AGREEMENT

CONCERNING THE ADOPTION OF UNIFORM CONDITIONS OF APPROVAL AND RECIPROCAL RECOGNITION OF APPROVAL FOR MOTOR VEHICLE EQUIPMENT AND PARTS

done at Geneva on 20 March 1958

Addendum 12: Regulation No. 13 to be annexed to the Agreement

Revision 2 — Amendment 3

Supplement 1 to the 05 series of amendments which entered into force on 1 April 1987

UNIFORM PROVISIONS CONCERNING THE APPROVAL OF VEHICLES WITH REGARD TO BRAKING

UNITED NATIONS

Paragraph 5.2: <u>Classification of vehicles</u>

Paragraph 5.2.1: <u>Category L</u>

Replace the value "40 km/h" by "50 km/h" in all the subparagraphs

Paragraph 5.2.2.1: <u>Category M₁</u>

Delete subparagraphs 5.2.2.1.1 and 5.2.2.1.2.

Paragraph 12.2., replace "1 April 1985" by "1 April 1987".

Replace annex 13 by the following text:

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"<u>Annex 13</u>

REQUIREMENTS APPLICABLE TO TESTS FOR VEHICLES
EQUIPPED WITH ANTI-LOCK DEVICES

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1.   GENERAL

1.1.   The purpose of this annex is to define the required performances for
          braking systems with anti-lock devices fitted to road vehicles.
          This annex does not make it compulsory to fit vehicles with
          anti-lock devices, but if such devices are fitted to a road vehicle
          they must meet the requirements of this annex. In addition,
          power-driven vehicles which are authorized to draw a trailer, and
          trailers equipped with compressed air braking systems, shall, when
          the vehicles are laden, meet the requirements for compatibility set
          out in annex 10 to this Regulation.

1.2.   The devices known at present comprise a sensor or sensors, a
          controller or controllers and a modulator or modulators. Any
          devices of a different design which may be introduced in the future
          will be deemed to be anti-lock devices within the meaning of this
          annex and annex 10 to this Regulation, if they provide performances
          equal to those prescribed by this annex.

2.   DEFINITIONS

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

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

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

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

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

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

3.　　　　TYPES OF ANTI-LOCK DEVICES

3.1.　　　A power-driven vehicle is deemed to be equipped with an anti-lock device within the meaning of paragraph 1 of annex 10 to this Regulation, if one of the following devices is fitted:

3.1.1.　　Category 1 anti-lock device

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

3.1.2.　　Category 2 anti-lock device

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

3.1.3.　　Category 3 anti-lock device

　　　　　A vehicle equipped with a category 3 anti-lock device shall meet all the relevant requirements of this annex, except those of paragraphs 5.3.4 and 5.3.5. On such vehicles, any individual axle (or bogie) which does not include at least one directly controlled wheel must fulfil the conditions of adhesion utilization and the wheel-locking sequence of annex 10 to this Regulation, instead of the adhesion utilization requirements prescribed in paragraph 5.2. of this annex. However, if the relative positions of the adhesion utilization curves do not meet the requirements of paragraph 3.1.1 of annex 10 to this Regulation, a check shall be made to ensure that the wheels on at least one of the rear axles do not lock before those of the front axle or axles under the conditions prescribed in paragraphs 3.1.1 and 3.1.4 of annex 10 to this Regulation, with regard to the braking ratio and the load respectively. These requirements may be checked on high- or low-adhesion road surfaces (about 0.8 and 0.3 maximum) by modulating the service brake control force.

3.2.　　　A towed vehicle is deemed to be equipped with an anti-lock device within the meaning of paragraph 1 of annex 10 to this Regulation, if it meets all the relevant requirements of this annex.

4.　　　　GENERAL REQUIREMENTS

4.1.2/　　Any break in the supply of electricity to the device and/or in the wiring external to the electronic controller(s) shall be signalled to the driver by a specific optical warning signal. This requirement also applies to the anti-lock device(s) of towed vehicles which are designed to be coupled to drawing vehicles of

categories other than M_1 and N_1. The warning device for the anti-lock device(s) of the towed vehicle must not give a signal when a towed vehicle without an anti-lock device, or when no towed vehicle, is coupled. This requirement must be met automatically. The warning signal shall light up when the anti-lock device is energized and go off at the latest when the vehicle reaches a speed of 10 km/h and no defect is present. The tell-tale lamps of the warning devices must be visible even in daylight, it must be easy for the driver to check that they are in working order.

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

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

4.4. In the event of failure of the anti-lock device, the residual braking performance must be that prescribed for the vehicle in question in the event of failure of a part of the transmission to the service brake (see paragraph 5.3.2.4 of this Regulation). This requirement shall not be construed as a departure from the requirements concerning secondary braking.

4.5. The operation of the device must not be adversely affected by magnetic or electrical fields. 3/

5. SPECIAL PROVISIONS CONCERNING POWER-DRIVEN VEHICLES

5.1. ENERGY CONSUMPTION

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

5.1.1 Test procedure

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

5.1.1.2.   From an initial speed of not less than 50 km/h, on a surface with a coefficient of adhesion of 0.3 4/ or less, the brakes of the laden vehicle shall be fully applied for a time t, and all the wheels equipped with an anti-lock device must remain under control throughout that time.

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

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

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

5.1.1.6.   During the tests, in the case of a power-driven vehicle authorized to draw a trailer equipped with a compressed air braking system, the supply line shall be stopped and an energy storage device of 0.5 litre capacity shall be connected to the control line (in accordance with paragraph 1.2.2.3 of annex 7). When the brakes are applied for the fifth time, as provided in paragraph 5.1.1.5, the energy level supplied to the control line must not be below half the level obtained at a full application starting with the initial energy level.

5.1.2.   Additional requirements

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

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

5.1.2.3.   The braking time t shall be determined by the formula:

$$t = \frac{Vmax}{7} \text{ (but not less than 15 seconds)}$$

where t is expressed in seconds and Vmax represents the maximum design speed of the vehicle expressed in km/h, with an upper limit of 160 km/h.

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

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

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

5.2. UTILIZATION OF ADHESION

5.2.1. The utilization of adhesion by the anti-lock device takes into account the actual increase in braking distance beyond the theoretical minimum. The anti-lock device shall be deemed to be satisfactory when the condition $\varepsilon \geqslant 0.75$ is satisfied, where ε represents the adhesion utilized, as defined in paragraph 1.2 of appendix 1 to this annex. This requirement shall not be construed as requiring a braking performance better than that prescribed in annex 4 for the vehicle in question.

5.2.2. The adhesion utilization ε shall be measured on road surfaces with a coefficient of adhesion of 0.3 4/ or less, and of about 0.8 (dry road), with an initial speed of 50 km/h.

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

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

5.2.5. The condition $\varepsilon \geqslant 0.75$ shall be checked with the vehicle laden and unladen.

5.3. ADDITIONAL CHECKS

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

5.3.1. The wheels directly controlled by an anti-lock device must not lock when the full force 5/ is suddenly applied on the control device, on the two kinds of road surfaces specified in paragraph 5.2.2 above, at low initial speeds V = 40 km/h and at high initial speeds $V \approx 0.8$ Vmax $\leqslant 120$ km/h.

5.3.2. When an axle passes from a high-adhesion surface (K_1) to a low-adhesion surface (K_2) where $K_1 \geqslant 0.5$ and $K_1/K_2 \geqslant 2$, 6/, with the full force 5/ applied on the control device, the directly controlled wheels must not lock. The running speed and the instant of applying the brake shall be so calculated that, with the anti-lock device fully cycling on the high-adhesion surface, the passage from one surface to the other is made at high and at low speed, under the conditions laid down in paragraph 5.3.1 above.

5.3.3. When a vehicle passes from a low-adhesion surface (K_2) to a high-adhesion surface (K_1) where $K_1 \geqslant 0.5$ and $K_1/K_2 \geqslant 2$, 6/, with the full force 5/ applied on the control device, the deceleration of the vehicle must rise to the appropriate high value within a reasonable time and the vehicle must not deviate from its

initial course. The running speed and the instant of applying the brake shall be so calculated that, with the anti-lock device fully cycling on the low-adhesion surface, the passage from one surface to the other occurs at approximately 50 km/h.

5.3.4. The provisions of this paragraph shall only apply to vehicles equipped with anti-lock devices of categories 1 or 2. When the right and left wheels of the vehicle are situated on surfaces with differing coefficients of adhesion (K_1 and K_2), where $K_1 \geqslant 0.5$ and $K_1/K_2 \geqslant 2$, 6/ the directly controlled wheels must not lock when the full force 5/ is suddenly applied on the control device at a speed of 50 km/h.

5.3.5. Furthermore, laden vehicles equipped with anti-lock devices of category 1 shall, under the conditions of paragraph 5.3.4 above, satisfy the prescribed braking ratio in appendix 2 to this annex.

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

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

6.   SPECIAL PROVISIONS CONCERNING TOWED VEHICLES

6.1.   ENERGY CONSUMPTION

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

6.1.1. Compliance with the above requirement shall be checked by the procedure specified below, with the vehicle unladen, on a straight and level road with a surface having a good coefficient of adhesion 7/ and with the brakes adjusted as closely as possible and with the proportioning/load-sensing valve (if fitted) held in the "laden" position throughout the test.

6.1.2. The initial energy level in the energy storage device(s) shall be the maximum specified by the vehicle manufacturer; in the case of a standard assembly as referred to in paragraph 3.1.2 of annex 10 to this Regulation, the initial energy level shall be equivalent to a pressure of 8 bar at the coupling head of the trailer's supply line.

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

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

6.1.5.   At the end of the braking, with the vehicle stationary, the service braking control shall be fully actuated four times. During the fifth application, the pressure in the operating circuit must be sufficient to provide a total braking force at the periphery of the wheels equal to not less than 22.5 per cent of the force corresponding to the maximum mass borne by the wheels when the vehicle is stationary.

6.2.   UTILIZATION OF ADHESION

6.2.1.   Braking systems equipped with an anti-lock device shall be deemed acceptable when the condition $\varepsilon \geqslant 0.75$ is satisfied, where ε represents the adhesion utilized, as defined in paragraph 2 of appendix 1 to this annex. This condition shall be verified with the vehicle unladen, on a straight and level road with a surface having a good coefficient of adhesion. 7/

6.3.   ADDITIONAL CHECKS

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

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

<u>Annex 13 - Appendix 1</u>

UTILIZATION OF ADHESION

1.   METHOD OF MEASUREMENT FOR POWER-DRIVEN VEHICLES

1.1.   DETERMINATION OF THE COEFFICIENT OF ADHESION (K)

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

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

1.1.3.   A number of tests at increments of line pressure shall be carried out to determine the maximum braking ratio of the vehicle (Zm). During each test, a constant input force shall be maintained and the braking ratio will be determined by reference to the time taken (t) for the speed to reduce from 40 km/h to 20 km/h using the formula:

$$Z \approx \frac{0.56}{t}$$

Zm is the maximum value of Z; t is in seconds.

1.1.4.   The braking forces shall be calculated from the measured braking ratio and the rolling resistance of the unbraked axle(s) which is equal to 0.015 and 0.010 of the static axle load for a driven axle and a non-driven axle respectively.

1.1.5.   The dynamic load on the axle shall be that given by the formula in annex 10 to this Regulation.

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

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

$$K = \frac{Z_m \cdot P - 0.015 \, P_2}{P_1 + \frac{h}{E} \cdot Z_m \cdot P}$$

The other symbols (P, h, E) are defined in annex 10 to this Regulation.

1.2. DETERMINATION OF THE ADHESION UTILIZED (ε)

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

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

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

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

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

1.2.5. In the case of a vehicle equipped with an anti-lock device of category 3, the value of Z max will be measured on each axle which has at least one directly controlled wheel. For example, for a two-axle vehicle with an anti-lock device acting only on the rear axle (2), the adhesion utilized (ε) is given by:

$$\varepsilon = \frac{Z \ max. \ P - 0.010 \ P_1}{K \ (P_2 - \frac{h}{E} . \ Z \ max \ . \ P)}$$

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

2. METHOD OF MEASUREMENT FOR TOWED VEHICLES

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

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

2.1.2. The mean braking ratio (Z) shall be determined, taking into account the rolling resistance of the unbraked axles. The test shall be conducted at a speed of 50 km/h and the rolling resistance coefficient may be estimated at 0.01.

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

$$\mathcal{E} = \frac{z_1}{z_0} \geqq 0.75$$

where:

$\mathcal{E}$ =   the adhesion utilized

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

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

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

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

2.2.1.   In the case of full trailers, the coefficient of adhesion (K) and the adhesion utilized ($\mathcal{E}$) shall be determined in accordance with the provisions for power-driven vehicles in paragraphs 1.1 and 1.2 of this appendix. The forces in the drawbar connection shall be taken into account.

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

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

$$\mathcal{E} = \frac{z_{max}}{z_0}$$

where:

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

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

2.2.2.2. The value of z_0 may be calculated by carrying out the procedure described in paragraph 1.1.3 of this appendix to determine the maximum braking ratio ($z*$).

Then $\quad z_0 \quad = \dfrac{TR}{PR_{dyn}}$

where: $\quad$ TR $\quad = $ braking force $\quad = z*.(P + PM) - 0.01\ W$

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

(W is the static mass of the unbraked axles)

The other symbols are defined in annex 10 to this Regulation.

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

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

Annex 13 - Appendix 2

PERFORMANCE ON DIFFERING-ADHESION SURFACES

1.   The prescribed braking ratio referred to in paragraph 5.3.5 of this
        annex may be calculated by reference to the measured coefficient of
        adhesion of the two surfaces on which this test is carried out.
        These two surfaces must satisfy the conditions prescribed in
        paragraph 5.3.4 of this annex.

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

3.   The prescribed braking ratio (z_3) for laden power-driven vehicles
        shall be:

$$z_3 \geq 0.75 \left[\frac{4 K_2 + K_1}{5} \right] \quad \text{and} \quad z_3 \geq K_2 \text{ "}$$

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Notes

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

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

(1) the supply of electricity to the anti-lock device(s) of the towed
vehicle is provided:

(a) first, via the ISO.3731 (24S) connector (using pins 2 and 6 for
failure warning and power supply, respectively) or via the special anti-lock
connector conforming to ISO.7638; and

(b) second, via the ISO.1185 (24N) connector (using pin 4 without
exceeding the present limits of the stop lamp circuit); if this is not
fulfilled, the requirements of annex 10 shall be satisfied: for example, by
the installation of a brake load sensing device on the towed vehicle;

(2) the towed vehicle is equipped with an optical device, within the
field of view of the driver's rear-view mirror and visible even in daylight,
to warn him of any break in the supply of electricity and/or in the wiring
external to the electronic controller of the anti-lock device of the towed
vehicle.

Notes (continued)

3/   Until uniform test procedures have been agreed, the manufacturers shall provide the Technical Services with their test procedures and results.

4/   Until such test surfaces become generally available, tyres at the limit of wear, and higher values up to 0.4 may be used at the discretion of the Technical Services. The actual value obtained and the type of tyres and surface shall be recorded.

5/   "Full force" means the maximum force prescribed in annex 4 to this Regulation for the category of vehicle: a higher force may be used if required to activate the anti-lock device.

6/ K_1 is the high-adhesion surface coefficient.
      K_2 is the low-adhesion surface coefficient.
      K_1 and K_2 are measured as laid down in appendix 1 to this annex.

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