.

68. By this requirement it should be ensured that the socket is protected against water and dust when the plug is removed from the socket.

Paragraph 3.5.4.

69. The tests requirements of ISO 4091:2003 are applicable to the following types of connectors: ISO 1185, ISO 1724, ISO 3731, ISO 3732, ISO 7638-1, ISO 7638-2, ISO 11446 and ISO 12098.

70. These test requirements refer amongst others e.g. to:

- Connection and disconnection;
- Locking device operation;
- Splash and high-pressure water;
- Protection against dust;
- Endurance;
- Vibration;
- Temperature / humidity;
- Salt spray.

71. In case of the 13-pole ISO 11446 connector which is the standard connector for passenger cars it is required in paragraph 6: "Connectors according to this International Standard shall be tested in accordance with ISO 4091 and shall fulfil its requirements".

72. Thus, by the requirement of paragraph 3.5.4. the fitment of a high quality connector is ensured.

Paragraph 3.5.5.

73. In order to avoid that the compressor uses temporarily too much energy from the installed power supply of the motor vehicle for the lighting system, the trailer shall be equipped with a battery of sufficient capacity. With trailer caravans it is today common to use battery charge controllers in order to perform a controlled charge of the trailer battery

74. The battery charge condition may be indicated by a Volt battery gauge which indicates the battery (voltage) charge condition by successively illuminating LEDs depending on the discharge of the battery.

Paragraph 3.5.6.

75. The satisfactory condition of the signal may be verifiable by the driver when the trailer is at standstill.

76. At the 79th GRRF session in February 2015 the issue of a "trailer mounted warning signal" was discussed (see also associated documents ECE/TRANS/WP.29/GRRF/2015/8,

proposing amendments to Regulation No. 79 (Steering) with respect to trailer steering systems, and document ECE/TRANS/WP.29/GRRF/2013/29 as to electrically operated trailers brakes in Regulation No. 13 on Brakes). At this February 2015 session of GRRF it was decided to clarify with GRE the issue of a warning (tell-tale) lamp on a trailer which is not yet regulated in Regulation No.48. For this purpose Informal document GRE-73-09 was produced. In its paragraph 5. it is outlined:

5. *The purpose of this document is to consult and inform GRE:*

- (a) *of the need to permit such warning signals based on the fact there is no standardised means of transmitting failure or status information associated with the above systems either by a hardwire link or electric control line data communications (the messages do not exist);*
- (b) *that such warnings would only be permitted provided they complied with the requirements of paragraph 5.10. of Regulation No. 48 and they were referenced within another UN Regulation.*

77. Since this is a problem which does also affect new proposed requirements for Annex 14 of Regulation No. 13 and the steering regulation Regulation No. 79, the whole paragraph is set into bracket in order to find a common solution how to deal with such trailer mounted warning signals.

Paragraph 3.6.

78. For pneumatic brakes automatic brake adjustment devices (integrated and non-integrated) are commonly available and should therefore be fitted to these kind of trailers in order to improve the braking behaviour.

Paragraph 3.7.

79. A big problem with trailers with an inertia (overrun) braking systems is to assess the service braking performance during a periodical technical inspection.

80. In the case of trailers equipped with an Annex 23 compressed-air braking system the generation of maximum braking forces under static conditions on a rolling road or roller brake tester is possible if a pressure test connection is provided enabling to produce a simulated control pressure.

81. The philosophy of paragraph 3.7.2. is similar to that of paragraph 5.1.4.2.2. of this Regulation where an additional test connection is required to simulate the laden condition.

Paragraph 3.7.3.

82. In order to distribute the braking force appropriately, compressed-air braking system according to Annex 23 may be also fitted with pressure limiting devices to fulfil the adhesion utilization requirements of paragraph 5 of Annex 10. Since these pressure limiting devices are specific to compressed-air braking system according to Annex 23 and not to trailers of categories O3 and O4 it is seen preferable to include this requirement in Annex 23 and not in paragraph 5.1.4.5. of this Regulation.

83. Whereas paragraph 5.1.4.5. covers only compressors of compressed-air braking system of motor vehicles, the compressors of compressed-air braking system installed on trailers are covered in this special Annex.

Paragraph 3.8.

84. This provision ensures that above a deceleration of about [2.0 m/s²] of the vehicle combination also the trailer service braking system is available even when the stop lamp signalling is failed.

85. Since it is most likely that the missing stop lamp signal is due to a failure in the stop-lamp circuit of the towing vehicle, the warning signal shall inform the driver of the missing stop lamp signal when the braking occurs.

Paragraph 4.

86. As an example in the case of braking systems according to 3.1., it is required to show the relationship of the travel of a mechanical control device (which is control input of a pneumatic regulating valve) and the control pressure (as defined in paragraph 1.2.).

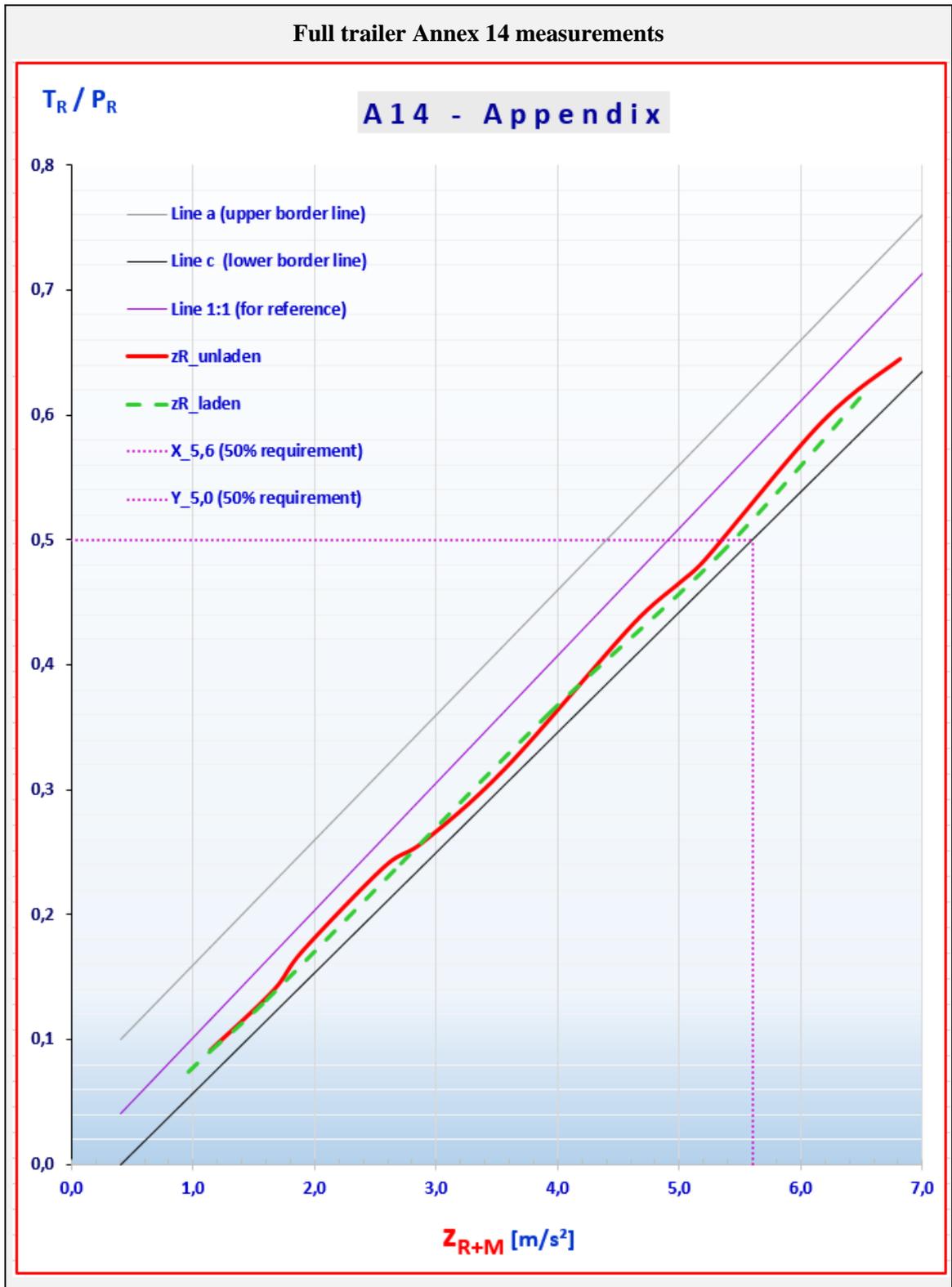
Paragraph 5.1.1.

87. Since trailers equipped with an Annex 23 compressed-air braking system have no pneumatic control line, the compatibility requirements of Annex 10 are not applicable.

88. In order to ensure a compatible braking performance of the trailer to the motor vehicle the same performance requirements applicable to trailers with electrical braking systems are proposed. In order to determine the ratio of T_R/P_R (see Appendix of Annex 14) the coupling forces between towing and towed vehicle have to be measured during the service brake performance tests. According to paragraph 3.4. of Annex 14, the prescribed braking force of the trailer of at least 50 per cent of the maximum total axle load shall be attained during the braking tests.

89. The following diagram shows the positive test results of the tests carried out according to Section 3 of Annex 14. The variance of the measured coupling forces between the towing vehicle and the trailer has a bigger effect in the unladen state than in the laden state.

90. These test results had been obtained with a prototype test trailer according to paragraph 3.1. It is assumed that the characteristics of the mechanical control device can be optimised leading to smaller coupling forces which would move both characteristic lines even closer to the ideal 1:1 reference line.



Paragraph 5.2.

91. As with trailers equipped with inertia (overrun) braking systems according to Annex 12 the alternative procedure for the Type-I test in accordance with the provisions laid down in Annex 11 will also be the standard procedure for trailers equipped with an Annex 23 compressed-air braking systems according to this new Annex 23; see also the justification as to paragraph 17.2.

92. Since there are "national Annex 14" approval reports which do not cover the Type-I fade test it is seen important to address also this test requirement specifically in this annex.

Paragraphs 6. and 6.1.

93. Paragraph 1.3. "Validation of the development of braking force" was added to Annex 10 by the 10 series of amendments (Date of entry into force: 4 April 2005).

94. In contrast to the compatibility band where the p_m -pressure refers to the vehicle deceleration, the p_m -pressure in the requirement of paragraph 1.3. is related to the individual axles in order to ensure that the development of braking force of each axle meets minimum response requirements.

95. Although the development of braking force within the p_m -pressure range "**20 to 100 kPa**" had always been specified by the "compatibility diagrams" 2 to 4 of Annex 10 it was felt necessary to define a standard procedure by which the development of the braking forces can be easily verified.

96. The industry found out that **in practice** (checking compliance by rotating the wheels by hand) it was often not possible to verify the requirement of the development of the braking force within this defined narrow pressure range in the case of conventional braking systems having 'mechanical' braking components with a significant threshold characteristic.

97. Therefore, the 10 series of amendments allowed a **four year** transitional period (paragraph 12.1.2.6.) in order to grant the industry sufficient time to replace these "mechanical" components (e.g. replacing 'ABS' by 'EBS' systems).

98. In the case of trailers equipped with an Annex 23 compressed-air braking system it will be generally not possible to replace such 'pneumatic-mechanical' braking components (e.g. load sensing devices, adapter valves, pressure reducing valves, etc.) by electronically controlled components.

99. Therefore, it is proposed to extend the pressure range of "**20 to 100 kPa**" required by paragraph 1.3. of Annex 10 to "**20 to 180 kPa**".

100. This extended pressure range is regarded as justified for the following reasons:

- Simultaneous development of braking forces of towing and towed vehicle is anyway principally not strictly possible in the case of trailers equipped with an Annex 23 compressed-air braking system (e.g. time delay in order to generate the control pressure (as defined in 1.2.)).
- The compatibility of the braking performances between towing and towed vehicle is ensured by the performance requirements of Annex 14 and its appendix (compatibility diagram).
- The requirement "validation of the development of braking force" is an additional braking requirement for trailers equipped with an Annex 23 compressed-air braking system which is not required for any other O₂ trailer without pneumatic connections.

Note: Tests with different trailer configurations (installed pressure regulating devices) showed that the development of braking on the test trailer occurred between 1.3 and 1.5 bar.

Paragraph 6.2.

101. With this procedure there is no need to specify any minimum forces when a brake force has been developed. The pressure differential between a freely rotating wheel and a wheel which cannot be rotated by hand anymore is so small that it is within the tolerance range of the control pressure measurement.

Paragraph 7.

102. The response time requirements of Annex 6 are only defined for trailers equipped with a supply and a control line according to paragraph 5.1.3.1. to this Regulation. Therefore, the response time requirements laid down in this Annex 23 had to be adapted.

103. It is anticipated that these requirements are very similar to what is required for conventional compressed-air braking systems of trailers, namely that also in an emergency manoeuvre, the time elapsing between the moment when the control device of the motor vehicle begins to be actuated and the moment when the braking force on the least favourably placed axle of the trailer reaches the level corresponding to the prescribed performance does not exceed the maximum permitted time of 0.6 seconds.

Paragraphs 7.1. and 7.2.

104. It is required that the coupling head of the supply line and the coupling head of the control line of the simulator are connected to the line feeding the air reservoir and with a line connected to the control line of the braking system respectively. In this way the simulator according to Appendix of Annex 6 can also be used for trailers equipped with an Annex 23 compressed-air braking system. Therefore, the response time requirements of this annex are similar to those of Annex 6.

Paragraph 7.4.

105. If e.g. (in case of a braking system according to paragraph 3.1.) the length of the travel of the control device has an influence on the response time measurement then the travel shall be adjusted in such a way as to represent the worst case condition (e.g. ensuring the generating of maximum braking forces).

Note: The response time measured with the test trailer (with a braking system according to paragraph 3.1.) was 0,33 s.

Paragraph 8.

106. Due to the non-existing supply and control lines and the existence of an energy source in the case of an Annex 23 trailer, the provisions of Annex 7, Part A relating to energy sources and energy storage devices (energy reservoirs) have been adapted.

107. Although with compressed-air braking systems according to Annex 23 there is no need to specify the same pressure levels as for conventional braking systems, this is done for the following practical reasons:

- If the maximum pressure level is not specified anymore the response time requirements cannot be carried out anymore with the simulator specified in the Appendix of Annex 6.

For cost reasons, there is today only **one** simulator on the market for which compliance with the Annex 6 requirements are demonstrated. If this simulator (used throughout Europe by manufacturers and Technical Services) cannot be used in the future for the response time measurement of Annex 23 trailers then it will be hardly possible to define a response time procedure which under cost and testing time consideration will be acceptable.

- The component industry offers pneumatic trailer braking components (e.g. valves, regulating devices, etc.) which are related to the pressure ranges which are today common for compressed-air braking systems of trailers (relating to the pressure range

up to 850 kPa). That the industry is interested to develop new brake components for a very limited amount of trailers for an undefined pressure range is not very likely.

Paragraph 8.1.2.1.

108. The pneumatic components and devices fitted on a trailer equipped with an Annex 23 compressed-air braking system will be similar as those of conventional compressed-air braking systems fitted to O3 and O4 trailers. In order to harmonise the testing requirement (see also pressure of 650 kPa in the case of the response time measurement, paragraph 7.1.) the same pressure of 850 kPa is proposed for the pressure in the energy storage device at the beginning of the test.

Paragraph 8.1.2.4.

109. Trailers equipped with an Annex 23 compressed-air braking system do not have a pneumatic control line (control line pressure p_m). Therefore, the control pressure of ' $p_m = 750$ kPa at each brake application' (compare Annex 7, Part A, paragraph 1.3.2.4.) cannot be generated with these kind of trailers.

110. Since there is no pneumatic control line it is proposed that the maximum possible control pressure (worst case) is simulated in the service braking system in order to carry out the prescribed energy exhaustion test.

111. In general, the control pressure at first application will be the prescribed initial air reservoir pressure of 850 kPa (compare paragraph 8.1.2.1.). The control pressure of the following brake applications will decrease to the available and constantly falling air reservoir pressure.

Paragraph 8.1.3.

112. In the case of motor vehicles it is ensured that secondary braking performance is always available in case of a failure in the braking system. This braking performance is about 50% of that prescribed for the service braking system. The 50% requirement of paragraph 8.1.3. is based on this philosophy to also guarantee a similar braking performance level as ensured in the case of motor vehicles.

Paragraph 8.1.4.

113. It is regarded as necessary that the driver can at any time easily check the level of air pressure in the air reservoir of the trailer.

Paragraph 8.2.

114. Currently, there are no requirements in ECE-R13 as to the capacity of pneumatic energy sources (compressors) for trailers. Therefore, the proposed requirements are similar to those laid down for power-driven vehicles (Annex 7, paragraph 1.2.).

115. However, the pressure " p_2 " is defined as a constant value (650 kPa) to be consistent with the requirements laid down for the response time requirements (paragraph 7.).

116. Although it is unlikely that O2-trailers equipped with an Annex 23 compressed-air braking system are equipped with energy storage device(s) for auxiliary equipment, the requirement that these storage device(s) "shall be isolated" has been kept (compare paragraph 2.3.2. of Annex 7, Part A).

Note: With regard to the pneumatic auxiliary equipment see the requirements laid down in paragraph 5.2.2.14. of the Regulation (80% braking performance must always be ensured).

117. With the test trailer (test vehicle data see above in this Justification, paragraph "General") the following test results were obtained: $t_1 = 50$ s || $t_2 = 93$ s.

Paragraph 8.3.

118. By repeatedly applying the service braking system, the energy level in the air reservoir will fall to the cut-in pressure of the compressor where the compressor begins to recharge the air reservoir again until the cut-out pressure of the compressor is reached again and the air reservoir pressure is falling again. How many charging cycles the compressor is able to perform depends on the remaining available energy of the battery.

119. With the test trailer as specified in this Justification, paragraph "General", however, with an air reservoir volume of 40 l (instead of 20 l) tests had been carried out with a trailer battery charged by a battery management system (Charging Converter) to a "nominal" operating voltage of 13 V.

120. Starting from this "nominal" operating voltage of 13 V" and with an air reservoir pressure of 8.5 bar (cut-out pressure of the compressor), 162 full brake applications (13 charging cycles) with an air reservoir pressure of ≥ 6.5 bar (cut-in pressure of the compressor) had been carried out without receiving any electrical supply from the towing vehicle.

121. Starting from the warning voltage level of 12 V (see paragraph 3.5.6.) still 37 full brake applications could be carried out.
