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Agreement

Concerning the Adoption of Harmonized Technical United Nations Regulations for Wheeled Vehicles, Equipment and Parts which can be Fitted and/or be Used on Wheeled Vehicles and the Conditions for Reciprocal Recognition of Approvals Granted on the Basis of these United Nations Regulations*

(Revision 3, including the amendments which entered into force on 14 September 2017)

Addendum 77: UN Regulation No. 78

Revision 3

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Uniform provisions concerning the approval of vehicles of categories L1, L2, L3, L4 and L5 with regard to braking



UNITED NATIONS

* Former titles of the Agreement:

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 (original version);
Agreement concerning the Adoption of Uniform Technical Prescriptions for Wheeled Vehicles, Equipment and Parts which can be Fitted and/or be Used on Wheeled Vehicles and the Conditions for Reciprocal Recognition of Approvals Granted on the Basis of these Prescriptions, done at Geneva on 5 October 1995 (Revision 2).

This document is meant purely as documentation tool. The authentic and legal binding texts are: ECE/TRANS/WP.29/2019/46 and ECE/TRANS/WP.29/2020/65.

UN Regulation No. 78

Uniform provisions concerning the approval of vehicles of categories L₁, L₂, L₃, L₄ and L₅ with regard to braking

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1. Scope

This Regulation applies to vehicles of category L.¹

These categories do not include:

- (a) Vehicles with a Vmax of < 25 km/h;
- (b) Vehicles equipped for disabled riders.

2. Definitions

For the purposes of this Regulation:

- 2.1. "*Antilock Brake System (ABS)*" means a system which senses wheel slip and automatically modulates the pressure producing the braking forces at the wheel(s) to limit the degree of wheel slip.
- 2.2. "*Approval of a vehicle*" means the approval of a vehicle type with regard to braking.
- 2.3. "*Baseline test*" means a stop or a series of stops carried out in order to confirm the performance of the brake prior to subjecting it to a further test such as the heating procedure or wet brake stop.
- 2.4. "*Brake*" means those parts of the brake system where the forces opposing the movement of the vehicle are developed.
- 2.5. "*Brake system*" means the combination of parts consisting of the control, transmission, and brake, but excluding the engine, whose function it is to progressively reduce the speed of a moving vehicle, bring it to a halt, and keep it stationary when halted.
- 2.6. "*Combined brake system (CBS)*" means:

For vehicle categories L₁ and L₃: a service brake system where at least two brakes on different wheels are operated by the actuation of a single control.

For vehicle categories L₂, L₅, L₆ and L₇: a service brake system where the brakes on all wheels are operated by the actuation of a single control.

For vehicle category L₄: a service brake system where the brakes on at least the front and rear wheels are operated by the actuation of a single control. (If the rear wheel and sidecar wheel are braked by the same brake system, this is regarded as the rear brake.)
- 2.7. "*Components of the braking system*" means one of the individual parts which, when assembled, constitute the braking system.
- 2.8. "*Control*" means the part actuated directly by the rider in order to supply or control the energy required for braking the vehicle to the transmission.
- 2.9. "*Different types of braking systems*" means devices which differ in such essential respects as:
 - (a) Components having different characteristics;

¹ As defined in the Consolidated Resolution on the Construction of Vehicles (R.E.3), document ECE/TRANS/WP.29/78/Rev.6, para. 2 – <https://unece.org/transport/standards/transport/vehicle-regulations-wp29/resolutions>

- (b) A component made of materials having different characteristics, or a component differing in shape or size;
 - (c) A different assembly of the components.
- 2.10. "*Driver mass*" means the nominal mass of a driver that shall be 75 kg (subdivided into 68 kg occupant mass at the seat and 7 kg luggage mass).
 - 2.11. "*Engine disconnected*" means when the engine is no longer connected to the driving wheel(s).
 - 2.12. "*Gross vehicle mass*" or "*maximum mass*" means the technically permissible maximum laden mass as declared by the manufacturer.
 - 2.13. "*Initial brake temperature*" means the temperature of the hottest brake before any brake application.
 - 2.14. "*Laden*" means so loaded as to attain the gross vehicle mass as defined in paragraph 2.12.
 - 2.15. "*Lightly loaded*" means mass in running order plus 15 kg for test equipment, or the laden condition, whichever is less. In the case of ABS tests on a low friction surface (Annex 3, paragraphs 9.4. to 9.7.), the mass for test equipment is increased to 30 kg to account for outriggers.
 - 2.16. "*Mass in running order*" means the sum of the unladen vehicle mass and driver mass.
 - 2.17. "*Peak braking coefficient (PBC)*" means the measure of tyre to road surface friction based on the maximum deceleration of a rolling tyre.
 - 2.18. "*Power-assisted braking system*" means a brake system in which the energy necessary to produce the braking force is supplied by the physical effort of the rider assisted by one or more energy supplying devices, for example vacuum assisted (with vacuum booster).
 - 2.19. "*Secondary brake system*" means the second service brake system on a vehicle equipped with a combined brake system.
 - 2.20. "*Service brake system*" means a brake system which is used for slowing the vehicle when in motion.
 - 2.21. "*Single brake system*" means a brake system which acts on only one axle.
 - 2.22. "*Split service brake system (SSBS)*" means a brake system that operates the brakes on all wheels, consisting of two or more subsystems actuated by a single control designed so that a single failure in any subsystem (such as a leakage type failure of a hydraulic subsystem) does not impair the operation of any other subsystem.
 - 2.23. "*Stopping distance*" means the distance travelled by the vehicle from the point the rider begins to actuate the brake control to the point at which the vehicle reaches a full stop. For tests where the simultaneous actuation of two controls is specified, the distance travelled is taken from the point the first control is actuated.
 - 2.24. "*Test speed*" means the vehicle speed measured the moment the driver begins to actuate the brake control(s). For tests where the simultaneous actuation of two controls is specified, the vehicle speed is taken from the point the first control is actuated.

- 2.25. "Transmission" means the combination of components that provide the functional link between the control and the brake.
- 2.26. "Unladen vehicle mass" means the nominal mass of the vehicle as indicated by the manufacturer(s) including all factory fitted equipment for normal operation of that vehicle (e.g. fire extinguisher, tools, spare wheel), plus coolant, oils, 90 per cent of fuel and 100 per cent of other gas or liquids, as specified by the manufacturer.
- 2.27. "Vehicle type" means a sub-category of L-category vehicles which do not differ in such essential respects as:
- (a) The vehicle category, as defined in the Consolidated Resolution (R.E.3);
 - (b) The gross vehicle mass, as defined in paragraph 2.12.;
 - (c) The distribution of the mass between the axles;
 - (d) Vmax;
 - (e) A different type of braking device;
 - (f) The number and arrangement of the axles;
 - (g) The engine type;
 - (h) The number and ratios of gears;
 - (i) The final drive ratios;
 - (j) The tyre dimensions.
- 2.28. "Vmax" means either the speed attainable by accelerating at a maximum rate from a standing start for a distance of 1.6 km on a level surface, with the vehicle lightly loaded, or the speed measured in accordance with ISO 7117:1995.
- 2.29. "Wheel lock" means the condition that occurs when there is a slip ratio of 1.00.
- 2.30. "Emergency braking signal" means logic signal indicating emergency braking specified in paragraphs 5.1.15. to 5.1.15.2. of this Regulation.
- 2.31. "Braking Signal" means a logic signal indicating when illumination of the stop lamp is required or allowed as specified in paragraph 5.1.17. of this Regulation.
- 2.32. "Electric Regenerative Braking System" means a braking system which, during deceleration, provides for the conversion of vehicle kinetic energy into electrical energy and is not part of the service braking system.
- 2.33. "Disable the antilock brake system" means to put the system into a state where it will no longer fulfil the technical requirements in paragraph 9 of Annex 3 to this Regulation."

3. Application for approval

- 3.1. The application for approval of a vehicle type with regard to braking shall be submitted by the vehicle manufacturer or by his duly accredited representative.
- 3.2. It shall be accompanied by the under mentioned documents in triplicate and by the following particulars:

- 3.2.1. A description of the vehicle type with regard to the items specified in paragraph 2.27. The numbers and/or symbols identifying the vehicle type and the engine type shall be specified;
- 3.2.2. A list of components, duly identified, constituting the braking device;
- 3.2.3. A diagram of the assembled braking system and an indication of the position of its components on the vehicle;
- 3.2.4. Detailed drawings of each component to enable it to be easily located and identified.
- 3.3. A vehicle, representative of the vehicle type to be approved, shall be submitted to the Technical Service responsible for conducting the approval tests.

4. Approval

- 4.1. If the vehicle type submitted for approval pursuant to this Regulation meets the requirements of paragraphs 5. and 6. below, approval of that vehicle type shall be granted.
- 4.2. An approval number shall be assigned to each type approved. Its first two digits (at present 04 corresponding to the 04 series of amendments) shall indicate the series of amendments incorporating the most recent major technical amendments made to the Regulation at the time of issue of the approval. The same Contracting Party shall not assign the same number to the same vehicle type equipped with another type of braking device, or to another vehicle type.
- 4.3. Notice of approval or refusal or extension or withdrawal of approval or production definitively discontinued of a vehicle type pursuant to this Regulation shall be communicated to the Parties to the Agreement which apply this Regulation by means of a form conforming to the model in Annex 1 to this Regulation.
- 4.4. There shall be affixed, conspicuously and in a readily accessible place specified on the approval form, to every vehicle conforming to a vehicle type approved under this Regulation an international approval mark consisting of:
 - 4.4.1. A circle surrounding the letter "E" followed by the distinguishing number of the country which has granted approval;²
 - 4.4.2. The number of this Regulation, followed by the letter "R", a dash and the approval number to the right of the circle prescribed in paragraph 4.4.1.
- 4.5. If the vehicle conforms to a vehicle type approved, under one or more other Regulations annexed to the Agreement, in the country which has granted approval under this Regulation, the symbol prescribed in paragraph 4.4.1. needs not be repeated; in such a case, the Regulation and approval numbers and the additional symbols of all the Regulations under which approval has been granted in the country which has granted approval under this Regulation shall be placed in vertical columns to the right of the symbol prescribed in paragraph 4.4.1.

² The distinguishing numbers of the Contracting Parties to the 1958 Agreement are reproduced in Annex 3 to the Consolidated Resolution on the Construction of Vehicles (R.E.3), document ECE/TRANS/WP.29/78/Rev.6, Annex 3 - www.unece.org/trans/main/wp29/wp29wgs/wp29gen/wp29resolutions.html

- 4.6. The approval mark shall be clearly legible and be indelible.
- 4.7. The approval mark shall be placed close to or on the vehicle data plate affixed by the manufacturer.
- 4.8. Annex 2 to this Regulation gives examples of arrangements of approval marks.

5. Specifications

- 5.1. Brake system requirements
 - 5.1.1. Each vehicle shall meet each of the tests specified for a vehicle of its category and for those brake features on the vehicle.
 - 5.1.2. Service brake system control operation

Vehicles shall have configurations that enable a rider to actuate the service brake system control while seated in the normal driving position and with both hands on the steering control.
 - 5.1.3. Secondary brake system control operation

Vehicles shall have configurations that enable a rider to actuate the secondary brake system control while seated in the normal driving position and with at least one hand on the steering control.
 - 5.1.4. Parking brake system

If a parking brake system is fitted, it shall hold the vehicle stationary on the slope prescribed in paragraph 1.1.4. of Annex 3.

The parking brake system shall:

 - (a) Have a control which is separate from the service brake system controls; and
 - (b) Be held in the locked position by solely mechanical means.

Vehicles shall have configurations that enable a rider to be able to actuate the parking brake system while seated in the normal driving position.

For L₂, L₄, L₅, L₆ and L₇, the parking brake system shall be tested in accordance with paragraph 8. of Annex 3.
 - 5.1.5. Two-wheeled vehicles of categories L₁ and L₃ shall be equipped with either two separate service brake systems, or a split service brake system, with at least one brake operating on the front wheel and at least one brake operating on the rear wheel.
 - 5.1.6. Three-wheeled vehicles of vehicles category L₄ shall comply with the brake system requirements set out in paragraph 5.1.5. A brake on the sidecar wheel is not required if the vehicle meets the performance requirements prescribed in Annex 3.
 - 5.1.7. Three-wheeled vehicles of category L₂ and four-wheeled vehicles of category L₆ shall be equipped with a parking brake system plus one of the following service brake systems:
 - (a) Two separate service brake systems, except CBS, which, when applied together, operate the brakes on all wheels; or
 - (b) A split service brake system; or

- (c) A CBS that operates the brakes on all wheels and a secondary brake system which may be the parking brake system.
- 5.1.8. Category L₅ vehicles and category L₇ vehicles shall be equipped with:
 - 5.1.8.1. A parking brake system; and
 - 5.1.8.2. A foot-actuated service brake system which operates on the brakes on all wheels, by way of either:
 - (a) A split service brake system; or
 - (b) A CBS that operates the brakes on all wheels and a secondary brake system, which may be the parking brake system.
- 5.1.9. In cases where two separate service brake systems are installed, the systems may share a common brake, a common transmission, or both if the requirements of Annex 3, paragraph 12. are met.
- 5.1.10. For vehicles that use hydraulic fluid for brake force transmission, the master cylinder shall:
 - (a) Have a sealed, covered, separate reservoir for each brake system;
 - (b) Have a minimum reservoir capacity equivalent to 1.5 times the total fluid displacement required to satisfy the new to fully worn lining condition with the worst case brake adjustment condition; and
 - (c) Have a reservoir where the fluid level is visible for checking without removal of the cover.
- 5.1.11. All warning lamps shall be mounted in the rider's view.
- 5.1.12. Vehicles that are equipped with a split service brake system shall be fitted with a red warning lamp, which shall be activated:
 - (a) When there is a hydraulic failure on the application of a force of ≤ 90 N on the control; or
 - (b) Without actuation of the brake control, when the brake fluid level in the master cylinder reservoir falls below the greater of:
 - (i) That which is specified by the manufacturer; and
 - (ii) That which is less than or equal to half of the fluid reservoir capacity.

To permit function checking, the warning lamp shall be illuminated by the activation of the ignition switch and shall be extinguished when the check has been completed. The warning lamp shall remain on while a failure condition exists whenever the ignition switch is in the "on" position.

- 5.1.13. Vehicles that are equipped with an ABS system shall be fitted with a yellow warning lamp. The lamp shall be activated whenever there is a malfunction that affects the generation or transmission of signals in the vehicle's ABS system.

To permit function checking, the warning lamp shall be illuminated by the activation of the ignition switch and extinguished when the check has been completed.

The warning lamp shall remain on while a failure condition exists whenever the ignition switch is in the "on" position.

- 5.1.14. The effectiveness of the braking systems, including the anti-lock system, shall not be adversely affected by magnetic or electrical fields. This shall be demonstrated by fulfilling the technical requirements and respecting the transitional provisions of UN Regulation No. 10 (EMC) by applying:
- (a) The 03 series of amendments for vehicles without a coupling system for charging the Rechargeable Electric Energy Storage System (traction batteries);
 - (b) The 04 series of amendments for vehicles with a coupling system for charging the Rechargeable Electric Energy Storage System (traction batteries).
- 5.1.15. When a vehicle is equipped with the means to indicate emergency braking, activation and de-activation of the emergency braking signal shall only be generated by the application of any service braking system when the conditions in paragraphs 5.1.15.1. through 5.1.15.2. are fulfilled:³
- 5.1.15.1. The signal shall not be activated when the vehicle deceleration is below 6 m/s^2 but it may be generated at any deceleration at or above this value, the actual value being defined by the vehicle manufacturer.
- The signal shall be de-activated at the latest when the deceleration has fallen below 2.5 m/s^2 .
- 5.1.15.2. The following conditions may also be used:
- The signal may be activated at a speed above 50 km/h when the antilock system is fully cycling (as defined in paragraph 9.1. of Annex 3) and deceleration is at least 2.5 m/s^2 . The signal shall be deactivated when the antilock system is no longer fully cycling.
- 5.1.15.3. The signal may be generated from a prediction of the vehicle deceleration resulting from the braking demand respecting the activation and de-activation thresholds defined in paragraph 5.1.15.1. above.
- 5.1.16. A means to disable the antilock brake system is not permitted.
- By derogation a means to disable the antilock brake system is allowed, if, vehicles are fitted with a riding mode selector allowing an "off-road" or "all terrain" mode and the following provisions are met:
- (a) The vehicle is stationary; and
 - (b) The disablement of the antilock brake system function shall be the result of a deliberate action by the rider according to one of the following methods:
 - (i) Simultaneous actuation of the antilock brake system disable-switch and a service brake system control (i.e. brake lever or pedal); or
 - (ii) The actuation of the antilock brake system disable switch for a minimum of two seconds; or

³ At the time of type approval, compliance with this requirement shall be confirmed by the vehicle manufacturer.

- (iii) The progression through at least two successive steps or levels of actuation of a control (e.g. rotating knob, a touch panel switch or a menu option selector);
- (c) Disabling of the antilock brake system function shall only be allowed when the riding mode selector is in the "off-road" or "all terrain" mode; and
- (d) The antilock brake system function shall be automatically enabled when exiting from the "off-road" or "all-terrain" ride mode, or after each start-up of the vehicle, except for restarts after unintentional stalling of the engine; and
- (e) When disabled, the antilock brake system function shall be indicated by the activation of a yellow or amber tell-tale according to one of the following methods until the ABS is fully functional or operating again:
 - (i) The following symbol as specified in B.18 in ISO 2575:2010:



Or

- (ii) The following symbol as specified in B.05 of ISO 2575:2010:



With the word "OFF" as follows, according to Y.01 in ISO 2575:2010, whereby the tell tales are adjacent to each other:



Or;

- (iii) The text "ABS OFF", or "ABS not available", or,
 - (iv) The warning lamp referred to in paragraph 5.1.13., continuously activated (i.e. lit or flashing).
 - (f) Enabling of a functional stage which complies with anti-lock brake system requirements in paragraph 9 of Annex 3. shall be possible through the single actuation of a control (e.g. simple press of a button or switch) initiating ABS system start-up procedure; and
 - (g) Prohibition of any software and/or hardware defeat device compromising or allowing to circumnavigate one or more of the requirements set out in points (a) to (f).
- 5.1.17. Generation and de-activation of the braking signal to illuminate stop lamp(s) as defined in UN Regulation No. 53 shall only be under the following conditions:
- 5.1.17.1. Application of any service brake by the rider shall generate a braking signal that will be used to illuminate the stop lamps.

- 5.1.17.2. In addition, in case of vehicles powered solely by electric powertrain equipped with electric regenerative braking systems as defined in paragraph 2.32. of this Regulation, which produces a retarding force upon release of the accelerator control, the braking signal shall be generated also according to the following provisions:

<i>Vehicle decelerations</i>	<i>Signal generation</i>
$\leq 0.7 \text{ m/s}^2$	The signal shall not be generated
$> 0.7 \text{ m/s}^2$ and $\leq 1.3 \text{ m/s}^2$	The signal may be generated
$> 1.3 \text{ m/s}^2$	The signal shall be generated

In all cases the signal shall be de-activated at the latest when the deceleration has fallen below 0.7 m/s^2 .⁴

- 5.1.18. A vehicle fitted with an ABS system active on both axles may be fitted with a rider selectable mode to deactivate the ABS function on the rear axle. When the ABS function is deactivated on the rear axle this shall be indicated by a yellow or amber tell-tale or check control messages⁵ according to one of the following methods until the ABS is fully functional or operating on both axles again:

- (i) The following symbol as specified in B.18 in ISO 2575:2010:



With the word "REAR" adjacent to it; or

- (ii) The following symbol as specified in B.18 in ISO 2575:2010:



With a symbol of the vehicle adjacent to it with an arrow pointing to the rear axle; or

- (iii) The following symbol as specified in B.05 of ISO 2575:2010:



With the word "REAR OFF" adjacent to it; or

- (iv) The text " REAR ABS OFF", or " REAR ABS not available"; or
(v) The warning lamp referred to in paragraph 5.1.13., continuously flashing. If the disablement of the ABS system is also indicated by a flashing of this warning lamp as specified in 5.1.16. e-iv, the frequency of the flashing for indicating the deactivation of the ABS system on one

⁴ At the time of type approval, compliance with this requirement shall be confirmed by the vehicle manufacturer.

⁵ Popup messages in the instrument panel

axle shall be different from the frequency of flashing to indicate the disablement of the ABS system.

5.2. Durability

5.2.1. Wear of the brakes shall be compensated for by means of a system of automatic or manual adjustment.

5.2.2. The friction material thickness shall either be visible without disassembly, or where the friction material is not visible, wear shall be assessed by means of a device designed for that purpose.

5.2.3. During all the tests in this Regulation and on their completion, there shall be no friction material detachment and no leakage of brake fluid.

5.3. Measurement of dynamic performance

The method used to measure performance is as specified in the respective tests in Annex 3. There are three ways in which the service brake system performance may be measured:

5.3.1. MFDD (Mean Fully Developed Deceleration):

Calculation of MFDD:

$$d_m = \frac{V_b^2 - V_e^2}{25.92 \cdot (S_e - S_b)} \quad \text{in m/s}^2$$

where:

d_m = mean fully developed deceleration

V_1 = vehicle speed when rider actuates the control

V_b = vehicle speed at 0.8 V_1 in km/h

V_e = vehicle speed at 0.1 V_1 in km/h

S_b = distance travelled between V_1 and V_b in metres

S_e = distance travelled between V_1 and V_e in metres

5.3.2. Stopping distance:

Based on the basic equations of motion:

$$S = 0.1 \cdot V + (X) \cdot V^2$$

where:

S = stopping distance in metres

V = vehicle speed in km/h

X = a variable based on the requirement for each test

To calculate the corrected stopping distance using the actual vehicle test speed, the following formula is used:

$$S_s = 0.1 \cdot V_s + (S_a - 0.1 \cdot V_a) \cdot V_s^2 / V_a^2$$

where:

S_s = corrected stopping distance in metres

V_s = specified vehicle test speed in km/h

Sa = actual stopping distance in metres

Va = actual vehicle test speed in km/h

Note: This equation is only valid when the actual test speed (Va) is within ± 5 km/h of the specified test speed (Vs).

5.3.3. Continuous deceleration recording:

For the burnishing procedure and tests such as the wet brake and heat fade – heating procedure, there is a continuous recording of the vehicle's instantaneous deceleration from the moment a force is applied to the brake control until the end of the stop.

5.4. Brake lining materials:

Brake linings shall not contain asbestos.

6. Tests

The braking tests (test conditions and procedures) which vehicles submitted for approval are required to undergo, and the braking performance required, are prescribed in Annex 3 to this Regulation.

7. Modifications of vehicle type or braking system and extension of approval

7.1. Every modification of the vehicle type or of its braking system shall be communicated to the Type Approval Authority which approved the vehicle type. That Authority may then either:

7.1.1. Consider that the modifications made are unlikely to have an appreciable adverse effect and that in any case the vehicle still complies with the requirements; or

7.1.2. Require a further test report from the Technical Service responsible for conducting the tests.

7.2. Confirmation or refusal of approval, specifying the alterations, shall be communicated, by the procedure specified in paragraph 4.3., to the Parties to the Agreement which apply this Regulation.

7.3. The Type Approval Authority issuing the extension of approval shall assign a series number to each communication form drawn up for such an extension.

8. Conformity of production

8.1. Every vehicle (system) approved to this Regulation shall be so manufactured as to conform to the type approved by meeting the requirements set forth in paragraph 5.

8.2. In order to verify that the requirements of paragraph 8.1. are met, suitable controls of the production shall be carried out.

8.3. The holder of the approval shall in particular:

- 8.3.1. Ensure existence of procedures for the effective control of the quality of products;
- 8.3.2. Have access to the control equipment necessary for checking the conformity to each approved type;
- 8.3.3. Ensure that data of test results are recorded and that annexed documents shall remain available for a period to be determined in accordance with the Type Approval Authority;
- 8.3.4. Analyse the results of each type of test, in order to verify and ensure the stability of the product characteristics making allowance for variation of industrial production;
- 8.3.5. Ensure that for each type of product at least the tests prescribed in Annex 3 to this Regulation are carried out;
- 8.3.6. Ensure that any sampling of samples or test pieces giving evidence of non-conformity with the type of test considered shall give rise to another sampling and another test. All the necessary steps shall be taken to re-establish the conformity of the corresponding production.
- 8.4. The Type Approval Authority which has granted type approval may at any time verify the conformity control methods applicable to each production unit.
- 8.4.1. In every inspection, the test books and production survey records shall be presented to the visiting inspector.
- 8.4.2. The inspector may take samples at random which will be tested in the manufacturer's laboratory. The minimum number of samples may be determined according to the results of the manufacturer's own verification.
- 8.4.3. When the quality level appears unsatisfactory or when it seems necessary to verify the validity of the tests carried out in application of paragraph 8.4.2., the inspector shall select samples to be sent to the Technical Service which has conducted the type-approval tests.
- 8.4.4. The Type Approval Authority may carry out any test prescribed in this Regulation.
- 8.4.5. The normal frequency of inspections authorized by the Type Approval Authority shall be once every two years. In the case where negative results are recorded during one of these visits, the Type Approval Authority shall ensure that all necessary steps are taken to re-establish the conformity of production as rapidly as possible.

9. Transitional provisions

- 9.1. As from the official date of entry into force of the 04 series of amendments to this Regulation, no Contracting Party applying this Regulation shall refuse to grant or refuse to accept UN type approvals under this Regulation as amended by the 04 series of amendments.
- 9.2. As from 1 September 2018, Contracting Parties applying this Regulation shall grant approvals only if the type of vehicle corresponds to the requirements of this Regulation as amended by the 04 series of amendments.
- 9.3. As from 1 September 2021, Contracting Parties applying this Regulation shall not be obliged to accept, for the purpose of national or regional type approval,

a vehicle type approved to the preceding series of amendments to this Regulation.

- 9.4. Notwithstanding the transitional provisions above, Contracting Parties whose application of this Regulation comes into force after the date of entry into force of the most recent series of amendments are not obliged to accept UN type approvals which were granted in accordance with any of the preceding series of amendments to this Regulation.
- 9.5. As from the official date of entry into force of the 05 series of amendments, no Contracting Party applying this Regulation shall refuse to grant or refuse to accept UN type-approvals under this Regulation as amended by the 05 series of amendments.
- 9.6. As from 1 September 2023, Contracting Parties applying this Regulation shall not be obliged to accept UN type-approvals to the preceding series of amendments, first issued after 1 September 2023.
- 9.7. Notwithstanding the transitional provisions above, Contracting Parties who start to apply this Regulation after the date of entry into force of the most recent series of amendments are not obliged to accept UN type-approvals which were granted in accordance with any of the preceding series of amendments to this Regulation.
- 9.8. Notwithstanding paragraph 9.6., Contracting Parties applying this Regulation shall continue to accept UN type-approvals to the preceding series of amendments to this Regulation, first issued after 1 September 2023 and extension thereof, for the vehicle types which are not affected by the changes introduced by the 05 series of amendments.
- 9.9. Contracting Parties applying this Regulation shall not refuse to grant UN type-approvals according to any preceding series of amendments to this Regulation or extensions thereof.

10. Penalties for non-conformity of production

- 10.1. The approval granted in respect of a vehicle type pursuant to this Regulation may be withdrawn if the requirements laid down in paragraph 8.1. are not complied with or if a vehicle of this type has failed to pass the checks prescribed in paragraph 8.3.
- 10.2. If a Contracting Party to the Agreement which applies this Regulation withdraws an approval it has previously granted, it shall forthwith so notify the other Contracting Parties applying this Regulation, by means of a copy of the approval form bearing at the end, in large letters, the signed and dated annotation "APPROVAL WITHDRAWN".

11. Production definitively discontinued

If the holder of the approval completely ceases to manufacture a type of vehicle approved in accordance with this Regulation, he shall so inform the Type Approval Authority which granted the approval. Upon receiving the relevant communication, that Type Approval Authority shall inform thereof the other Parties to the Agreement applying this Regulation by means of a copy of the

approval form bearing at the end, in large letters, the signed and dated annotation "PRODUCTION DISCONTINUED".

12. Names and addresses of Technical Services responsible for conducting approval tests and of Type Approval Authorities

The Contracting Parties to the Agreement applying this Regulation shall communicate to the United Nations Secretariat the names and addresses of the Technical Services responsible for conducting approval tests and of Type Approval Authorities which grant approval and to which forms certifying approval or extension or refusal or withdrawal of approval, issued in other countries, are to be sent.

Annex 1*

Communication

(Maximum format: A4 (210 x 297 mm))



issued by:

Name of administration:

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

Concerning:²

Approval granted
Approval extended
Approval refused
Approval withdrawn
Production definitively discontinued

of a type of vehicle of category L with regard to braking pursuant to UN Regulation No. 78

Approval No. Extension No.

1. Trade name or mark of the vehicle
2. Vehicle type designation by the manufacturer
3. Name and address of the manufacturer:
4. Name and address of the manufacturer's representative
(if applicable):
5. Summarized description:
- 5.1. Vehicle:
Category of vehicle:
Gross vehicle mass of vehicle:
- 5.2. Engine:
- 5.3. Transmission:
Number and ratios of gears:
Final drive ratio:
Tyre dimensions:

* At the request of (an) applicant(s) for UN Regulation No. 90 approval, the information shall be provided by the Type Approval Authority, as contained in Appendix 1 to this annex. However, this information shall not be provided for purposes other than UN Regulation No. 90 approvals.

¹ Distinguishing number of the country which has granted/extended/refused/withdrawn approval (see approval provisions in the Regulation).

² Strike out what does not apply.

- 5.4. Braking system:
Make(s) and type(s) of linings:
Service brake(s) (front, rear, combined)²
Secondary braking, parking brake (if applicable)²
Other systems (anti-lock brakes, etc.)
6. Technical Service conducting approval tests:
7. Date of test report:
8. Number of test report:
9. Reason for extension of approval (if applicable):
10. Other remarks (if applicable), (right or left hand driven):
11. Place:
12. Date:
13. Signature:
14. Annexed the list of parts constituting the approval documents, which can be obtained on request, submitted to the Type Approval Authority which has delivered the approval.

Annex 1 – Appendix

List of vehicle data for the purpose of UN Regulation No. 90 approvals

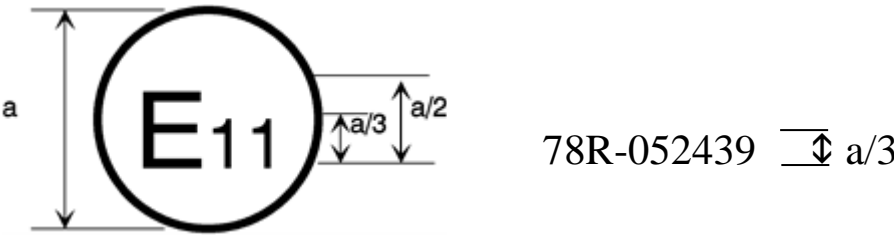
1. Description of the vehicle type:
- 1.1. Trade name or mark of the vehicle, if available:
- 1.2. Vehicle category:
- 1.3. Vehicle type according to UN Regulation No. 78 approval:
- 1.4. Models or trade names of vehicles constituting the vehicle type, if available:
- 1.5. Manufacturer's name and address:
2. Make and type of brake linings:
3. Minimum mass of vehicle:
- 3.1. Distribution of mass of each axle (maximum value):
4. Gross vehicle mass of vehicle:
- 4.1. Distribution of mass of each axle (maximum value):
5. Vmax km/h
6. Tyre and wheel dimensions:
7. Configuration of the independent braking systems:
8. Specifications of brake valves (if applicable):
- 8.1. Adjustment specifications of the load sensing valve:
- 8.2. Setting of pressure valve:
9. Specification of brake:
- 9.1. Disc brake type (e.g. number of pistons with diameter(s), ventilated or solid disc): ...
- 9.2. Drum brake type (e.g. simplex, with piston size and drum dimensions):
10. Master cylinder type and size (if applicable):

Annex 2

Arrangements of approval marks

Model A

(See paragraph 4.4. of this Regulation)

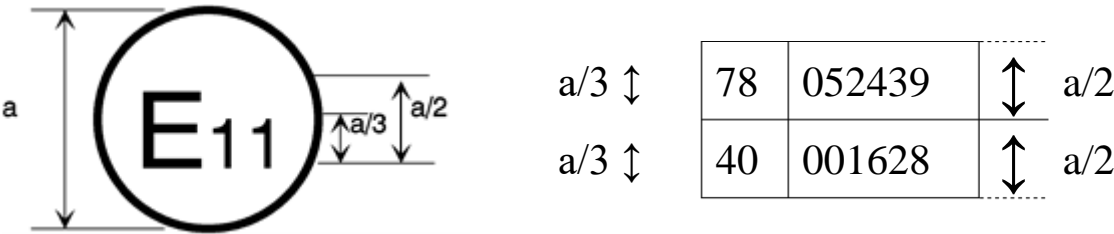


a = 8 mm min.

The above approval mark affixed to a vehicle¹ shows that the vehicle type concerned has, with regard to braking, been approved in the United Kingdom (E 11) pursuant to UN Regulation No. 78 under approval number 052439. The first two digits of the approval number indicate that UN Regulation No. 78 already included the 05 series of amendments when the approval was granted.

Model B

(See paragraph 4.5. of this Regulation)



a = 8 mm min.

The above approval mark affixed to a vehicle shows that the vehicle type concerned has been approved in the United Kingdom (E 11) pursuant to UN Regulations Nos. 78 and 40.² The first two digits of the approval numbers indicate that, at the dates when the respective approvals were granted, UN Regulation No. 78 included the 05 series of amendments but UN Regulation No. 40 was still in its original form.

¹ This latter number is given merely as an example.

² This latter number is given merely as an example.

Annex 3

Test conditions, procedures and performance requirements

1. General
- 1.1. Test surfaces
 - 1.1.1. High friction surface:
 - (a) Applicable to all dynamic brake tests excluding the ABS tests where a low-friction surface is specified;
 - (b) The test area is a clean and level surface, with a gradient ≤ 1 per cent;
 - (c) The surface has a nominal peak braking coefficient (PBC) of 0.9, unless otherwise specified.
 - 1.1.2. Low friction surface:
 - (a) Applicable to all dynamic brake tests where a low-friction surface is specified;
 - (b) The test area is a clean and level surface, with a gradient ≤ 1 per cent;
 - (c) The surface has a PBC of ≤ 0.45 .
 - 1.1.3. Measurement of PBC:

The PBC is measured as determined by the approval Type Approval Authority using either:

 - (a) An ASTM International (ASTM) E1136-93 (Re-approved 2003) standard reference test tyre, in accordance with ASTM Method E1337-90 (Re-approved 2008), at a speed of 40 mph; or
 - (b) The method specified in the Appendix 1 to this annex:
 - 1.1.4. Parking brake system tests:

The specified test slope shall have a test surface gradient of 18 per cent and shall have a clean and dry surface that does not deform under the mass of the vehicle.
 - 1.1.5. Test lane width:

For two-wheeled vehicles (vehicle categories L₁ and L₃) the test lane width is 2.5 m.

For three-wheeled and four-wheeled vehicles (vehicle categories L₂, L₄, L₅, L₆ and L₇) the test lane width is 2.5 m plus the vehicle width.
- 1.2. Ambient temperature

The ambient temperature is between 4 °C and 45 °C.
- 1.3. Wind speed

The wind speed is not more than 5 m/s.
- 1.4. Test speed tolerance

The test speed tolerance is ± 5 km/h.

In the event of the actual test speed deviating from the specified test speed, the actual stopping distance is corrected using the formula in paragraph 5.3.2. of this Regulation.

1.5. Automatic transmission

Vehicles with automatic transmission shall complete all tests - whether they are for "engine connected" or "engine disconnected".

If an automatic transmission has a neutral position, the neutral position is selected for tests where "engine disconnected" is specified.

1.6. Vehicle position and wheel lock:

- (a) The vehicle is positioned in the centre of the test lane for the beginning of each stop;
- (b) Stops are made without the vehicle wheels passing outside the applicable test lane and without wheel lock.

1.7. Test sequence

Table 1

<i>Test order</i>	<i>Paragraph</i>
1. Dry stop - single brake control actuated	3.
2. Dry stop - all service brake controls actuated	4.
3. High speed	5.
4. Wet brake	6.
5. Heat fade *	7.
6. If fitted:	
6.1. Parking brake system	8.
6.2. ABS	9.
6.3. Partial failure, for split service brake systems	10.
6.4. Power-assisted braking system failure	11.

* *Note:* Heat fade is always the last test to be carried out.

2. Preparation

2.1. Engine idle speed

The engine idle speed is set to the manufacturer's specification.

2.2. Tyre pressures

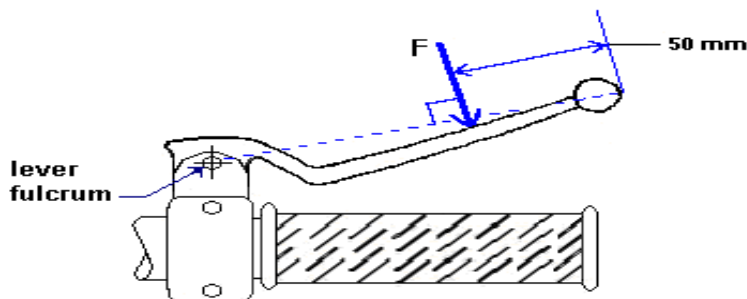
The tyres are inflated to the manufacturer's specification for the vehicle loading condition for the test.

2.3. Control application points and direction

For a hand control lever, the input force (F) is applied on the control lever's forward surface perpendicular to the axis of the lever fulcrum and its outermost point on the plane along which the control lever rotates (see Figure 1 below).

The input force is applied to a point located 50 mm from the outermost point of the control lever, measured along the axis between the central axis of the fulcrum of the lever and its outermost point.

Figure 1



For a foot control pedal, the input force is applied to the centre of, and at right angles to, the control pedal.

2.4. Brake temperature measurement

As determined by the Type Approval Authority, the brake temperature is measured on the approximate centre of the braking path of the disc or drum using:

- (a) A rubbing thermocouple that is in contact with the surface of the disc or drum; or
- (b) A thermocouple that is embedded in the friction material.

2.5. Burnishing procedure

The vehicle brakes are burnished prior to evaluating performance. This procedure may be completed by the manufacturer:

- (a) Vehicle lightly loaded;
- (b) Engine disconnected;
- (c) Test speed:
 - (i) Initial speed: 50 km/h or 0.8 V_{max} , whichever is lower;
 - (ii) Final speed = 5 to 10 km/h;
- (d) Brake application:
 - (i) Each service brake system control actuated separately;
- (e) Vehicle deceleration:
 - (i) Single front brake system only:
 - 3.0-3.5 m/s^2 for vehicle categories L_3 and L_4 ;
 - 1.5-2.0 m/s^2 for vehicle categories L_1 and L_2 ;
 - (ii) Single rear brake system only: 1.5-2.0 m/s^2 ;
 - (iii) CBS or split service brake system: 3.5-4.0 m/s^2 ;

- (f) Number of decelerations: 100 per brake system;
 - (g) Initial brake temperature before each brake application $\leq 100\text{ }^{\circ}\text{C}$;
 - (h) For the first stop, accelerate the vehicle to the initial speed and then actuate the brake control under the conditions specified until the final speed is reached. Then reaccelerate to the initial speed and maintain that speed until the brake temperature falls to the specified initial value. When these conditions are met, reapply the brake as specified. Repeat this procedure for the number of specified decelerations. After burnishing, adjust the brakes in accordance with the manufacturer's recommendations.
3. Dry stop test - single brake control actuated
- 3.1. Vehicle condition:
- (a) The test is applicable to all vehicle categories;
 - (b) Laden:
For vehicles fitted with CBS and split service brake systems: the vehicle is tested in the lightly loaded condition in addition to the laden condition;
 - (c) Engine disconnected.
- 3.2. Test conditions and procedure:
- (a) Initial brake temperature: $\geq 55\text{ }^{\circ}\text{C}$ and $\leq 100\text{ }^{\circ}\text{C}$;
 - (b) Test speed:
 - (i) Vehicle categories L_1 , L_2 and L_6 : 40 km/h or 0.9 V_{max} , whichever is lower;
 - (ii) Vehicle categories L_3 , L_4 , L_5 and L_7 : 60 km/h or 0.9 V_{max} , whichever is lower;
 - (c) Brake application:
 - (i) Each service brake system control actuated separately;
 - (d) Brake actuation force:
 - (i) Hand control: $\leq 200\text{ N}$;
 - (ii) Foot control: $\leq 350\text{ N}$ for vehicle categories L_1 , L_2 , L_3 , L_4 and L_6 ;
 $\leq 500\text{ N}$ for vehicle category L_5 and L_7 ;
 $\leq 500\text{ N}$ for vehicle category L_5 ;
 - (e) Number of stops: until the vehicle meets the performance requirements, with a maximum of 6 stops;
 - (f) For each stop, accelerate the vehicle to the test speed and then actuate the brake control under the conditions specified in this paragraph.
- 3.3. Performance requirements
- When the brakes are tested in accordance with the test procedure set out in paragraph 3.2., the stopping distance shall be as specified in column 2 or the MFDD shall be as specified in Column 3 of the following table:

Table 2

Column 1	Column 2	Column 3
Vehicle Category	STOPPING DISTANCE(S) (Where V is the specified test speed in km/h and S is the required stopping distance in metres)	MFDD
Single brake system, front wheel(s) braking only:		
L ₁	$S \leq 0.1 V + 0.0111 V^2$	$\geq 3.4 \text{ m/s}^2$
L ₂ and L ₆	$S \leq 0.1 V + 0.0143 V^2$	$\geq 2.7 \text{ m/s}^2$
L ₃	$S \leq 0.1 V + 0.0087 V^2$	$\geq 4.4 \text{ m/s}^2$
L ₅ and L ₇	Not applicable	Not applicable
L ₄	$S \leq 0.1 V + 0.0105 V^2$	$\geq 3.6 \text{ m/s}^2$
Single brake system, rear wheel(s) braking only:		
L ₁	$S \leq 0.1 V + 0.0143 V^2$	$\geq 2.7 \text{ m/s}^2$
L ₂ and L ₆	$S \leq 0.1 V + 0.0143 V^2$	$\geq 2.7 \text{ m/s}^2$
L ₃	$S \leq 0.1 V + 0.0133 V^2$	$\geq 2.9 \text{ m/s}^2$
L ₅ and L ₇	Not applicable	Not applicable
L ₄	$S \leq 0.1 V + 0.0105 V^2$	$\geq 3.6 \text{ m/s}^2$
Vehicles with CBS or split service brake systems: for laden and lightly loaded conditions:		
L ₁ , L ₂ and L ₆	$S \leq 0.1 V + 0.0087 V^2$	$\geq 4.4 \text{ m/s}^2$
L ₃	$S \leq 0.1 V + 0.0076 V^2$	$\geq 5.1 \text{ m/s}^2$
L ₅ and L ₇	$S \leq 0.1 V + 0.0077 V^2$	$\geq 5.0 \text{ m/s}^2$
L ₄	$S \leq 0.1 V + 0.0071 V^2$	$\geq 5.4 \text{ m/s}^2$
Vehicles with CBS – secondary service brake systems:		
ALL	$S \leq 0.1 V + 0.0154 V^2$	$\geq 2.5 \text{ m/s}^2$

4. Dry stop test – all service brake controls actuated
 - 4.1. Vehicle condition:
 - (a) The test is applicable to vehicle categories L₃, L₄, L₅ and L₇;
 - (b) Lightly loaded;
 - (c) Engine disconnected.
 - 4.2. Test conditions and procedure:

- (a) Initial brake temperature: $\geq 55\text{ }^{\circ}\text{C}$ and $\leq 100\text{ }^{\circ}\text{C}$;
- (b) Test speed: 100 km/h or 0.9 V_{max} , whichever is lower;
- (c) Brake application:
Simultaneous actuation of both brake controls, in the case of a vehicle with two service brake systems or actuation of the single brake control in the case of a vehicle with one service brake system.
- (d) Brake actuation force:
Hand control: $\leq 250\text{ N}$;
Foot control: $\leq 400\text{ N}$ for vehicle categories L_3 and L_4 ;
 $\leq 500\text{ N}$ for vehicle category L_5 and L_7 ;
- (e) Number of stops: until the vehicle meets the performance requirements, with a maximum of 6 stops;
- (f) For each stop, accelerate the vehicle to the test speed and then actuate the brake controls under the conditions specified in this paragraph.

4.3. Performance requirements

When the brakes are tested in accordance with the test procedure set out in paragraph 4.2., the stopping distance (S) shall be $S \leq 0.0060 V^2$ (where V is the specified test speed in km/h and S is the required stopping distance in metres).

5. High speed test

5.1. Vehicle condition:

- (a) The test is applicable to vehicle categories L_3 , L_4 , L_5 and L_7 ;
- (b) Test is not required for vehicles with $V_{\text{max}} \leq 125\text{ km/h}$;
- (c) Lightly loaded;
- (d) Engine connected with the transmission in the highest gear.

5.2. Test conditions and procedure:

- (a) Initial brake temperature: $\geq 55\text{ }^{\circ}\text{C}$ and $\leq 100\text{ }^{\circ}\text{C}$;
- (b) Test speed: 0.8 V_{max} for vehicles with $V_{\text{max}} > 125\text{ km/h}$ and $< 200\text{ km/h}$;
160 km/h for vehicles with $V_{\text{max}} \geq 200\text{ km/h}$;
- (c) Brake application:
Simultaneous actuation of both brake controls, in the case of a vehicle with two service brake systems or actuation of the single brake control in the case of a vehicle with one service brake system.
- (d) Brake actuation force:
Hand control: $\leq 200\text{ N}$;
Foot control: $\leq 350\text{ N}$ for vehicle categories L_3 and L_4 ;
 $\leq 500\text{ N}$ for vehicle category L_5 and L_7 ;

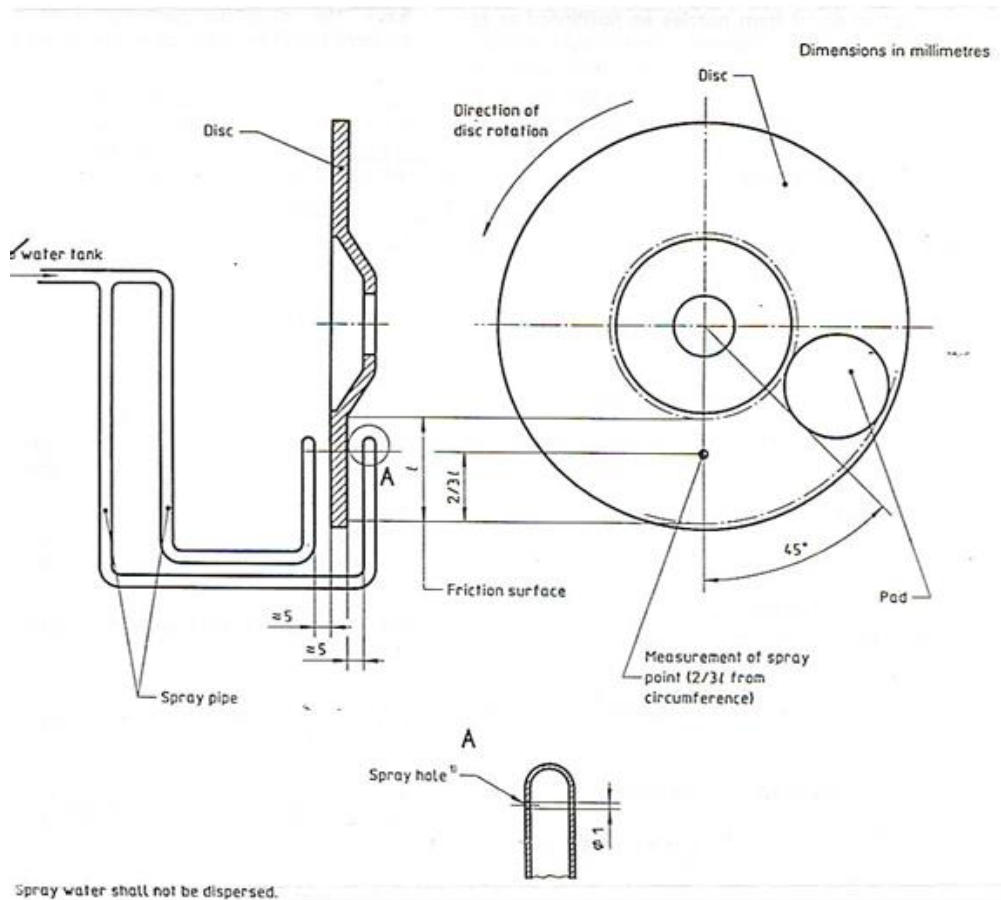
- (e) Number of stops: until the vehicle meets the performance requirements, with a maximum of 6 stops;
 - (f) For each stop, accelerate the vehicle to the test speed and then actuate the brake control(s) under the conditions specified in this paragraph.
- 5.3. Performance requirements:

When the brakes are tested in accordance with the test procedure set out in paragraph 5.2.:

 - (a) The stopping distance (S) shall be $\leq 0.1 V + 0.0067 V^2$
(where V is the specified test speed in km/h and S is the required stopping distance in metres); or
 - (b) The MFDD shall be $\geq 5.8 \text{ m/s}^2$.
- 6. Wet brake test
- 6.1. General:
 - (a) The test is comprised of two parts that are carried out consecutively for each brake system:
 - (i) A baseline test based on the dry stop test - single brake control actuated (section 3. of this annex);
 - (ii) A single wet brake stop using the same test parameters as in (i), but with the brake(s) being continuously sprayed with water while the test is conducted in order to measure the brakes' performance in wet conditions;
 - (b) The test is not applicable to a parking brake system, unless it is the secondary brake;
 - (c) Drum brakes or fully enclosed disc brakes are exempt from this test unless ventilation or open inspection ports are present;
 - (d) This test requires the vehicle to be fitted with instrumentation that gives a continuous recording of brake control force and vehicle deceleration. The MFDD and the stopping distance measurements are not appropriate in this case.
- 6.2. Vehicle condition:
 - (a) The test is applicable to all vehicle categories;
 - (b) Laden:

For vehicles fitted with CBS and split service brake systems: the vehicle is tested in the lightly loaded condition in addition to the laden condition;
 - (c) Engine disconnected;
 - (d) Each brake is fitted with water spray equipment:
 - (i) Disc brakes: Sketch of water spray equipment:

Figure 2



The disc brake water spray equipment is installed as follows:

- a. Water is sprayed onto each brake with a flow rate of 15 litres/hr. The water is equally distributed on each side of the rotor;
- b. If the surface of the rotor has any shielding, the spray is applied 45° prior to the shield;
- c. If it is not possible to locate the spray in the position shown on the sketch, or if the spray coincides with a brake ventilation hole or similar, the spray nozzle may be advanced by an additional 90° maximum from the edge of the pad, using the same radius;
- (ii) Drum brakes with ventilation and open inspection ports:

The water spray equipment is installed as follows:

- a. Water is sprayed equally onto both sides of the drum brake assembly (on the stationary back plate and on the rotating drum) with a flow rate of 15 litres/hr;

- b. The spray nozzles are positioned two thirds of the distance from the outer circumference of the rotating drum to the wheel hub centre;
- c. The nozzle position is $> 15^\circ$ from the edge of any opening in the drum back plate.

6.3. Baseline test

6.3.1. Test conditions and procedure:

- (a) The test in section 3. of this annex (dry stop test - single brake control actuated) is carried out for each brake system but with the brake control force that results in a vehicle deceleration of $2.5 - 3.0 \text{ m/s}^2$, and the following is determined:
 - (i) The average brake control force measured when the vehicle is travelling between 80 per cent and 10 per cent of the specified test speed;
 - (ii) The average vehicle deceleration in the period 0.5 to 1.0 seconds after the point of actuation of the brake control;
 - (iii) The maximum vehicle deceleration during the complete stop but excluding the final 0.5 seconds;
- (b) Conduct 3 baseline stops and average the values obtained in (i), (ii), and (iii).

6.4. Wet brake stop

6.4.1. Test conditions and procedure:

- (a) The vehicle is ridden at the test speed used in the baseline test set out in paragraph 6.3. with the water spray equipment operating on the brake(s) to be tested and with no application of the brake system;
- (b) After a distance of $\geq 500 \text{ m}$, apply the averaged brake control force determined in the baseline test for the brake system being tested;
- (c) Measure the average vehicle deceleration in the period 0.5 to 1.0 seconds after the point of actuation of the brake control;
- (d) Measure the maximum vehicle deceleration during the complete stop but excluding the final 0.5 seconds.

6.5. Performance requirements

When the brakes are tested in accordance with the test procedure set out in paragraph 6.4.1., the wet brake deceleration performance shall be:

- (a) The value measured in paragraph 6.4.1.(c) ≥ 60 per cent of the averaged deceleration values recorded in the baseline test in paragraph 6.3.1.(a)(ii), i.e. in the period 0.5 to 1.0 seconds after the point of application of the brake control; and
- (b) The value measured in 6.4.1.(d) ≤ 120 per cent of the averaged deceleration values recorded in the baseline test 6.3.1.(a)(iii), i.e. during the complete stop but excluding the final 0.5 seconds.

7. Heat fade test
- 7.1. General:
- (a) The test comprises three parts that are carried out consecutively for each brake system:
 - (i) A baseline test using the dry stop test - single brake control actuated (section 3. of this annex);
 - (ii) A heating procedure which consists of a series of repeated stops in order to heat the brake(s);
 - (iii) A hot brake stop using the dry stop test - single brake control actuated (section 3 of this annex), to measure the brake's performance after the heating procedure;
 - (b) The test is applicable to vehicle categories L₃, L₄, L₅ and L₇;
 - (c) The test is not applicable to parking brake systems and secondary service brake systems;
 - (d) All stops are carried out with the vehicle laden;
 - (e) The heating procedure requires the vehicle to be fitted with instrumentation that gives a continuous recording of brake control force and vehicle deceleration. The MFDD and stopping distance measurements are not appropriate for the heating procedure. The baseline test and the hot brake stop require the measurement of either MFDD or the stopping distance.
- 7.2. Baseline test
- 7.2.1. Vehicle condition:
- (a) Engine disconnected.
- 7.2.2. Test conditions and procedure:
- (a) Initial brake temperature: $\geq 55\text{ }^{\circ}\text{C}$ and $\leq 100\text{ }^{\circ}\text{C}$;
 - (b) Test speed: 60 km/h or 0.9 V_{max}, whichever is lower;
 - (c) Brake application:
Each service brake system control actuated separately;
 - (d) Brake actuation force:
Hand control: $\leq 200\text{ N}$;
Foot control: $\leq 350\text{ N}$ for vehicle categories L₃ and L₄;
 $\leq 500\text{ N}$ for vehicle category L₅ and L₇;
 - (e) Accelerate the vehicle to the test speed, actuate the brake control under the conditions specified and record the control force required to achieve the vehicle braking performance specified in the table to paragraph 3.3. of this annex.

- 7.3. Heating procedure
- 7.3.1. Vehicle condition:
- (a) Engine transmission:
 - (i) From the specified test speed to 50 per cent specified test speed: connected, with the highest appropriate gear selected such that the engine speed remains above the manufacturer's specified idle speed;
 - (ii) From 50 per cent specified test speed to standstill: disconnected.
- 7.3.2. Test conditions and procedure:
- (a) Initial brake temperature prior to first stop only: $\geq 55\text{ }^{\circ}\text{C}$ and $\leq 100\text{ }^{\circ}\text{C}$;
 - (b) Test speed:
 - Single brake system, front wheel braking only: 100 km/h or 0.7 V_{max} , whichever is lower;
 - Single brake system, rear wheel braking only: 80 km/h or 0.7 V_{max} , whichever is lower;
 - CBS or split service brake system: 100 km/h or 0.7 V_{max} , whichever is lower;
 - (c) Brake application:
 - Each service brake system control actuated separately;
 - (d) Brake actuation force:
 - (i) For the first stop:
 - The constant control force that achieves a vehicle deceleration rate of $3.0 - 3.5\text{ m/s}^2$ while the vehicle is decelerating between 80 per cent and 10 per cent of the specified speed;
 - If the vehicle is unable to achieve the specified vehicle deceleration rate, this stop is carried out to meet the deceleration requirements in the table in paragraph 3.3. of this annex;
 - (ii) For the remaining stops:
 - a. The same constant brake control force as used for the first stop;
 - b. Number of stops: 10;
 - c. Interval between stops: 1000 m;
 - (e) Carry out a stop to the conditions specified in this paragraph and then immediately use maximum acceleration to reach the specified speed and maintain that speed until the next stop is made.
- 7.4. Hot brake stop
- 7.4.1. Test conditions and procedure:
- Perform a single stop under the conditions used in the baseline test (paragraph 7.2.) for the brake system that has been heated during the procedure in accordance with paragraph 7.3. This stop is carried out within one minute of the completion of the procedure set out in paragraph 7.3. with a brake

control application force less than or equal to the force used during the test set out in paragraph 7.2.

7.5. Performance requirements

When the brakes are tested in accordance with the test procedure set out in paragraph 7.4.1.:

- (a) The stopping distance: $S_2 \leq 1.67 S_1 - 0.67 \times 0.1V$

where:

S_1 = corrected stopping distance in metres achieved in the baseline test set out in paragraph 7.2.

S_2 = corrected stopping distance in metres achieved in the hot brake stop set out in paragraph 7.4.1.

V = specified test speed in km/h; or

- (b) The MFDD \geq 60 per cent of the MFDD recorded in the test set out in paragraph 7.2.

8. Parking brake system test – for vehicles equipped with parking brakes

8.1. Vehicle condition:

- (a) The test is applicable to vehicle categories L₂, L₄, L₅ and L₇;
(b) Laden;
(c) Engine disconnected.

8.2. Test conditions and procedure:

- (a) Initial brake temperature: ≤ 100 °C;
(b) Test surface gradient = 18 per cent;
(c) Brake actuation force:
Hand control: ≤ 400 N;
Foot control: ≤ 500 N;
(d) For the first part of the test, park the vehicle on the test surface gradient facing up the slope by applying the parking brake system under the conditions specified in this paragraph. If the vehicle remains stationary, start the measurement of the test period;
(e) On completion of the test with vehicle facing up the gradient, repeat the same test procedure with the vehicle facing down the gradient.

8.3. Performance requirements:

When tested in accordance with the test procedure set out in paragraph 8.2., the parking brake system shall hold the vehicle stationary for 5 minutes when the vehicle is both facing up and facing down the gradient.

9. ABS tests
- 9.1. General:
- (a) The tests are only applicable to the ABS if fitted and enabled;
 - (b) The tests are to confirm the performance of brake systems equipped with ABS and their performance in the event of ABS electrical failure;
 - (c) "*Fully cycling*" means that the anti-lock system is repeatedly or continuously modulating the brake force to prevent the directly controlled wheels from locking;
 - (d) Wheel-lock is allowed as long as the stability of the vehicle is not affected to the extent that it requires the operator to release the control or causes a vehicle wheel to pass outside the test lane.
 - (e) Vehicles with driver selectable ABS modes (e.g. a dual channel ABS system whereby the ABS on the rear axle can be disabled) shall comply with the technical requirements of this paragraph in all modes where ABS is enabled.

The test series comprises the following individual tests, which may be carried out in any order:

Table 3

<i>ABS Tests</i>	<i>Paragraph</i>
a. Stops on a high friction surface - as specified in paragraph 1.1.1.	9.3.
b. Stops on a low friction surface - as specified in paragraph 1.1.2.	9.4.
c. Wheel lock checks on high and low friction surfaces.	9.5.
d. Wheel lock check - high to low friction surface transition.	9.6.
e. Wheel lock check - low to high friction surface transition.	9.7.
f. Stops with an ABS electrical failure.	9.8.

- 9.2. Vehicle condition:
- (a) Lightly loaded;
 - (b) Engine disconnected.
- 9.3. Stops on a high friction surface:
- 9.3.1. Test conditions and procedure:
- (a) Initial brake temperature: $\geq 55\text{ }^{\circ}\text{C}$ and $\leq 100\text{ }^{\circ}\text{C}$;
 - (b) Test speed: 60 km/h or 0.9 Vmax, whichever is lower;
 - (c) Brake application:
Simultaneous actuation of both brake controls, in the case of a vehicle with two service brake systems or actuation of the single brake control in the case of a vehicle with one service brake system.
 - (d) Brake actuation force:
The force applied is that which is necessary to ensure that the ABS will be fully cycling throughout each stop, down to 10 km/h;

- (e) If one wheel is not equipped with ABS, the control for the service brake on that wheel shall be actuated with a force that is lower than the force that will cause the wheel to lock;
 - (f) Number of stops: until the vehicle meets the performance requirements, with a maximum of 6 stops;
 - (g) For each stop, accelerate the vehicle to the test speed and then actuate the brake control under the conditions specified in this paragraph.
- 9.3.2. Performance requirements

When the brakes are tested in accordance with the test procedures referred to in paragraph 9.3.1.:

 - (a) The stopping distance (S) shall be $\leq 0.0063V^2$ (where V is the specified test speed in km/h and S is the required stopping distance in metres) or the MFDD shall be $\geq 6.17 \text{ m/s}^2$; and
 - (b) There shall be no wheel lock and the vehicle wheels shall stay within the test lane.
- 9.4. Stops on a low friction surface:
- 9.4.1. Test conditions and procedure:

As set out in paragraph 9.3.1., but using the low friction surface instead of the high friction one;
- 9.4.2. Performance requirements

When the brakes are tested in accordance with the test procedures set out in paragraph 9.4.1.:

 - (a) The stopping distance (S) shall be $\leq 0.0056V^2/P$ (where V is the specified test speed in km/h, P is the peak braking coefficient and S is the required stopping distance in metres) or the MFDD shall be $\geq 6.87 \times P$, in m/s^2 ; and
 - (b) There shall be no wheel lock and the vehicle wheels shall stay within the test lane.
- 9.5. Wheel lock checks on high and low friction surfaces:
- 9.5.1. Test conditions and procedure:
 - (a) Test surfaces:
 - (i) High friction; and
 - (ii) Low friction;
 - (b) Initial brake temperature: $\geq 55 \text{ }^\circ\text{C}$ and $\leq 100 \text{ }^\circ\text{C}$;
 - (c) Test speed:
 - (i) On the high friction surface: 80 km/h or 0.8 Vmax, whichever is lower;
 - (ii) On the low friction surface: 60 km/h or 0.8 Vmax, whichever is lower;
 - (d) Brake application:
 - (i) Each service brake system control actuated separately;

- (ii) Where ABS is fitted to both brake systems, simultaneous actuation of both brake controls in addition to (i);
 - (e) Brake actuation force:

The force applied is that which is necessary to ensure that the ABS will be fully cycling throughout each stop, down to 10 km/h;
 - (f) Brake application rate:

The brake control actuation force is applied in 0.1 – 0.5 seconds;
 - (g) Number of stops: until the vehicle meets the performance requirements, with a maximum of 3 stops;
 - (h) For each stop, accelerate the vehicle to the test speed and then actuate the brake control under the conditions specified in this paragraph.
- 9.5.2. Performance requirements:
- When the brakes are tested in accordance with the test procedures set out in paragraph 9.5.1., there shall be no wheel lock and the vehicle wheels shall stay within the test lane.
- 9.6. Wheel lock check - high to low friction surface transition:
- 9.6.1. Test conditions and procedure:
- (a) Test surfaces:

A high friction surface immediately followed by a low friction surface;
 - (b) Initial brake temperature: $\geq 55\text{ }^{\circ}\text{C}$ and $\leq 100\text{ }^{\circ}\text{C}$;
 - (c) Test speed:

The speed that will result in 50 km/h or 0.5 Vmax, whichever is lower, at the point where the vehicle passes from the high friction to the low friction surface;
 - (d) Brake application:
 - (i) Each service brake system control actuated separately;
 - (ii) Where ABS is fitted to both brake systems, simultaneous actuation of both brake controls in addition to (i);
 - (e) Brake actuation force:

The force applied is that which is necessary to ensure that the ABS will be fully cycling throughout each stop, down to 10 km/h;
 - (f) Number of stops: until the vehicle meets the performance requirements, with a maximum of 3 stops;
 - (g) For each stop, accelerate the vehicle to the test speed and then actuate the brake control before the vehicle reaches the transition from one friction surface to the other.
- 9.6.2. Performance requirements:
- When the brakes are tested in accordance with the test procedures set out in paragraph 9.6.1., there shall be no wheel lock and the vehicle wheels shall stay within the test lane.

- 9.7. Wheel lock check - low to high friction surface transition:
- 9.7.1. Test conditions and procedure:
- (a) Test surfaces:
A low friction surface immediately followed by a high friction surface with a PBC ≥ 0.8 ;
 - (b) Initial brake temperature: $\geq 55\text{ }^{\circ}\text{C}$ and $\leq 100\text{ }^{\circ}\text{C}$;
 - (c) Test speed:
The speed that will result in 50 km/h or 0.5 Vmax, whichever is lower, at the point where the vehicle passes from the low friction to the high friction surface;
 - (d) Brake application:
 - (i) Each service brake system control applied separately;
 - (ii) Where ABS is fitted to both brake systems, simultaneous application of both brake controls in addition to (i);
 - (e) Brake actuation force:
The force applied is that which is necessary to ensure that the ABS will be fully cycling throughout each stop, down to 10 km/h;
 - (f) Number of stops: until the vehicle meets the performance requirements, with a maximum of 3 stops;
 - (g) For each stop, accelerate the vehicle to the test speed and then actuate the brake control before the vehicle reaches the transition from one friction surface to the other;
 - (h) Record the vehicle's continuous deceleration.
- 9.7.2. Performance requirements:
- (a) When the brakes are tested in accordance with the test procedures set out in paragraph 9.7.1., there shall be no wheel lock and the vehicle wheels shall stay within the test lane;
 - (b) Within 1 second of the rear wheel passing the transition point between the low and high friction surfaces, the vehicle deceleration shall increase.
- 9.8. Stops with an ABS electrical failure:
- 9.8.1. Test conditions and procedure:
- (a) With the ABS electrical system disabled, carry out the test set out in section 3. of this annex, (dry stop test – single brake control actuated) applying the conditions relevant to the brake system and vehicle being tested.
- 9.8.2. Performance requirements:
- When the brakes are tested in accordance with the test procedure set out in paragraph 9.8.1.:
- (a) The system shall comply with the failure warning requirements of paragraph 5.1.13. of this Regulation; and

- (b) The minimum requirements for stopping distance or MFDD shall be as specified in column 2 or 3, respectively, under the heading "Single brake system, rear wheel(s) braking only" in the table to paragraph 3.3. of this annex.
- 10. Partial failure test - for split service brake systems
- 10.1. General information:
 - (a) The test is only applicable to vehicles that are equipped with split service brake systems;
 - (b) The test is to confirm the performance of the remaining subsystem in the event of a hydraulic system leakage failure.
- 10.2. Vehicle condition:
 - (a) The test is applicable to vehicle categories L₃, L₄, L₅ and L₇;
 - (b) Lightly loaded;
 - (c) Engine disconnected.
- 10.3. Test conditions and procedure:
 - (a) Initial brake temperature: $\geq 55\text{ }^{\circ}\text{C}$ and $\leq 100\text{ }^{\circ}\text{C}$;
 - (b) Test speeds: 50 km/h and 100 km/h or 0.8 V_{max}, whichever is lower;
 - (c) Brake actuation force:
Hand control: $\leq 250\text{ N}$;
Foot control: $\leq 400\text{ N}$;
 - (d) Number of stops: until the vehicle meets the performance requirements, with a maximum of 6 stops for each test speed;
 - (e) Alter the service brake system to induce a complete loss of braking in any one subsystem. Then, for each stop, accelerate the vehicle to the test speed and then actuate the brake control under the conditions specified in this paragraph;
 - (f) Repeat the test for each subsystem.
- 10.4. Performance requirements:

When the brakes are tested in accordance with the test procedure set out in paragraph 10.3.:

 - (a) the system shall comply with the failure warning requirements set out in paragraph 5.1.11. of this Regulation; and
 - (b) the stopping distance (S) shall be $\leq 0.1 V + 0.0117 V^2$ (where V is the specified test speed in km/h and S is the required stopping distance in metres) or the MFDD shall be $\geq 3.3\text{ m/s}^2$.
- 11. Power-assisted braking system failure test
- 11.1. General information:
 - (a) The test is not conducted when the vehicle is equipped with another separate service brake system;

- (b) The test is to confirm the performance of the service brake system in the event of failure of the power assistance.
- 11.2. Test conditions and procedure:
- (a) Carry out the test set out in section 3. of this annex, (dry stop test – single brake control actuated) for each service brake system with the power assistance disabled.
- 11.3. Performance requirements
- When the brakes are tested in accordance with the test procedure set out in paragraph 11.2., the stopping distance shall be as specified in Column 2 or the MFDD shall be as specified in Column 3 of the following table:

Table 4

Column 1	Column 2	Column 3
Vehicle Category	STOPPING DISTANCE(S) (Where V is the specified test speed in km/h and S is the required stopping distance in metres)	MFDD
Single brake system		
L ₁	$S \leq 0.1 V + 0.0143 V^2$	$\geq 2.7 \text{ m/s}^2$
L ₂ and L ₆	$S \leq 0.1 V + 0.0143 V^2$	$\geq 2.7 \text{ m/s}^2$
L ₃	$S \leq 0.1 V + 0.0133 V^2$	$\geq 2.9 \text{ m/s}^2$
L ₄	$S \leq 0.1 V + 0.0105 V^2$	$\geq 3.6 \text{ m/s}^2$
Vehicles with CBS or SSBS		
ALL	$S \leq 0.1 V + 0.0154 V^2$	$\geq 2.5 \text{ m/s}^2$

Note that if the power assistance may be activated by more than one control, the above performance shall be achieved when each control is actuated separately.

12. CBS failure test
- 12.1. General information:
- (a) This test will only apply to vehicles fitted with CBS of which the separate service brake systems share a common hydraulic or common mechanical transmission;
- (b) The test is to confirm the performance of the service brake systems in the event of a transmission failure. This can be demonstrated by a common hydraulic hose or mechanical cable failure.
- 12.2. Test conditions and procedure:
- (a) Alter the brake system to produce a failure causing a complete loss of braking in the portion of the system which is shared;
- (b) Perform the dry stop test specified in section 3. in the laden condition. Other conditions to be observed are sections 3.1.(c) and 3.2.(a), (b), (d), (e) and (f). Instead of the provisions in section 3.2.(c), only apply the control for the brake not affected by the simulated failure.

12.3. Performance requirements

When the brakes are tested in accordance with the test procedure set out in paragraph 12.2., the stopping distance shall be as specified in Column 2 or the MFDD shall be as specified in Column 3 of the following table:

Table 5

Column 1	Column 2	Column 3
Vehicle Category	STOPPING DISTANCE (S) (Where V is the specified test speed in km/h and S is the required stopping distance in metres)	MFDD
Front wheel(s) braking only		
L ₁	$S \leq 0.1 V + 0.0111 V^2$	$\geq 3.4 \text{ m/s}^2$
L ₂ and L ₆	$S \leq 0.1 V + 0.0143 V^2$	$\geq 2.7 \text{ m/s}^2$
L ₃	$S \leq 0.1 V + 0.0087 V^2$	$\geq 4.4 \text{ m/s}^2$
L ₄	$S \leq 0.1 V + 0.0105 V^2$	$\geq 3.6 \text{ m/s}^2$
L ₅ and L ₇	$S \leq 0.1 V + 0.0117 V^2$	$\geq 3.3 \text{ m/s}^2$
Rear wheel(s) braking only		
L ₁	$S \leq 0.1 V + 0.0143 V^2$	$\geq 2.7 \text{ m/s}^2$
L ₂ and L ₆	$S \leq 0.1 V + 0.0143 V^2$	$\geq 2.7 \text{ m/s}^2$
L ₃	$S \leq 0.1 V + 0.0133 V^2$	$\geq 2.9 \text{ m/s}^2$
L ₄	$S \leq 0.1 V + 0.0105 V^2$	$\geq 3.6 \text{ m/s}^2$
L ₅ and L ₇	$S \leq 0.1 V + 0.0117 V^2$	$\geq 3.3 \text{ m/s}^2$

Annex 3 - Appendix 1

Alternative method for the determination of peak braking coefficient (PBC)

(see paragraph 1.1.3. to this annex)

1.1. General:

- (a) The test is to establish a PBC for the vehicle type when being braked on the test surfaces described in Annex 3, paragraphs 1.1.1. and 1.1.2.
- (b) The test comprises a number of stops with varying brake control forces. Both wheels shall be braked simultaneously up to the point reached before wheel lock, in order to achieve the maximum vehicle deceleration rate on the given test surface.
- (c) The maximum vehicle deceleration rate is the highest value recorded during all the test stops.
- (d) The Peak Braking Coefficient (PBC) is calculated from the test stop that generates the maximum vehicle deceleration rate, as follows:

$$PBC = \frac{0.566}{t}$$

where:

t = time taken for the vehicle speed to reduce from 40 km/h to 20 km/h in seconds.

Note: For vehicles unable to achieve a test speed of 50 km/h, PBC shall be measured as follows:

$$PBC = \frac{0.566}{t}$$

where:

t = time taken, in seconds, for the speed of the vehicle to reduce from 0.8 Vmax to (0.8 Vmax - 20), where Vmax is measured in km/h.

- (e) The value of PBC shall be rounded to two decimal places.

1.2. Vehicle condition:

- (a) The test is applicable to all vehicle categories.
- (b) The anti-lock system shall be either disconnected or inoperative (ABS function disabled), between 40 km/h and 20 km/h.
- (c) Lightly loaded.
- (d) Engine disconnected.

1.3. Test conditions and procedure:

- (a) Initial brake temperature: ≥ 55 °C and ≤ 100 °C.
- (b) Test speed: 60 km/h or 0.9 Vmax, whichever is lower.

- (c) Brake application:

Simultaneous actuation of both service brake system controls, if so equipped, or of the single service brake system control in the case of a service brake system that operates on all wheels.

For vehicles equipped with a single service brake system control, it may be necessary to modify the brake system if one of the wheels is not approaching maximum deceleration.
- (d) Brake actuation force:

The control force that achieves the maximum vehicle deceleration rate as defined in paragraph 1.1.(c).

The application of the control force shall be constant during braking.
- (e) Number of stops: until the vehicle meets its maximum deceleration rate.
- (f) For each stop, accelerate the vehicle to the test speed and then actuate the brake control(s) under the conditions specified in this paragraph.

15 June 2023

Agreement

Concerning the Adoption of Harmonized Technical United Nations Regulations for Wheeled Vehicles, Equipment and Parts which can be Fitted and/or be Used on Wheeled Vehicles and the Conditions for Reciprocal Recognition of Approvals Granted on the Basis of these United Nations Regulations*

(Revision 3, including the amendments which entered into force on 14 September 2017)

Addendum 151 – UN Regulation No. 152

Revision 2

Incorporating all valid text up to:

Supplement 1 to the 01 series of amendments – Date of entry into force: 3 January 2021

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02 series of amendments – Date of entry into force: 30 September 2021

Uniform provisions concerning the approval of motor vehicles with regard to the Advanced Emergency Braking System (AEBS) for M₁ and N₁ vehicles



UNITED NATIONS

* Former titles of the Agreement:

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 (original version);
Agreement concerning the Adoption of Uniform Technical Prescriptions for Wheeled Vehicles, Equipment and Parts which can be Fitted and/or be Used on Wheeled Vehicles and the Conditions for Reciprocal Recognition of Approvals Granted on the Basis of these Prescriptions, done at Geneva on 5 October 1995 (Revision 2).



This document is meant purely as documentation tool. The authentic and legal binding texts are: ECE/TRANS/WP.29/2020/69, ECE/TRANS/WP.29/2021/16 and ECE/TRANS/WP.29/2021/18.

UN Regulation No. 152

Uniform provisions concerning the approval of motor vehicles with regard to the Advanced Emergency Braking System (AEBS) for M₁ and N₁ vehicles

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Introduction

The intention of this Regulation is to establish uniform provisions for Advanced Emergency Braking Systems (AEBS) fitted to motor vehicles of the Categories M₁ and N₁ primarily used within urban driving conditions.

The system shall automatically detect an imminent forward collision, provide the driver with an appropriate warning and activate the vehicle braking system to decelerate the vehicle with the purpose of avoiding or mitigating the severity of a collision in the event that the driver does not respond to the warning.

In the case of a failure in the system, the safe operation of the vehicle shall not be endangered.

During any action taken by the system, the driver can, at any time through a conscious action, e.g. by a steering action or an accelerator kick-down, take control and override the system.

This Regulation cannot cover all the traffic conditions and infrastructure features in the type-approval process; this Regulation recognises that the performances required in this Regulation cannot be achieved in all conditions (vehicle condition, road adhesion, weather conditions, deteriorated road infrastructure and traffic scenarios etc. may affect the system performances). Actual conditions and features in the real world should not result in false warnings or false braking to the extent that they encourage the driver to switch the system off.

The Regulation provides the requirements for the approval for an AEBS designed to avoid collision either with cars or pedestrians or both.

This Regulation is an "if-fitted" regulation. It shall not prevent contracting parties from mandating the fitting of AEBS designed to avoid collision either with cars or pedestrians or both approved in accordance to this Regulation.

1. Scope

This Regulation applies to the approval of vehicles of Category M₁ and N₁¹ with regard to an on-board system to

- (a) Avoid or mitigate the severity of a rear-end in lane collision with a passenger car;
- (b) Avoid or mitigate the severity of an impact with a pedestrian;
- (c) Avoid or mitigate the severity of an impact with a bicycle.

2. Definitions

For the purposes of this Regulation:

- 2.1. "*Advanced Emergency Braking System (AEBS)*" means a system which can automatically detect an imminent forward collision and activate the vehicle braking system to decelerate the vehicle with the purpose of avoiding or mitigating-a collision.
- 2.2. "*Emergency Braking*" means a braking demand emitted by the AEBS to the service braking system of the vehicle.
- 2.3. "*Collision Warning*" means a warning emitted by the AEBS to the driver when the AEBS has detected an imminent forward collision.
- 2.4. "*Vehicle Type with Regard to its Advanced Emergency Braking System*" means a category of vehicles which do not differ in such essential aspects as:
 - (a) Vehicle features which significantly influence the performances of the Advanced Emergency Braking System;
 - (b) The type and design of the Advanced Emergency Braking System.
- 2.5. "*Subject Vehicle*" means the vehicle being tested.
- 2.6. "*Soft Target*" means a target that will suffer minimum damage and cause minimum damage to the subject vehicle in the event of a collision.
- 2.7. "*Vehicle Target*" means a target that represents a vehicle
- 2.8. "*Pedestrian Target*" means a soft target that represents a pedestrian
- 2.9. "*Bicycle Target*" means a soft target that represents a bicycle with cyclist
- 2.10. "*Common Space*" means an area on which two or more information functions (e.g. symbol) may be displayed, but not simultaneously.
- 2.11. "*Self-Check*" means an integrated function that checks for a system failure on a continuous basis at least while the system is active.
- 2.12. "*Time To Collision (TTC)*" means the value of time obtained by dividing the longitudinal distance (in the direction of travel of the subject vehicle) between the subject vehicle and the target by the longitudinal relative speed of the subject vehicle and the target, at any instant in time.
- 2.13. "*Dry road*" means a road with a nominal peak braking coefficient of 0.9
- 2.14. "*Peak braking coefficient (PBC)*": means the measure of tyre to road surface friction based on the maximum deceleration of a rolling tyre.

¹ As defined in the Consolidated Resolution on the Construction of Vehicles (R.E.3.), document ECE/TRANS/WP.29/78/Rev.6, para. 2 - <https://unece.org/transport/standards/transport/vehicle-regulations-wp29/resolutions>

- 2.15. "*Initialisation*" means the process of setting-up the operation of the system after switching ON the vehicle until it is fully functioning.
- 2.16. "*Mass of a vehicle in running order*" means the mass of an unladen vehicle with bodywork, including coolant, oils, at least 90 per cent of fuel, 100 per cent of other liquids, driver (75 kg) but except used waters, tools, spare wheel.
- 2.17. "*Maximum mass*" means the maximum mass stated by the vehicle manufacturer to be technically permissible (this mass may be higher than the "permissible maximum mass" laid down by the national administration).

3. Application for approval

- 3.1. The application for approval of a vehicle type with regard to the AEBS shall be submitted by the vehicle manufacturer or by his authorised representative.
- 3.2. It shall be accompanied by the documents mentioned below in triplicate:
- 3.2.1. A description of the vehicle type with regard to the items mentioned in paragraph 2.4., together with a documentation package which gives access to the basic design of the AEBS and the means by which it is linked to other vehicle systems or by which it directly controls output variables. The numbers and/or symbols identifying the vehicle type shall be specified.
- 3.3. A vehicle representative of the vehicle type to be approved shall be submitted to the Technical Service conducting the approval tests.

4. Approval

- 4.1. If the vehicle type submitted for approval pursuant to this Regulation meets the requirements of paragraph 5. below, approval of that vehicle shall be granted.
- 4.2. An approval number shall be assigned to each type approved; its first two digits (at present 00 corresponding to the 00 series of amendments) shall indicate the series of amendments incorporating the most recent major technical amendments made to the Regulation at the time of issue of the approval. The same Contracting Party shall not assign the same number to the same vehicle type equipped with another type of AEBS, or to another vehicle type.
- 4.3. Notice of approval or of refusal or withdrawal of approval pursuant to this Regulation shall be communicated to the Contracting Parties to the Agreement which apply this Regulation by means of a form conforming to the model in Annex 1 and documentation supplied by the applicant being in a format not exceeding A4 (210 × 297mm), or folded to that format, and on an appropriate scale or electronic format.
- 4.4. There shall be affixed, conspicuously and in a readily accessible place specified on the approval form, to every vehicle conforming to a vehicle type approved under this Regulation, an international approval mark conforming to the model described in Annex 2, consisting of:
- 4.4.1. A circle surrounding the Letter "E" followed by the distinguishing number of the country which has granted approval;²
- 4.4.2. The number of this Regulation, followed by the Letter "R", a dash and the approval number to the right of the circle prescribed in paragraph 4.4.1. above.

² The distinguishing numbers of the Contracting Parties to the 1958 Agreement are reproduced in Annex 3 to the Consolidated Resolution on the Construction of Vehicles (R.E.3), document ECE/TRANS/WP.29/78/Rev.6, Annex 3 - <https://unece.org/transport/standards/transport/vehicle-regulations-wp29/resolutions>

- 4.5. If the vehicle conforms to a vehicle type approved under one or more other Regulations, annexed to the Agreement, in the country which has granted approval under this Regulation, the symbol prescribed in paragraph 4.4.1. above need not be repeated; in such a case, the Regulation and approval numbers and the additional symbols shall be placed in vertical columns to the right of the symbol prescribed in paragraph 4.4.1. above.
- 4.6. The approval mark shall be clearly legible and be indelible.
- 4.7. The approval mark shall be placed close to or on the vehicle data plate.

5. Specifications

- 5.1. General requirements
 - 5.1.1. Any vehicle fitted with an AEBS complying with the definition of paragraph 2.1. above shall, when activated and operated within the prescribed speed ranges, meet the performance requirements:
 - 5.1.1.1. of paragraphs 5.1. and paragraphs 5.3. to 5.6. of this Regulation for all vehicles;
 - 5.1.1.2. of paragraph 5.2.1. of this Regulation for vehicles submitted to approval for Car to car scenario;
 - 5.1.1.3. of paragraph 5.2.2. of this Regulation for vehicles submitted to approval for Car to pedestrian scenario.
 - 5.1.1.4. Of paragraph 5.2.3. of this Regulation for vehicles submitted to approval for Car to bicycle scenario.
 - 5.1.2. The effectiveness of AEBS shall not be adversely affected by magnetic or electrical fields. This shall be demonstrated by fulfilling the technical requirements and respecting the transitional provisions of the 05 series of amendments to UN Regulation No. 10.
 - 5.1.3. Conformity with the safety aspects of electronic control systems shall be shown by meeting the requirements of Annex 3.
 - 5.1.4. Warnings

In addition to the collision warnings described in paragraphs 5.2.1.1. and 5.2.2.1., the system shall provide the driver with appropriate warning(s) as below:

 - 5.1.4.1. A failure warning when there is a failure in the AEBS that prevents the requirements of this Regulation of being met. The warning shall be as specified in paragraph 5.5.4.
 - 5.1.4.1.1. There shall not be an appreciable time interval between each AEBS self-check, and subsequently there shall not be a delay in illuminating the warning signal, in the case of an electrically detectable failure.
 - 5.1.4.1.2. If the system has not been initialised after a cumulative driving time of 15 seconds above a speed of 10km/h, information of this status shall be indicated to the driver. This information shall exist until the system has been successfully initialised.
 - 5.1.4.1.3. Upon detection of any non-electrical failure condition (e.g. sensor blindness or sensor misalignment), the warning signal as defined in paragraph 5.1.4.1. shall be illuminated.
 - 5.1.4.2. A deactivation warning, if the vehicle is equipped with a means to deactivate the AEBS, shall be given when the system is deactivated. This shall be as specified in paragraph 5.4.3.
 - 5.1.5. Emergency braking

Subject to the provisions of paragraphs 5.3.1. and 5.3.2., the system shall provide emergency braking interventions described in paragraphs 5.2.1.2., 5.2.2.2. and 5.2.3.2. having the purpose of significantly decreasing the speed of the subject vehicle.

5.1.6. False reaction avoidance

The system shall be designed to minimise the generation of collision warning signals and to avoid advanced emergency braking in situations where there is no risk of an imminent collision. This shall be demonstrated in the assessment carried out under Annex 3, and this assessment shall include in particular scenarios listed in Appendix 2 of Annex 3.

5.1.7. Any vehicle fitted with an AEBS shall meet the performance requirements of UN Regulation No. 13-H in its 01 series of amendments for vehicles of Category M₁ and N₁ or Regulation No. 13 in its 11 series of amendments for vehicles of Category N₁ and shall be equipped with an anti-lock braking function in accordance with the performance requirements of Annex 6 to UN Regulation No.13-H in its 01 series of amendments or of Annex 13 to UN Regulation No. 13 in its 11 series of amendments.

5.2. Specific Requirements

5.2.1. Car to car scenario

5.2.1.1. Collision warning

When a collision with a preceding vehicle of Category M₁, in the same lane with a relative speed above that speed up to which the subject vehicle is able to avoid the collision, is imminent, a collision warning shall be provided as specified in paragraph 5.5.1., and shall be triggered at the latest 0.8 seconds before the start of emergency braking.

However, in case the collision cannot be anticipated in time to give a collision warning 0.8 seconds ahead of an emergency braking a collision warning shall be provided as specified in paragraph 5.5.1. and shall be provided no later than the start of emergency braking intervention.

The collision warning may be aborted if the conditions prevailing a collision are no longer present.

This shall be tested according to paragraphs 6.4. and 6.5.

5.2.1.2. Emergency braking

When the system has detected the possibility of an imminent collision, there shall be a braking demand of at least 5.0 m/s² to the service braking system of the vehicle.

The emergency braking may be aborted if the conditions prevailing a collision are no longer present.

This shall be tested in accordance with paragraphs 6.4. and 6.5. of this Regulation.

5.2.1.3. Speed range

The system shall be active at least within the vehicle speed range between 10 km/h and 60 km/h and at all vehicle load conditions, unless deactivated as per paragraph 5.4.

5.2.1.4. Speed reduction by braking demand

In absence of driver's input which would lead to interruption according to paragraph 5.3.2., the AEBS shall be able to achieve a relative impact speed that is less or equal to the maximum relative impact speed as shown in the following table:

- (a) For collisions with unobstructed and constantly travelling or stationary targets;
- (b) On flat, horizontal and dry roads;
- (c) In maximum mass and mass in running order conditions;
- (d) In situations where the vehicle longitudinal centre planes are displaced by not more than 0.2 m;
- (e) In ambient illumination conditions of at least 1000 Lux without blinding of the sensors (e.g. direct blinding sunlight);
- (f) In absence of weather conditions affecting the dynamic performance of the vehicle (e.g. no storm, not below 0°C);
- (g) When driving straight with no curve, and not turning at an intersection.

It is recognised that the performances required in this table may not be fully achieved in other conditions than those listed above. However, the system shall not deactivate or unreasonably switch the control strategy in these other conditions. This shall be demonstrated in accordance with Annex 3 of this Regulation.

Maximum relative Impact Speed (km/h) for M₁ vehicle³

Relative Speed (km/h)	Stationary/ Moving	
	Maximum mass	Mass in running order
10	0.00	0.00
15	0.00	0.00
20	0.00	0.00
25	0.00	0.00
30	0.00	0.00
35	0.00	0.00
40	0.00	0.00
42	10.00	0.00
45	15.00	15.00
50	25.00	25.00
55	30.00	30.00
60	35.00	35.00

All values in km/h

Maximum relative Impact Speed (km/h) for N₁ vehicles⁴

Relative Speed (km/h)	Stationary/Moving	
	Maximum mass	Mass in running order
10	0.00	0.00

³ For relative speeds between the listed values (e.g. 53 km/h), the maximum relative impact speed (i.e. 30/30 km/h) assigned to the next higher relative speed (i.e. 55 km/h) shall apply.

For masses above the mass in running order, the maximum relative impact speed assigned to the maximum mass shall apply.

⁴ For relative speeds between the listed values (e.g. 53 km/h), the maximum relative impact speed (i.e. 35/30 km/h) assigned to the next higher relative speed (i.e. 55 km/h) shall apply.

For masses above the mass in running order, the maximum relative impact speed assigned to the maximum mass shall apply.

15	0.00	0.00
20	0.00	0.00
25	0.00	0.00
30	0.00	0.00
32	0.00	0.00
35	0.00	0.00
38	0.00	0.00
40	10.00	0.00
42	15.00	0.00
45	20.00	15.00
50	30.00	25.00
55	35.00	30.00
60	40.00	35.00

All values in km/h

5.2.2. Car to pedestrian scenario

5.2.2.1. Collision warning

When the AEBS has detected the possibility of a collision with a pedestrian crossing the road at a constant speed of 5 km/h, a collision warning shall be provided as specified in paragraph 5.5.1. and shall be provided no later than the start of emergency braking intervention.

The collision warning may be aborted if the conditions prevailing a collision are no longer present.

5.2.2.2. Emergency braking

When the system has detected the possibility of an imminent collision, there shall be a braking demand of at least 5.0 m/s² to the service braking system of the vehicle.

The emergency braking may be aborted if the conditions prevailing a collision are no longer present

This shall be tested in accordance with paragraph 6.6. of this Regulation.

5.2.2.3. Speed range

The system shall be active at least within the vehicle speed range between 20 km/h and 60 km/h and at all vehicle load conditions, unless deactivated as per paragraph 5.4.

5.2.2.4. Speed reduction by braking demand

In absence of driver's input which would lead to interruption according to paragraph 5.3.2., the AEBS shall be able to achieve an impact speed that is less or equal to the maximum relative impact speed as shown in the following table:

- With unobstructed perpendicularly crossing pedestrians with a lateral speed component of not more than 5 km/h;
- In unambiguous situations (e.g. not multiple pedestrians);
- On flat, horizontal and dry roads;
- In maximum mass and mass in running order conditions;
- In situations where the anticipated impact point is displaced by not more than 0.2 m compared to the vehicle longitudinal centre plane;
- In ambient illumination conditions of at least 2000 Lux without blinding of the sensors (e.g. direct blinding sunlight).

- (g) In absence of weather conditions affecting the dynamic performance of the vehicle (e.g. no storm, not below 0°C) and
- (h) When driving straight with no curve, and not turning at an intersection..

It is recognised that the performances required in this table may not be fully achieved in other conditions than those listed above. However the system shall not deactivate or unreasonably switch the control strategy in these other conditions. This shall be demonstrated in accordance with Annex 3 of this Regulation.

Maximum Impact Speed (km/h) for M₁⁵

<i>Subject vehicle speed (km/h)</i>	<i>Maximum mass</i>	<i>Mass in running order</i>
20	0.00	0.00
25	0.00	0.00
30	0.00	0.00
35	0.00	0.00
40	0.00	0.00
42	10.00	0.00
45	15.00	15.00
50	25.00	25.00
55	30.00	30.00
60	35.00	35.00

All values in km/h

Maximum Impact Speed (km/h) for N₁ vehicles⁶

<i>Subject vehicle speed (km/h)</i>	<i>Maximum mass</i>	<i>Mass in running order</i>
20	0.00	0.00
25	0.00	0.00
30	0.00	0.00
35	0.00	0.00
38	0.00	0.00
40	10.00	0.00
42	15.00	0.00
45	20.00	15.00
50	30.00	25.00
55	35.00	30.00
60	40.00	35.00

All values in km/h

⁵ For relative speeds between the listed values (e.g. 53 km/h), the maximum relative impact speed (i.e. 30/30 km/h) assigned to the next higher relative speed (i.e. 55 km/h) shall apply. For masses above the mass in running order, the maximum relative impact speed assigned to the maximum mass shall apply.

⁶ For subject vehicle speeds between the listed values (e.g. 53 km/h), the maximum impact speed (i.e. 35/30 km/h) assigned to the next higher subject vehicle speed (i.e. 55 km/h) shall apply. For masses above the mass in running order, the maximum relative impact speed assigned to the maximum mass shall apply.

5.2.3. Car to bicycle scenario

5.2.3.1. Collision warning

When the AEBS has detected the possibility of a collision with a bicycle crossing the road at a constant speed of 15 km/h, a collision warning shall be provided as specified in paragraph 5.5.1. and shall be provided no later than the start of emergency braking intervention.

The collision warning may be aborted if the conditions prevailing a collision are no longer present.

5.2.3.2. Emergency braking

When the system has detected the possibility of an imminent collision, there shall be a braking demand of at least 5.0 m/s² to the service braking system of the vehicle.

The emergency braking may be aborted if the conditions prevailing a collision are no longer present

This shall be tested in accordance with paragraph 6.7. of this Regulation.

5.2.3.3. Speed range

The system shall be active at least within the vehicle speed range between 20 km/h and 60 km/h and at all vehicle load conditions., unless deactivated as per paragraph 5.4.

5.2.3.4. Speed reduction by braking demand

In absence of driver's input which would lead to interruption according to paragraph 5.3.2., the AEBS shall be able to achieve an impact speed that is less or equal to the maximum relative impact speed as shown in the following table:

- (a) With unobstructed perpendicularly crossing bicycles with constant speeds from 10 to 15 km/h;
- (b) In unambiguous situations (e.g. not multiple bicycles);
- (c) On flat, horizontal and dry roads;
- (d) In maximum mass and mass in running order conditions;
- (e) In situations where the anticipated impact point of the crankshaft of the bicycle is displaced by not more than 0.2 m compared to the vehicle longitudinal centre plane;
- (f) In ambient illumination conditions of at least 2000 Lux without blinding of the sensors (e.g. direct blinding sunlight);
- (g) In absence of weather conditions affecting the dynamic performance of the vehicle (e.g. no storm, not below 273.15K or 0°C); and
- (h) When driving straight with no curve, and not turning at an intersection.

It is recognised that the performances required in this table may not be fully achieved in other conditions than those listed above. However the system shall not deactivate or unreasonably switch the control strategy in these other conditions. This shall be demonstrated in accordance with Annex 3 of this Regulation.

Maximum Impact Speed (km/h) for M₁⁷

<i>Subject vehicle speed (km/h)</i>	<i>Maximum mass</i>	<i>Mass in running order</i>
20	0.00	0.00
25	0.00	0.00
30	0.00	0.00
35	0.00	0.00
38	0.00	0.00
40	10.00	0.00
45	25.00	25.00
50	30.00	30.00
55	35.00	35.00
60	40.00	40.00

All values in km/h

Maximum Impact Speed (km/h) for N₁⁸

<i>Subject vehicle speed (km/h)</i>	<i>Maximum mass</i>	<i>Mass in running order</i>
20	0.00	0.00
25	0.00	0.00
30	0.00	0.00
35	0.00	0.00
36	0.00	0.00
38	15.00	0.00
40	25.00	0.00
45	30.00	25.00
50	35.00	30.00
55	40.00	35.00
60	45.00	40.00

All values in km/h

5.3. Interruption by the Driver

- 5.3.1. The AEBS shall provide the means for the driver to interrupt the collision warning and the emergency braking.
- 5.3.2. In both cases above, this interruption may be initiated by any positive action (e.g. kick-down, operating the direction indicator control) that indicates that the driver is aware of the emergency situation. The vehicle manufacturer shall provide a list of these positive actions to the technical service at the time of type approval and it shall be annexed to the test report.
- 5.4. Deactivation
- 5.4.1. When a vehicle is equipped with a means to manually deactivate the AEBS function, the following conditions shall apply as appropriate:
- 5.4.1.1 The AEBS function shall be automatically reinstated at the initiation of each new ignition cycle.

⁷ For subject vehicle speeds between the listed values (e.g. 53 km/h), the maximum relative impact speed (i.e. 35/35 km/h) assigned to the next higher relative speed (i.e. 55 km/h) shall apply.

For masses above the mass in running order, the maximum relative impact speed assigned to the maximum mass shall apply.

⁸ For subject vehicle speeds between the listed values (e.g. 53 km/h), the maximum relative impact speed (i.e. 40/35 km/h) assigned to the next higher relative speed (i.e. 55 km/h) shall apply.

For masses above the mass in running order, the maximum relative impact speed assigned to the maximum mass shall apply.

- 5.4.1.2. The AEBS control shall be designed in such a way that manual deactivation shall not be possible with less than two deliberate actions.
- 5.4.1.3. The AEBS control shall be installed so as to comply with the relevant requirements and transitional provisions of UN Regulation No. 121 in its 01 series of amendments or any later series of amendments.
- 5.4.1.4. It shall not be possible to manually deactivate the AEBS at a speed above 10 km/h.
- 5.4.2. When the vehicle is equipped with a means to automatically deactivate the AEBS function, for instance in situations such as off-road use, being towed, being operated on a dynamometer, being operated in a washing plant, the following conditions shall apply as appropriate:
 - 5.4.2.1. The vehicle manufacturer shall provide a list of situations and corresponding criteria where the AEBS function is automatically deactivated to the technical service at the time of type approval and it shall be annexed to the test report.
 - 5.4.2.2. The AEBS function shall be automatically reactivated as soon as the conditions that led to the automatic deactivation are not present anymore.
 - 5.4.2.3. Where automatic deactivation of the AEBS function is a consequence of the driver manually switching off the ESC function of the vehicle, this deactivation of the AEBS shall require at least two deliberate actions by the driver.
- 5.4.3. A constant optical warning signal shall inform the driver that the AEBS function has been deactivated. The yellow warning signal specified in paragraph 5.5.4. below may be used for this purpose.
- 5.4.4. While automated driving functions are in longitudinal control of the vehicle (e.g. ALKS is active) the AEBS function may be suspended or its control strategies (i.e. braking demand, warning timing) adapted without indication to the driver, as long as it remains ensured that the vehicle provides at least the same collision avoidance capabilities as the AEBS function during manual operation.
- 5.5. Warning Indication
 - 5.5.1. The collision warning referred to in paragraphs 5.2.1.1., 5.2.2.1. and 5.2.3.1. shall be provided by at least two modes selected from acoustic, haptic or optical.
 - 5.5.2. A description of the warning indication and the sequence in which the collision warning signals are presented to the driver shall be provided by the vehicle manufacturer at the time of type-approval and recorded in the test report.
 - 5.5.3. Where an optical means is used as part of the collision warning, the optical signal may be the flashing of the failure warning signal specified in paragraph 5.5.4.
 - 5.5.4. The failure warning referred to in paragraph 5.1.4.1. shall be a constant yellow optical warning signal.
 - 5.5.5. Each AEBS optical warning signal shall be activated either when the ignition (start) switch is turned to the "on" (run) position or when the ignition (start) switch is in a position between the "on" (run) and "start" position that is designated by the manufacturer as a check position (initial system (power-on)). This requirement does not apply to warning signals shown in a common space.
 - 5.5.6. The optical warning signals shall be visible even by daylight; the satisfactory condition of the signals must be easily verifiable by the driver from the driver's seat.
 - 5.5.7. When the driver is provided with an optical warning signal to indicate that the AEBS is temporarily not available, for example due to inclement weather

conditions, the signal shall be constant. The failure warning signal specified in paragraph 5.5.4. above may be used for this purpose.

5.6. Provisions for the Periodic Technical Inspection

- 5.6.1. At a Periodic Technical Inspection, it shall be possible to confirm the correct operational status of the AEBS by a visible observation of the failure warning signal status. following a "power-ON" and any bulb check.

In the case of the failure warning signal being in a common space. the common space must be observed to be functional prior to the failure warning signal status check.

- 5.6.2. At the time of type approval, the means to protect against simple unauthorised modification of the operation of the failure warning signal chosen by the manufacturer shall be confidentially outlined.

Alternatively, this protection requirement is fulfilled when a secondary means of checking the correct operational status of the AEBS is available.

6. Test procedure

6.1. Test Conditions

- 6.1.1. The test shall be performed on a flat. dry concrete or asphalt surface affording good adhesion.

- 6.1.1.1. The road test surface shall have a nominal⁹ peak braking coefficient (PBC) of 0.9. unless otherwise specified. when measured using either:

- 6.1.1.2. The American Society for Testing and Materials (ASTM) E1136 standard reference test tyre. in accordance with ASTM Method E1337-90. at a speed of 40 mph; or

- 6.1.1.3. The k-test method specified in Appendix 2 to Annex 6 of UN Regulation No. 13-H.

- 6.1.1.4. The test surface has a consistent slope between level and 1 per cent.

- 6.1.2. The ambient temperature shall be between 0°C and 45°C.

- 6.1.3. The horizontal visibility range shall allow the target to be observed throughout the test.

- 6.1.4. The tests shall be performed when there is no wind liable to affect the results.

- 6.1.5. Natural ambient illumination must be homogeneous in the test area and in excess of 1000 lux in the case of car to car scenario as stipulated in paragraph 5.2.1. and of 2000 lux in the case of car to pedestrian scenario as stipulated in paragraph 5.2.2. and of 2000 lux in the case of car to bicycle scenario as stipulated in paragraph 5.2.3. It should be ensured that testing is not performed whilst driving towards, or away from the sun at a low angle.

- 6.1.6. At the request of the manufacturer and with the agreement of the Technical Service tests may be conducted under deviating test conditions (suboptimal conditions, e.g. on a not dry surface; below the specified minimum ambient temperature), whilst the performance requirements are still to be met.

6.2. Vehicle Conditions

- 6.2.1. Test mass

The vehicle shall be tested:

⁹ The "nominal" value is understood as being the minimum theoretical target value.

- (a) At the mass in running order with an additional mass of maximum 125 kg where this additional mass includes the measuring equipment and a possible second person who is responsible for noting the results in order to demonstrate compliance with the requirements referring to the mass in running order, and

- (b) At the maximum mass

The load distribution shall be according to the manufacturer's recommendation and be annexed to the test report. No alteration shall be made once the test procedure has begun.

During the series of test runs, the fuel level may decrease but shall never fall below 50 per cent.

6.2.2. Pre-Test Conditioning

6.2.2.1. If requested by the vehicle manufacturer:

- (a) The vehicle can be driven a maximum of 100 km on a mixture of urban and rural roads with other traffic and roadside furniture to initialise the sensor system.
- (b) The vehicle can undergo a sequence of brake activations in order to ensure the service brake system is bedded in prior to the test.
- (c) The average temperature of the service brakes on the hottest axle of the vehicle, measured inside the brake linings or on the braking path of the disc or drum, is between 65 and 100°C prior to each test run.

6.2.2.2. Details of the pre-test condition strategy requested by the vehicle manufacturer shall be identified and recorded in the vehicle type approval documentation.

6.2.3. The mounted tyres shall be identified and recorded in the vehicle type approval documentation.

6.3. Test Targets

6.3.1. The target used for the vehicle detection tests shall be a regular high-volume series production passenger car of Category M₁ AA saloon, or alternatively a "soft target" representative of such a vehicle in terms of its identification characteristics applicable to the sensor system of the AEBS under test according to ISO 19206-3:2020. The reference point for the location of the vehicle shall be the most rearward point on the centreline of the vehicle.

6.3.2. The target used for the pedestrian detection tests shall be a child "articulated soft target" and be representative of the human attributes applicable to the sensor system of the AEBS under test according to ISO 19206-2:2018.

6.3.3. The targets used for the bicycle detection tests shall be a "soft target" and be representative of the bicycle with an adult cyclist attributes applicable to the sensor system of the AEBS under test according to ISO 19206-4:2020.

6.3.4. Details that enable the target(s) to be specifically identified and reproduced shall be recorded in the vehicle type approval documentation.

6.4. Warning and Activation Test with a Stationary Vehicle Target

The subject vehicle shall approach the stationary target in a straight line for at least two seconds prior to the functional part of the test with a subject vehicle to target centreline offset of not more than 0.2 m.

Tests shall be conducted with a vehicle travelling at speeds shown in tables below for respectively M₁ and N₁ Categories. If this is deemed justified, the technical service may test any other speeds listed in the tables in paragraph 5.2.1.4. and within the prescribed speed range as defined in paragraph 5.2.1.3.

Subject vehicle test speed for M₁ category in stationary target scenario

<i>Maximum mass</i>	<i>Mass in running order</i>	<i>Tolerance</i>
20	20	+2/-0
40	42	+0/-2
60	60	+0/-2

All values in km/h

Subject vehicle test speed for N₁ category in stationary target scenario

<i>Maximum mass</i>	<i>Mass in running order</i>	<i>Tolerance</i>
20	20	+2/-0
38	42	+0/-2
60	60	+0/-2

All values in km/h

The functional part of the test shall start when the subject vehicle is travelling at a constant speed and is at a distance corresponding to a Time To Collision (TTC) of at least 4 seconds from the target.

From the start of the functional part until the point of collision there shall be no adjustment to any control of the subject vehicle by the driver other than slight adjustments to the steering control to counteract any drifting.

6.5. **Warning and Activation Test with a Moving Vehicle Target**

The subject vehicle and the moving target shall travel in a straight line, in the same direction, for at least two seconds prior to the functional part of the test, with a subject vehicle to target centreline offset of not more than 0.2m.

Tests shall be conducted with a vehicle travelling at speeds shown in tables below for respectively M₁ and N₁ categories and target travelling at 20 km/h (with a tolerance of +0/-2 km/h for the target vehicles). If this is deemed justified, the Technical Service may test any other speeds for subject vehicle and target vehicle within the speed range as defined in paragraph 5.2.1.3.

Subject vehicle test speed for M₁ category in moving target scenario

<i>Maximum mass</i>	<i>Mass in running order</i>	<i>Tolerance</i>
30	30	+2/-0
60	60	+0/-2

All values in km/h

Subject vehicle test speed for N₁ category in moving target scenario

<i>Maximum mass</i>	<i>Mass in running order</i>	<i>Tolerance</i>
30	30	+2/-0
58	60	+0/-2

All values in km/h

The functional part of the test shall start when the subject vehicle is travelling at a constant speed and is at a distance corresponding to a TTC of at least 4 seconds from the target.

From the start of the functional part of the test until the subject vehicle comes to a speed equal to that of the target there shall be no adjustment to any subject vehicle control by the driver other than slight steering adjustments to counteract any drifting.

6.6. **Warning and Activation Test with a Pedestrian Target**

6.6.1. The subject vehicle shall approach the impact point with the pedestrian target in a straight line for at least two seconds prior to the functional part of the test

with an anticipated subject vehicle to impact point centreline offset of not more than 0.1 m.

The functional part of the test shall start when the subject vehicle is travelling at a constant speed and is at a distance corresponding to a TTC of at least 4 seconds from the collision point.

The pedestrian target shall travel in a straight line perpendicular to the subject vehicle's direction of travel at a constant speed of 5 km/h ± 0.4 km/h, starting not before the functional part of the test has started. The pedestrian target's positioning shall be coordinated with the subject vehicle in such a way that the impact point of the pedestrian target on the front of the subject vehicle is on the longitudinal centreline of the subject vehicle, with a tolerance of not more than 0.1 m. if the subject vehicle would remain at the prescribed test speed throughout the functional part of the test and does not brake.

Tests shall be conducted with a vehicle travelling at speeds shown in tables below for respectively M₁ and N₁ categories. The technical service may test any other speeds listed in the table in paragraph 5.2.2.4. and within the prescribed speed range as defined in paragraphs 5.2.2.3.

Subject vehicle test speed for M₁ category in pedestrian target scenario

<i>Maximum mass</i>	<i>Mass in running order</i>	<i>Tolerance</i>
20	20	+2/-0
40	42	+0/-2
60	60	+0/-2

All values in km/h

Subject vehicle test speed for N₁ category in pedestrian target scenario

<i>Maximum mass</i>	<i>Mass in running order</i>	<i>Tolerance</i>
20	20	+2/-0
38	42	+0/-2
60	60	+0/-2

All values in km/h

From the start of the functional part until the subject vehicle has avoided the collision or the subject vehicle has passed the impact point with the pedestrian target there shall be no adjustment to any control of the subject vehicle by the driver other than slight adjustments to the steering control to counteract any drifting.

The test prescribed above shall be carried out with a child pedestrian "soft target" defined in 6.3.2.

6.6.2. The assessment of the impact speed shall be based on the actual contact point between the target and the vehicle, taking into account the vehicle shape.

6.7. Warning and Activation Test with a Bicycle Target

6.7.1. The subject vehicle shall approach the impact point with the bicycle target in a straight line for at least two seconds prior to the functional part of the test with an anticipated subject vehicle to crankshaft of the bicycle impact point centreline offset of not more than 0.1 m.

The functional part of the test shall start when the subject vehicle is travelling at a constant speed and is at a distance corresponding to a TTC of at least 4 seconds from the collision point.

The bicycle target shall travel in a straight line perpendicular to the subject vehicle's direction of travel at a constant speed of 15 km/h ± 1 km/h, starting not before the functional part of the test has started. During the acceleration phase of the bicycle prior to the functional part of the test the bicycle target

shall be obstructed. The bicycle target's positioning shall be coordinated with the subject vehicle in such a way that the impact point of the bicycle target on the front of the subject vehicle is on the longitudinal centreline of the subject vehicle, with a tolerance of not more than 0.1 m, if the subject vehicle would remain at the prescribed test speed throughout the functional part of the test and does not brake.

Tests shall be conducted with a vehicle travelling at speeds shown in tables below for respectively M₁ and N₁ Categories. The technical service may test any other speeds listed in the table in paragraph 5.2.3.4. and within the prescribed speed range as defined in paragraphs 5.2.3.3.

Subject vehicle test speed for M₁ category in bicycle target scenario

<i>Maximum mass</i>	<i>Mass in running order</i>	<i>Tolerance</i>
20	20	+2/-0
38	40	+0/-2
60	60	+0/-2

All values in km/h

Subject vehicle test speed for N₁ category in bicycle target scenario

<i>Maximum mass</i>	<i>Mass in running order</i>	<i>Tolerance</i>
20	20	+2/-0
36	40	+0/-2
60	60	+0/-2

All values in km/h

From the start of the functional part until the subject vehicle has avoided the collision or the subject vehicle has passed the impact point with the bicycle target there shall be no adjustment to any control of the subject vehicle by the driver other than slight adjustments to the steering control to counteract any drifting.

The test prescribed above shall be carried out with a bicycle "soft target" defined in paragraph 6.3.3.

- 6.7.2. The assessment of the impact speed shall be based on the actual contact point between the target and the vehicle, taking into account the vehicle shape.
- 6.8. Failure Detection Test
 - 6.8.1 Simulate an electrical failure, for example, by disconnecting the power source to any AEBS component or disconnecting any electrical connection between AEBS components. When simulating an AEBS failure, neither the electrical connections for the driver warning signal of paragraph 5.5.4. above nor the optional manual AEBS deactivation control of paragraph 5.4.1. shall be disconnected.
 - 6.8.2. The failure warning signal mentioned in paragraph 5.5.4. above shall be activated and remain activated not later than 10 s after the vehicle has been driven at a speed greater than 10 km/h and be reactivated immediately after a subsequent ignition "off" ignition "on" cycle with the vehicle stationary as long as the simulated failure exists.
- 6.9. Deactivation Test
 - 6.9.1. For vehicles equipped with means to manually deactivate the AEBS, turn the ignition (start) switch to the "on" (run) position and deactivate the AEBS. The warning signal mentioned in paragraph 5.4.3. above shall be activated. Turn the ignition (start) switch to the "off" position. Again, turn the ignition (start) switch to the "on" (run) position and verify that the previously activated warning signal is not reactivated, thereby indicating that the AEBS has been reinstated as specified in paragraph 5.4.1. above. If the ignition system is

activated by means of a "key", the above requirement shall be fulfilled without removing the key.

- 6.10. Robustness of the system
- 6.10.1. Any of the above test scenarios, where a scenario describes one test setup at one subject vehicle speed at one load condition of one category (Car to Car, Car to Pedestrian, Car to Bicycle), shall be performed two times. If one of the two test runs fails to meet the required performance, the test may be repeated once. A test scenario shall be accounted as passed if the required performance is met in two test runs. The number of failed tests runs within one category shall not exceed:
 - (a) 10.0 per cent of the performed test runs for the Car to Car tests;
 - (b) 10.0 per cent of the performed test runs for the Car to Pedestrian tests; and
 - (c) 20.0 per cent of the performed test runs for the Car to Bicycle tests.
- 6.10.2. The root cause of any failed test run shall be analyzed together with the Technical Service and annexed to the test report. If the root cause cannot be linked to a deviation in the test setup, the technical service may test any other speeds within the speed range as defined in paragraphs 5.2.1.3., 5.2.1.4., 5.2.2.3., 5.2.2.4., 5.2.3.3. or 5.2.3.4. as relevant.
- 6.10.3. During the assessment as per Annex 3, the manufacturer shall demonstrate, via appropriate documentation, that the system is capable of reliably delivering the required performances.

7. Modification of vehicle type and extension of approval

- 7.1. Every modification of the vehicle type as defined in paragraph 2.4. above shall be notified to the Type Approval Authority which approved the vehicle type. The Type Approval Authority may then either:
 - 7.1.1. Consider that the modifications made do not have an adverse effect on the conditions of the granting of the approval and grant an extension of approval;
 - 7.1.2. Consider that the modifications made affect the conditions of the granting of the approval and require further tests or additional checks before granting an extension of approval.
- 7.2. Confirmation or refusal of approval, specifying the alterations, shall be communicated by the procedure specified in paragraph 4.3. above to the Contracting Parties to the Agreement which apply this Regulation.
- 7.3. The Type Approval Authority shall inform the other Contracting Parties of the extension by means of the communication form which appears in Annex 1 to this Regulation. It shall assign a serial number to each extension to be known as the extension number.

8. Conformity of production

- 8.1. Procedures concerning conformity of production shall comply with those set out in the 1958 Agreement, Schedule 1 (E/ECE/TRANS/505/Rev.3) and meet the following requirements:
- 8.2. A vehicle approved pursuant to this Regulation shall be so manufactured as to conform to the type approved by meeting the requirements of paragraph 5. above;

- 8.3. The Type Approval Authority which has granted approval may at any time verify the conformity of control methods applicable to each production unit. The normal frequency of such inspections shall be once every two years.

9. Penalties for non-conformity of production

- 9.1. The approval granted in respect of a vehicle type pursuant to this Regulation may be withdrawn if the requirements laid down in paragraph 8, above are not complied with.
- 9.2. If a Contracting Party withdraws an approval it had previously granted, it shall forthwith so notify the other Contracting Parties applying this Regulation by sending them a communication form conforming to the model in Annex 1 to this Regulation.

10. Production definitively discontinued

If the holder of the approval completely ceases to manufacture a type of vehicle approved in accordance with this Regulation, he shall so inform the Type Approval Authority which granted the approval, which in turn shall forthwith inform the other Contracting Parties to the Agreement applying this Regulation by means of a communication form conforming to the model in Annex 1 to this Regulation.

11. Names and addresses of the Technical Services responsible for conducting approval tests and of Type Approval Authorities

The Contracting Parties to the Agreement applying this Regulation shall communicate to the United Nations Secretariat¹⁰ the names and addresses of the Technical Services responsible for conducting approval tests and of the Type Approval Authorities which grant approval and to which forms certifying approval or extension or refusal or withdrawal of approval are to be sent.

12. Transitional provisions

- 12.1. Transitional provisions applicable to the 01 series of amendments
- 12.1.1. As from the official date of entry into force of the 01 series of amendments, no Contracting Party applying this Regulation shall refuse to grant or refuse to accept type approvals under this Regulation as amended by the 01 series of amendments.
- 12.1.2. As from 1 May 2024, Contracting Parties applying this Regulation shall not be obliged to accept type approvals to the original version of this Regulation, first issued after 1 May 2024.
- 12.1.3. Until 1 May 2026, Contracting Parties applying this Regulation shall accept type approvals to the original version of this Regulation, first issued before 1 May 2024.
- 12.1.4. As from 1 May 2026, Contracting Parties applying this Regulation shall not be obliged to accept type approvals issued to the original version of this Regulation.

¹⁰ The UNECE secretariats provides the online platform ("343 Application") for exchange of such information with the secretariat: <https://www.unece.org/trans/main/wp29/datasharing.html>

- 12.1.5. Notwithstanding paragraph 12.1.4., Contracting Parties applying this Regulation shall continue to accept type approvals issued according to the original version of this Regulation, for vehicles which are not affected by the changes introduced by the 01 Series of amendments.
- 12.2. Transitional provisions applicable to the 02 series of amendments
 - 12.2.1. As from the official date of entry into force of the 02 series of amendments, no Contracting Party applying this Regulation shall refuse to grant or refuse to accept type approvals under this Regulation as amended by the 02 series of amendments.
 - 12.2.2. As from 1 May 2024, Contracting Parties applying this Regulation shall not be obliged to accept type approvals to the preceding series of amendments of this Regulation, first issued after 1 May 2024.
 - 12.2.3. Until 1 July 2026, Contracting Parties applying this Regulation shall accept type approvals to the preceding series of this Regulation, first issued before 1 May 2024.
 - 12.2.4. As from 1 July 2026, Contracting Parties applying this Regulation shall not be obliged to accept type approvals issued to the preceding series of this Regulation.
 - 12.2.5. Notwithstanding paragraph 12.2.4., Contracting Parties applying this Regulation shall continue to accept type approvals issued according to the preceding series of amendments to this Regulation, for vehicles which are not affected by the changes introduced by the 02 series of amendments (i.e. car-to-car and/or car-to-pedestrian approvals are not affected by this new 02 series).
- 12.3. General transitional provisions
 - 12.3.1. Contracting Parties applying this Regulation may grant type approvals according to any preceding series of amendments to this Regulation or extensions thereof.
 - 12.3.2. Contracting Parties applying this Regulation shall continue to grant extensions of existing approvals to any preceding series of amendments to this Regulation.

Annex 1

Communication

(Maximum format: A4 (210 x 297 mm))



issued by :

(Name of
administration)

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

Concerning: ² Approval granted
 Approval extended
 Approval refused
 Approval withdrawn
 Production definitively discontinued

of a type of vehicle with regard to the advanced emergency braking system pursuant to UN
Regulation No. 152

Approval No.:

1. Trademark:
2. Type and trade name(s):
3. Name and address of manufacturer:
4. If applicable, name and address of manufacturer's representative:
5. Brief description of vehicle:
6. Date of submission of vehicle for approval:
7. Technical Service performing the approval tests:
8. Date of report issued by that Service:
9. Number of report issued by that Service:
10. Approval
- 10.1. to car to car scenario granted/refused/extended/withdrawn:²
- 10.2. to car to pedestrian scenario granted/refused/extended/withdrawn:²
- 10.3. to car to bicycle scenario granted/refused/extended/withdrawn:²
11. Place:
12. Date:
13. Signature:
14. Annexed to this communication are the following documents, bearing the approval
 number indicated above:
15. Any remarks:

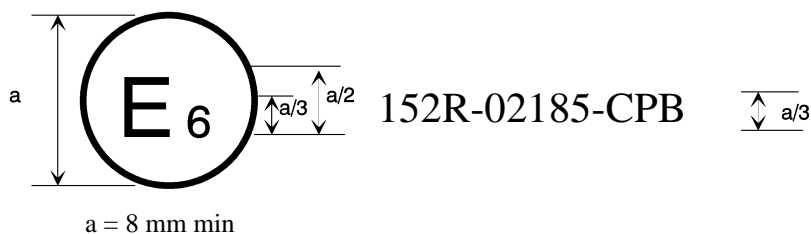
¹ Distinguishing number of the country which has granted/extended/refused/withdrawn an approval
(see approval provisions in the Regulation).

² Strike out what does not apply.

Annex 2

Arrangements of approval marks

(see paragraphs 4.4. to 4.4.2. of this Regulation)



The above approval mark affixed to a vehicle shows that the vehicle type concerned has been approved in Belgium (E 6) with regard to the Advanced Emergency Braking Systems (AEBS) pursuant to UN Regulation No. 152 (marked with C for Car to Car, P for Car to Pedestrian, B for Car to Bicycle). The first two digits of the approval number indicate that the approval was granted in accordance with the requirements of UN Regulation No. 152as amended by the 02 series of amendments.

Annex 3

Special requirements to be applied to the safety aspects of electronic control systems

1. General

This annex defines the special requirements for documentation, fault strategy and verification with respect to the safety aspects of Complex Electronic Vehicle Control Systems (paragraph 2.4. below) as far as this Regulation is concerned.

This annex shall also apply to safety related functions identified in this Regulation which are controlled by electronic system(s) (paragraph 2.3.) as far as this Regulation is concerned.

This annex does not specify the performance criteria for "The System" but covers the methodology applied to the design process and the information which must be disclosed to the Technical Service, for type approval purposes.

This information shall show that "The System" respects, under non-fault and fault conditions, all the appropriate performance requirements specified elsewhere in this Regulation and that it is designed to operate in such a way that it does not induce safety critical risks.

2. Definitions

For the purposes of this annex,

- 2.1. *The System*" means an electronic control system or complex electronic control system that provides or forms part of the control transmission of a function to which this Regulation applies. This also includes any other system covered in the scope of this Regulation, as well as transmission links to or from other systems that are outside the scope of this Regulation, that acts on a function to which this Regulation applies."
- 2.2. *"Safety Concept"* is a description of the measures designed into the system, for example within the electronic units, so as to address system integrity and thereby ensure safe operation under fault and non-fault conditions, including in the event of an electrical failure. The possibility of a fall-back to partial operation or even to a back-up system for vital vehicle functions may be a part of the safety concept.
- 2.3. *"Electronic Control System"* means a combination of units, designed to co-operate in the production of the stated vehicle control function by electronic data processing. Such systems, often controlled by software, are built from discrete functional components such as sensors, electronic control units and actuators and connected by transmission links. They may include mechanical, electro-pneumatic or electro-hydraulic elements.
- 2.4. *"Complex Electronic Vehicle Control Systems"* are those electronic control systems in which a function controlled by an electronic system or the driver may be over-ridden by a higher-level electronic control system/function. A function which is over-ridden becomes part of the complex system, as well as any overriding system/function within the scope of this Regulation. The transmission links to and from overriding systems/function outside of the scope of this Regulation shall also be included.

- 2.5. *"Higher-Level Electronic Control"* systems/functions are those which employ additional processing and/or sensing provisions to modify vehicle behaviour by commanding variations in the function(s) of the vehicle control system. This allows complex systems to automatically change their objectives with a priority which depends on the sensed circumstances.
- 2.6. *"Units"* are the smallest divisions of system components which will be considered in this annex, since these combinations of components will be treated as single entities for purposes of identification, analysis or replacement.
- 2.7. *"Transmission links"* are the means used for inter-connecting distributed units for the purpose of conveying signals, operating data or an energy supply. This equipment is generally electrical but may, in some part, be mechanical, pneumatic or hydraulic.
- 2.8. *"Range of control"* refers to an output variable and defines the range over which the system is likely to exercise control.
- 2.9. *"Boundary of functional operation"* defines the boundaries of the external physical limits within which the system is able to maintain control.
- 2.10. *"Safety Related Function"* means a function of "The System" that is capable of changing the dynamic behaviour of the vehicle. "The System" may be capable of performing more than one safety related function.

3. Documentation

3.1. Requirements

The manufacturer shall provide a documentation package which gives access to the basic design of "The System" and the means by which it is linked to other vehicle systems or by which it directly controls output variables. The function(s) of "The System" and the safety concept, as laid down by the manufacturer, shall be explained. Documentation shall be brief, yet provide evidence that the design and development has had the benefit of expertise from all the system fields which are involved. For periodic technical inspections, the documentation shall describe how the current operational status of "The System" can be checked.

The Technical Service shall assess the documentation package to show that "The System":

- (a) Is designed to operate, under non-fault and fault conditions, in such a way that it does not induce safety critical risks;
- (b) Respects, under non-fault and fault conditions, all the appropriate performance requirements specified elsewhere in this Regulation; and,
- (c) Was developed according to the development process/method declared by the manufacturer.

3.1.1. Documentation shall be made available in two parts:

- (a) The formal documentation package for the approval, containing the material listed in paragraph 3. (with the exception of that of paragraph 3.4.4.) which shall be supplied to the Technical Service at the time of submission of the type approval application. This documentation package shall be used by the Technical Service as the basic reference for the verification process set out in paragraph 4. of this annex. The Technical Service shall ensure that this documentation package remains available for a period determined in agreement with the Approval Authority. This period shall be at least 10 years counted from the time when production of the vehicle is definitely discontinued.

- (b) Additional material and analysis data of paragraph 3.4.4. which shall be retained by the manufacturer, but made open for inspection at the time of type approval. The manufacturer shall ensure that this material and analysis data remains available for a period of 10 years counted from the time when production of the vehicle is definitely discontinued.
- 3.2. Description of the functions of "The System"
- A description shall be provided which gives a simple explanation of all the control functions of "The System" and the methods employed to achieve the objectives, including a statement of the mechanism(s) by which control is exercised.
- Any described function that can be over-ridden shall be identified and a further description of the changed rationale of the function's operation provided.
- 3.2.1. A list of all input and sensed variables shall be provided and the working range of these defined.
- 3.2.2. A list of all output variables which are controlled by "The System" shall be provided and an indication given, in each case, of whether the control is direct or via another vehicle system. The range of control (paragraph 2.8.) exercised on each such variable shall be defined.
- 3.2.3. Limits defining the boundaries of functional operation (paragraph 2.9.) shall be stated where appropriate to system performance.
- 3.3. System layout and schematics
- 3.3.1. Inventory of components.
- A list shall be provided, collating all the units of "The System" and mentioning the other vehicle systems which are needed to achieve the control function in question.
- An outline schematic showing these units in combination, shall be provided with both the equipment distribution and the interconnections made clear.
- 3.3.2. Functions of the units
- The function of each unit of "The System" shall be outlined and the signals linking it with other units or with other vehicle systems shall be shown. This may be provided by a labelled block diagram or other schematic, or by a description aided by such a diagram.
- 3.3.3. Interconnections
- Interconnections within "The System" shall be shown by a circuit diagram for the electric transmission links, by a piping diagram for pneumatic or hydraulic transmission equipment and by a simplified diagrammatic layout for mechanical linkages. The transmission links both to and from other systems shall also be shown
- 3.3.4. Signal flow, operating data and priorities
- There shall be a clear correspondence between these transmission links and the signals and/or operating data carried between units. Priorities of signals and/or operating data on multiplexed data paths shall be stated wherever priority may be an issue affecting performance or safety as far as this Regulation is concerned.
- 3.3.5. Identification of units
- Each unit shall be clearly and unambiguously identifiable (e.g. by marking for hardware and marking or software output for software content) to provide corresponding hardware and documentation association.
- Where functions are combined within a single unit or indeed within a single computer, but shown in multiple blocks in the block diagram for clarity and

ease of explanation, only a single hardware identification marking shall be used. The manufacturer shall, by the use of this identification, affirm that the equipment supplied conforms to the corresponding document.

- 3.3.5.1. The identification defines the hardware and software version and, where the latter changes such as to alter the function of the unit as far as this Regulation is concerned, this identification shall also be changed.

3.4. Safety concept of the manufacturer

- 3.4.1. The Manufacturer shall provide a statement which affirms that the strategy chosen to achieve "The System" objectives will not, under non-fault conditions, prejudice the safe operation of the vehicle.

- 3.4.2. In respect of software employed in "The System", the outline architecture shall be explained and the design methods and tools used shall be identified. The manufacturer shall show evidence of the means by which they determined the realisation of the system logic, during the design and development process.

- 3.4.3. The Manufacturer shall provide the Technical Service with an explanation of the design provisions built into "The System" so as to generate safe operation under fault conditions. Possible design provisions for failure in "The System" are for example:

- (a) Fall-back to operation using a partial system.
- (b) Change-over to a separate back-up system.
- (c) Removal of the high level function.

In case of a failure, the driver shall be warned for example by warning signal or message display. When the system is not deactivated by the driver, e.g. by turning the ignition (run) switch to "off", or by switching off that particular function if a special switch is provided for that purpose, the warning shall be present as long as the fault condition persists.

- 3.4.3.1. If the chosen provision selects a partial performance mode of operation under certain fault conditions, then these conditions shall be stated and the resulting limits of effectiveness defined.

- 3.4.3.2. If the chosen provision selects a second (back-up) means to realise the vehicle control system objective, the principles of the change-over mechanism, the logic and level of redundancy and any built in back-up checking features shall be explained and the resulting limits of back-up effectiveness defined.

- 3.4.3.3. If the chosen provision selects the removal of the Higher Level Function, all the corresponding output control signals associated with this function shall be inhibited, and in such a manner as to limit the transition disturbance.

- 3.4.4. The documentation shall be supported, by an analysis which shows, in overall terms, how the system will behave on the occurrence of any individual hazard or fault which will have a bearing on vehicle control performance or safety.

The chosen analytical approach(es) shall be established and maintained by the Manufacturer and shall be made open for inspection by the Technical Service at the time of the type approval.

The Technical Service shall perform an assessment of the application of the analytical approach(es). The audit shall include:

- (a) Inspection of the safety approach at the concept (vehicle) level with confirmation that it includes consideration of interactions with other vehicle systems. This approach shall be based on a Hazard / Risk analysis appropriate to system safety.
- (b) Inspection of the safety approach at the system level. This approach shall be based on a Failure Mode and Effect Analysis (FMEA), a Fault

Tree Analysis (FTA) or any similar process appropriate to system safety.

- (c) Inspection of the validation plans and results. This validation shall use, for example, Hardware in the Loop (HIL) testing, vehicle on-road operational testing, or any means appropriate for validation.

The assessment shall consist of checks of hazards and faults chosen by the Technical Service to establish that the manufacturer's explanation of the safety concept is understandable, logical and that the validation plans are suitable and have been completed.

The Technical Service may perform or may require to perform tests as specified in paragraph 4. to verify the safety concept.

- 3.4.4.1. This documentation shall itemize the parameters being monitored and shall set out, for each fault condition of the type defined in paragraph 3.4.4. of this annex, the warning signal to be given to the driver and/or to service/technical inspection personnel.

- 3.4.4.2. This documentation shall describe the measures in place to ensure the "The System" does not prejudice the safe operation of the vehicle when the performance of "The System" is affected by environmental conditions e.g. climatic, temperature, dust ingress, water ingress, ice packing.

4. Verification and test

- 4.1. The functional operation of "The System", as laid out in the documents required in paragraph 3., shall be tested as follows:

- 4.1.1. Verification of the function of "The System"

The Technical Service shall verify "The System" under non-fault conditions by testing a number of selected functions from those declared by the manufacturer in paragraph 3.2. above.

For complex electronic systems, these tests shall include scenarios whereby a declared function is overridden.

- 4.1.2. Verification of the safety concept of paragraph 3.4.

The reaction of "The System" shall be checked under the influence of a failure in any individual unit by applying corresponding output signals to electrical units or mechanical elements in order to simulate the effects of internal faults within the unit. The Technical Service shall conduct this check for at least one individual unit, but shall not check the reaction of "The System" to multiple simultaneous failures of individual units.

The Technical Service shall verify that these tests include aspects that may have an impact on vehicle controllability and user information (HMI aspects)."

- 4.1.2.1. The verification results shall correspond with the documented summary of the failure analysis, to a level of overall effect such that the safety concept and execution are confirmed as being adequate.

5. Reporting by Technical Service

Reporting of the assessment by the Technical Service shall be performed in such a manner that allows traceability, e.g. versions of documents inspected are coded and listed in the records of the Technical Service.

An example of a possible layout for the assessment form from the Technical Service to the Type Approval Authority is given in Appendix 1 to this Annex.

Annex 3 - Appendix 1

Model assessment form for electronic systems

Test report No:

1. Identification

1.1. Vehicle make:

1.2. Type:

1.3. Means of identification of type if marked on the vehicle:

1.4. Location of that marking:.....

1.5. Manufacturer's name and address:.....

1.6. If applicable, name and address of manufacturer's representative:.....

1.7. Manufacturer's formal documentation package:

Documentation reference No:

Date of original issue:

Date of latest update:

2. Test vehicle(s)/system(s) description

2.1. General description:

2.2. Description of all the control functions of "The System", and methods of operation: ..

2.3. Description of the components and diagrams of the interconnections within "The System":

3. Manufacturer's safety concept

3.1. Description of signal flow and operating data and their priorities:

3.2. Manufacturer's declaration:

The manufacturer(s) affirm(s) that the strategy chosen to achieve "The System", objectives will not, under non-fault conditions, prejudice the safe operation of the vehicle.

3.3. Software outline architecture and the design methods and tools used:

3.4. Explanation of design provisions built into "The System" under fault conditions:

3.5. Documented analyses of the behaviour of "The System" under individual hazard or fault conditions:

3.6. Description of the measures in place for environmental conditions:

3.7. Provisions for the periodic technical inspection of "The System":

3.8. Results of "The System" verification test, as per para. 4.1.1. of Annex 3 to UN Regulation No. 152:

3.9. Results of safety concept verification test, as per para. 4.1.2. of Annex 3 to UN Regulation No. 152:

3.10. Date of test:

3.11. This test has been carried out and the results reported in accordance with to UN Regulation No. 152 as last amended by the series of amendments.

Technical Service¹ carrying out the test

Signed:

Date:

3.12. Type Approval Authority¹

Signed:

Date:

3.13. Comments:

¹ To be signed by different persons even when the Technical Service and Type Approval Authority are the same or alternatively, a separate Type Approval Authority authorization is issued with the report.

Annex 3 - Appendix 2

False Reaction scenarios

The following scenarios shall be used to assess the system's strategies implemented in order to minimize the generation of false reactions. For each type of scenario the vehicle manufacturer shall explain the principle strategies implemented to ensure safety.

The manufacturer shall provide evidence (e.g. simulation results, real-world test data, track test data) of the system's behaviour in the described types of scenarios. The parameters described in subparagraph 2 of each scenario shall be used as guidance if the Technical Service deems a demonstration of the scenario necessary.

- (a) Definition of overlap ratio between the subject vehicle and the related vehicle

Overlap ratio between the subject vehicle and the related vehicle is calculated by the following formula.

$$R_{\text{overlap}} = L_{\text{overlap}} / W_{\text{vehicle}} * 100$$

Where:

R_{overlap} : Overlap ratio [%]

L_{overlap} : Amount of overlap between extended lines of the width of the subject vehicle and the related vehicle [m]

W_{vehicle} : Width of the subject vehicle [m] (sensors, devices for indirect vision, door handles and connections for tyre-pressure gauges are not included when measuring the width of the vehicle)

- (b) Definition of offset ratio between the subject vehicle and the stationary object

Offset ratio between the subject vehicle and the stationary object is calculated by the following formula.

$$R_{\text{offset}} = L_{\text{offset}} / (0.5 * W_{\text{vehicle}}) * 100$$

R_{offset} : Offset ratio [%]

L_{offset} : Amount of offset between the centre of the subject vehicle and the centre of the stationary object, and the direction of offset to the driver's seat side is defined as plus (+) [m]

W_{vehicle} : Width of the subject vehicle [m] (sensors, devices for indirect vision, door handles and connections for tyre-pressure gauges are not included when measuring the width of the vehicle)

Scenario 1

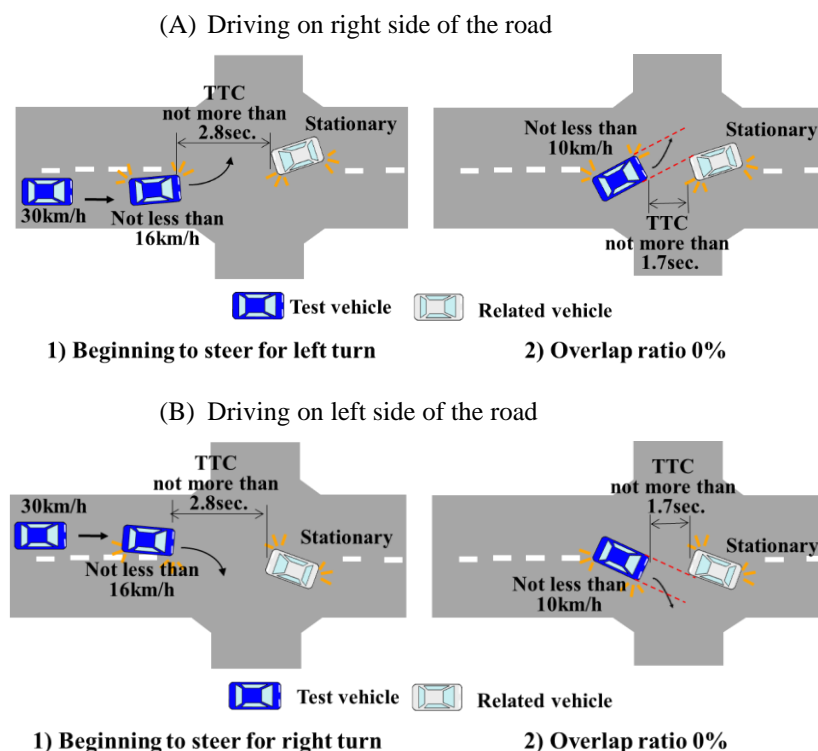
Left turn or Right turn at the intersection

- 1.1. In this scenario, the subject vehicle passes by a left turn or right turn in front of an oncoming vehicle that is stopped to make a left turn or right turn at an intersection.
- 1.2. An example of the detail scenario:

The subject vehicle drives at a speed of 30 km/h (with a tolerance of ± 2 km/h) toward the intersection, and decelerates by braking to a speed of not less than 16 km/h at a point where the subject vehicle begins to steer left / right, and the Time To Collision (TTC) to the oncoming vehicle is not more than 2.8 seconds. When the subject vehicle turns left or right in the intersection, the speed is reduced to not less than 10 km/h, and then drives at a constant speed. The TTC to the oncoming vehicle is not more than 1.7 seconds at when the overlap ratio between the subject vehicle and the oncoming vehicle becomes 0 per cent.

Figure 1

Left turn or right turn at the intersection



Scenario 2

Right turn or Left turn of a forward vehicle

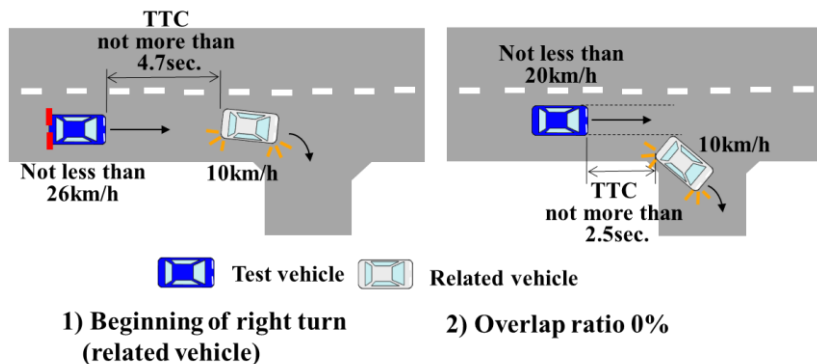
- 2.1. In this scenario, the subject vehicle follows a forward vehicle. After that, the forward vehicle turns right or left at a corner, and the subject vehicle goes straight.
- 2.2. An example of the detail scenario:

Both the forward vehicle and the subject vehicle drive at a speed of 40 km/h (with a tolerance of ± 2 km/h) on the straight road. The forward vehicle decelerates by braking to a speed of 10 km/h (with a tolerance of ± 2 km/h) in order to turn right or left at the corner, and the subject vehicle also decelerates by braking to keep appropriate distance with the forward vehicle. At when the forward vehicle begins to turn right or left, the speed of the subject vehicle is not less than 26 km/h and the TTC to the frontal vehicle is not more than 4.7 seconds. After that, the subject vehicle decelerates to a speed of not less than 20 km/h, and then drives at a constant speed. The TTC to the forward vehicle is not more than 2.5 seconds at when the overlap ratio between the subject vehicle and the forward vehicle becomes 0 per cent.

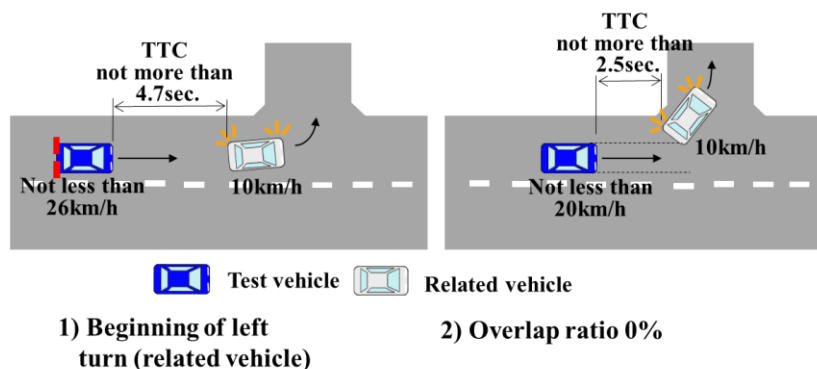
Figure 2

Right turn or left turn of a forward vehicle

(A) Driving on right side of the road



(B) Driving on left side of the road



Scenario 3

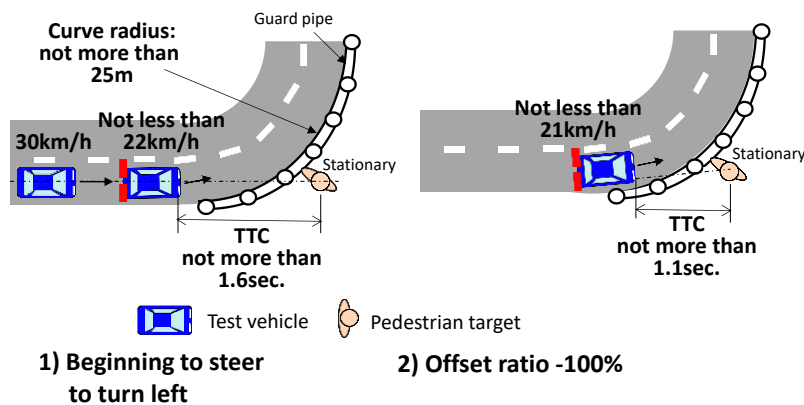
Curved road with guard pipes and a stationary object

- 3.1. In this scenario, the subject vehicle drives a small radius curved road of which the guard pipes are constructed to the outer side, and a stationary vehicle (M_1 category), a stationary pedestrian target or a stationary bicycle target is positioned just outside of the guard pipes and where on the extension of the centre of the lane.
- 3.2. An example of the detail scenario:

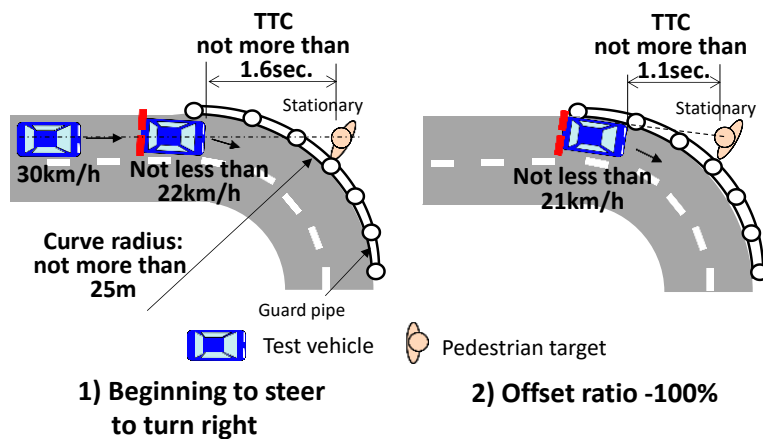
The subject vehicle drives at a speed of 30 (with a tolerance of ± 2 km/h) km/h toward the curve of which the radius is not more than 25 m at the outer side of the road, and decelerates by braking to a speed of not less than 22 km/h at a point where the subject vehicle enters the curve. The TTC to the stationary object is not more than 1.6 seconds at when the subject vehicle begins to turn in the curve. In the curve, the subject vehicle drives outer lane than the centre of the road. After that, the subject vehicle continue to turn in the curve at a constant speed of not less than 21 km/h. The TTC to the stationary object is not more than 1.1 second at when the overlap ratio between the subject vehicle and the stationary vehicle becomes 0 per cent, or at when the offset ratio between the subject vehicle and the centre of the stationary pedestrian target or the stationary bicycle target becomes -100 per cent.

Figure 3
Curved road with guard pipes and a stationary object

(A) Driving on right side of the road



(B) Driving on left side of the road



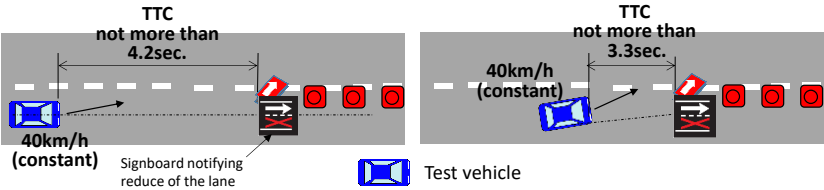
Scenario 4

Lane change due to road construction

- 4.1. In this scenario, the subject vehicle changes the lane in front of the signboard which is positioned in the centre of the lane and notifies the driver that the lane is reduced.
- 4.2. An example of the detail scenario:
The subject vehicle drives a straight road at a speed of 40 km/h (with a tolerance of +0/-2 km/h) and begins to steer in order to change the lane in front of the signboard which notifies reducing the lane. No other vehicles approach the subject vehicle. The TTC to the signboard is not more than 4.2 seconds at when the subject vehicle begins to steer. During changing the lane, the speed of the subject vehicle is constant, and the TTC to the signboard is not more than 3.3 seconds at when the offset ratio between the subject vehicle and the centre of the signboard becomes -100 per cent.

Figure 4
Lane change due to road construction

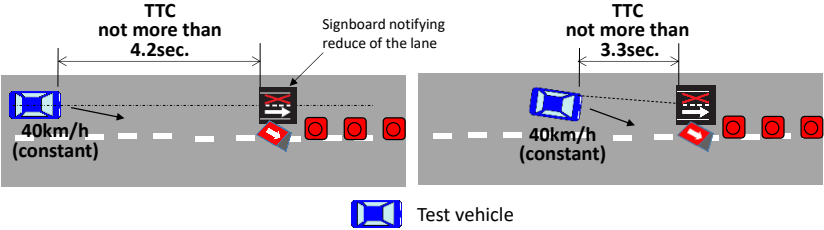
(A) Driving on right side of the road



1) Beginning to steer for lane change

2) Offset ratio -100%

(B) Driving on left side of the road



1) Beginning to steer for lane change

2) Offset ratio -100%

29 January 2020

Agreement

Concerning the Adoption of Harmonized Technical United Nations Regulations for Wheeled Vehicles, Equipment and Parts which can be Fitted and/or be Used on Wheeled Vehicles and the Conditions for Reciprocal Recognition of Approvals Granted on the Basis of these United Nations Regulations*

(Revision 3, including the amendments which entered into force on 14 September 2017)

Addendum 138 – UN Regulation No. 139

Amendment 2

Supplement 2 to the original version of the Regulation – Date of entry into force: 11 January 2020

Uniform provisions concerning the approval of passenger cars with regard to Brake Assist Systems

This document is meant purely as documentation tool. The authentic and legal binding text is: ECE/TRANS/WP.29/2019/48.



UNITED NATIONS

* Former titles of the Agreement:

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 (original version);
Agreement concerning the Adoption of Uniform Technical Prescriptions for Wheeled Vehicles, Equipment and Parts which can be Fitted and/or be Used on Wheeled Vehicles and the Conditions for Reciprocal Recognition of Approvals Granted on the Basis of these Prescriptions, done at Geneva on 5 October 1995 (Revision 2).

Paragraph 5.1., amend to read:

- "5.1. To comply with this Regulation, vehicles shall be equipped with a brake assist system meeting the functional requirements specified in paragraph 6. of this Regulation. Compliance with these requirements shall be demonstrated by meeting the provisions of paragraphs 8. or 9. of this Regulation under the test requirements specified in paragraph 7. of this Regulation. In addition to the requirements of this Regulation, vehicles equipped with a brake assist system shall also be equipped with ABS in accordance with technical requirements of UN Regulation 13-H."
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