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Automatic Emergency Braking and Lane

Departure Warning Systems (AEBS/LDWS)

Proposal for a Regulation on advanced emergency braking system

Submitted by the Informal group on [Automatic Advanced] Emergency Braking and Lane Departure Warning Systems (AEBS/LDWS) *

The text reproduced below was prepared by the Informal group on [Automatic Advanced] Emergency Braking and Lane Departure Warning Systems (AEBS/LDWS) to develop a new Regulation on advanced emergency braking system.

* In accordance with the programme of work of the Inland Transport Committee for 2006–2010 (ECE/TRANS/166/Add.1, programme activity 02.4), the World Forum will develop, harmonize and update Regulations in order to enhance the performance of vehicles. The present document is submitted in conformity with that mandate.

I. Proposal

Regulation on uniform provisions concerning the approval of motor vehicles with regard to ~~a collision mitigation an~~ advanced emergency braking system

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Justification:

An introduction provides an overview of the expectations of an advanced emergency braking system in a single concise form and does not require a novice, with regard to such systems, to extract and assemble this information from different paragraphs in the regulation.

Annexes

1. Communication
2. Arrangements of approval marks
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of complex electronic vehicle control systems

0. Introduction

The intention of this regulation is to establish uniform provisions for the layout and performance of automatic emergency braking systems fitted to motor vehicles of the category M2; M3; N2 and N3 used on the road.

The system shall automatically detect a potential forward collision, provide the driver with a 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.

The system shall only operate in driving situations where braking will avoid or mitigate the severity of an accident, and should take no action in normal driving situations.

In the case of a defect or failure in the system, the safe operation of the vehicle shall not be endangered and the full functionality of all other vehicle systems maintained.

The driver may have the possibility to switch off the system. In such a case, the driver shall receive an indication when the system is inactive. So as to ensure the long term benefit for traffic safety, the system shall be automatically re-activated on each startup.

The system shall provide an acoustic or haptic warning, which may also be a sharp deceleration, so that a driver who is inattentive – has been driving for a long period of time without, e.g. actively using the brakes – is made aware of a critical situation.

During any action taken by the system (the warning and emergency braking phases) 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 to avoid the accident.

Because of the fact that the emergency braking is done when an accident can not be avoided by an active intervention of the driver, the responsibility for the vehicle etc. clearly lies with the driver.

As the system is only active in an emergency situation, there is also no connection with the subject “autonomous driving or braking”. The responsibility for the vehicle, as with active operation of the automatic emergency braking system, rests with the driver

While the regulation can not, due to the complexity of road traffic conditions – overtaking, oncoming traffic, traffic travelling in the same direction to the right and left, crossing traffic, moving and stationary traffic – and road infrastructure features – curves, junctions, bridges, roadside guardrails, roadside signs, manholes – include all such conditions and features in the type-approval process, they are part of an automatic emergency braking system. Such conditions and features should not result in false warnings to the extent that they encourage the driver to switch the system off.

To only fulfil the type-approval conditions is not sufficient; the vehicle manufacturer has to ensure the overall suitability of the vehicle for use on the road.

Comment:

While some text improvements may be necessary, the principle of the above text is fully supported.

1. Scope and purpose

This Regulation applies to the approval of vehicles of category M₂, N₂, M₃ and N₃¹ ~~[M₂ and N₂]~~ **equipped with a full pneumatic braking system and pneumatic rear suspension** with regard to an on-board system to mitigate or avoid a rear-end in lane collision.

Justification:

M₂, N₂ category vehicles should be part of the regulation as there are M₂ and N₂ vehicles with full air braking systems that do not significantly differ from the M₃ and N₃ vehicles mentioned in the scope.

The word “full” ensures that air-over-hydraulic systems are not considered to be included under “pneumatic”.

2. Definitions

2.1. “Advanced Emergency Braking System (AEBS)” means a system which can automatically detect a potential forward collision and activate the vehicle braking system to decelerate the vehicle with the purpose of avoiding or mitigating a collision.

~~2.1.1. “Advanced Emergency Braking System Mitigation (AEBS-M)” means a system which can automatically detect a potential forward collision and activate the vehicle braking system to decelerate the vehicle with the purpose of mitigating a collision.~~

~~2.1.2. “Advanced Emergency Braking System Avoidance (AEBS-A)” means a system which can automatically detect a potential forward collision and activate the vehicle braking system to decelerate the vehicle with the purpose of avoiding a collision.~~

~~2.2. “Collision mitigation” means the actions taken by the system, such as obstacle detection, the computing of the relevant data and the automatic activation of the service brakes, aiming at significantly decreasing the speed of the vehicle at the time of the collision.~~

2.2. “Vehicle type with regard to its Advanced Emergency Braking” means a category of vehicles which do not differ in such essential respects as:

- (a) The manufacturer's trade name or mark,
- (b) Vehicle features which significantly influence the performances of the Advanced Emergency Braking System,
- (c) The type and design of the Advanced Emergency Braking System.

¹ As defined in Annex 7 to the Consolidated Resolution on the Construction of Vehicles (R.E.3) (document TRANS/WP.29/78/Rev.1 as last amended by Amend.4).

- 2.3. “*Subject vehicle*” means the vehicle being tested
- 2.4. “*Target*” means a high volume series production passenger car of category M₁ AA saloon ¹ or in the case of a soft target an object representative of such a vehicle in terms of its detection characteristics applicable to the sensor system of the AEBS under test.
- 2.5. “*Moving target*” means a target travelling at a constant speed in the same direction and in the centre of the same lane of travel as the subject vehicle.
- 2.6. “*Stationary target*” means a target **on in** the centre of the test lane at standstill throughout the test.
- 2.7. “*Soft target*” means a target that will suffer minimum damage and cause minimum damage to the subject vehicle in the event of a collision.
- 2.8. “*Collision warning phase*” means the phase directly preceding the emergency braking phase, during which the AEBS warns the driver of a potential forward collision.
- 2.9. “*Emergency braking phase*” means the phase starting when the AEBS emits a braking demand for at least 4 m/s² deceleration to the service braking system of the vehicle.
- 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 semi-continuous basis at least while the system is active.

3. Application for Approval

- 3.1. The application for approval of a vehicle type with regard to the Advanced Emergency Braking System shall be submitted by the vehicle manufacturer or by his authorized 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 2.2., 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 (00 for the Regulation in its initial form) 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 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 x 297 mm), 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.
- 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. 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

² 1 for Germany, 2 for France, 3 for Italy, 4 for the Netherlands, 5 for Sweden, 6 for Belgium, 7 for Hungary, 8 for the Czech Republic, 9 for Spain, 10 for Serbia, 11 for the United Kingdom, 12 for Austria, 13 for Luxembourg, 14 for Switzerland, 15 (vacant), 16 for Norway, 17 for Finland, 18 for Denmark, 19 for Romania, 20 for Poland, 21 for Portugal, 22 for the Russian Federation, 23 for Greece, 24 for Ireland, 25 for Croatia, 26 for Slovenia, 27 for Slovakia, 28 for Belarus, 29 for Estonia, 30 (vacant), 31 for Bosnia and Herzegovina, 32 for Latvia, 33 (vacant), 34 for Bulgaria, 35 (vacant), 36 for Lithuania, 37 for Turkey, 38 (vacant), 39 for Azerbaijan, 40 for The former Yugoslav Republic of Macedonia, 41 (vacant), 42 for the European Union (Approvals are granted by its Member States using their respective ECE symbol), 43 for Japan, 44 (vacant), 45 for Australia, 46 for Ukraine, 47 for South Africa, 48 for New Zealand, 49 for Cyprus, 50 for Malta, 51 for the Republic of Korea, 52 for Malaysia, 53 for Thailand, 54 and 55 (vacant) and 56 for Montenegro. Subsequent numbers shall be assigned to other countries in the chronological order in which they ratify or accede to the 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, and the numbers thus assigned shall be communicated by the Secretary-General of the United Nations to the Contracting Parties to the Agreement.

- 5.1.1. Any vehicle fitted with an AEBS complying with the definition of paragraph 2.1. shall meet the performance requirements contained in paragraphs 5.1. to 5.6.2. of this Regulation and shall be equipped with an anti-lock braking function in accordance with the performance requirements of Annex 13 of Regulation No.13 [and a Vehicle Stability Function in accordance with the performance requirements of Annex 21 of Regulation No.13].

Comment:

As a result of AEBS action in adverse weather conditions, a vehicle stability function could be more beneficial than an anti-lock braking system as the vehicle stability function would assist the driver in any avoiding manoeuvre while the anti-lock braking system would only be effective in the braking phase. Therefore, as a vehicle stability function also includes an anti-lock braking function, a vehicle stability function is preferred.

- 5.1.2. The effectiveness of the AEBS shall not be adversely affected by magnetic or electrical fields. This shall be demonstrated by compliance with Regulation No. 10, 03 Series of Amendments.

Comment:

The need to mention ECE Reg.10 is being questioned with regard to ECE Reg.13 and the result of the discussion should be applied to this regulation.

- 5.1.3. Conformity with the safety aspects of complex electronic control systems shall be shown by meeting the requirements of Annex 3.

5.2. Performance requirements

- 5.2.1. The system shall provide the driver with appropriate warning(s) as below:

- 5.2.1.1. A collision warning when the AEBS has detected ~~the possibility~~ of a collision with a preceding vehicle of category M, N or O in the same lane which is travelling at a slower speed, has slowed to a halt or is stationary having not being identified as moving. The warning shall be as specified in paragraph 5.5.1.

Justification:

Original wording is appropriate.

- 5.2.1.2. 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.

- 5.2.1.2.1. There shall not be ~~an~~ appreciable time interval between each AEBS self-check, or ~~an~~ appreciable delay in illuminating the warning signal in the case of an electrical detectable failure.

Justification:

Original wording is appropriate. This is the state-of-the-art with regard to vehicle safety systems.

- 5.2.1.3. A deactivation warning, if the vehicle is equipped with a means to manually deactivate the AEBS, shall be given when the system is deactivated. This shall be as specified in paragraph 5.4.2.
- 5.2.2. Subsequent to the start of the warning(s) of paragraph 5.2.1.1., and subject to the provisions of paragraphs 5.3.1. to 5.3.3., the system shall autonomously activate the vehicle service braking system to decelerate the vehicle with the purpose of avoiding a collision or to ~~[at least significantly decreasing~~ **decrease the speed of the vehicle at the time of to mitigate the severity of the collision]** This shall be tested in accordance with paragraphs ~~[6.6.3., and 6.7.~~ **6.6. and 6.7.]**

Justification:

A collision is a black/white event – it occurs or does not occur. Therefore it is necessary to include “severity” to indicate a reduced impact situation.

- 5.2.3. The system shall be active at least within the vehicle speed range of 15 km/h up to the maximum design speed of the vehicle, and at all vehicle load conditions between laden and unladen, unless manually deactivated as per paragraph 5.4. ~~[In the case of a semi-trailer tractor, the unladen condition is with an unladen semi-trailer attached.]~~
- 5.2.4. The system shall be designed to minimize the generation of collision warning signals and to avoid autonomous braking in situations where the driver would not recognize an impending forward collision. This shall be demonstrated in accordance with paragraph. 6.10.
- 5.3. Interruption by the driver
- 5.3.1. The AEBS ~~[may / shall]~~ provide the means for the driver to interrupt the collision warning phase.

Comment:

The “may” gives the vehicle manufacturer the freedom to determine the man/machine interface and take into account functional safety aspects.

- 5.3.2. The AEBS shall provide the means for the driver to interrupt the emergency braking phase.
- 5.3.3. In both cases above, a clear movement of a driver control that indicates that the driver is aware of the impending collision **may/shall** result in the AEBS actions being overridden. 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.

Comment:

If the driver interruption of the warning phase is a “may” then the “may/shall” option is required to cover the “may” for the warning and the “shall” for the emergency braking.

- 5.4. When a vehicle is equipped with a means to deactivate the AEBS function, the following conditions shall apply as appropriate:

- 5.4.1. The AEBS function shall be automatically reinstated at the initiation of each new ignition cycle.
- 5.4.2. 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. may be used for this purpose.

~~5.4.3. The AEBS off control switch shall have measures which discourage the driver to operate the switch easily.~~

Justification:

To enable the Technical Services to apply a common standard, the “measures which discourage” require to be specified in detail, but in specifying them in detail they become design restrictive. It can be imagined that to provide an off-switch and then make it difficult to operate will create a negative feeling in the driver and could increase (create a new!) driver distraction danger. Therefore, if an off-switch is to be provided, its positioning/design should be so that it is easy to use (at the discretion of the vehicle manufacturer). Over use of the off-switch should be address by requiring a low level of false warnings – not allowing a lot of false warnings and then positioning/designing the off-switch so that the driver can not use it while driving.

The desire to prevent the driver excessively using an “easy to use” off-switch can be countered by an automatic re-installment system, e.g. time limited, speed controlled, traffic environment situation.

- 5.5. Warning indication
- 5.5.1. The collision warning referred to in paragraph 5.2.1.1. shall be ~~provided~~ **generated** by at least two modes **selected** from acoustic, haptic or optical.
- The timing of the warning signals shall be such that they provide the possibility for the driver to react to the risk of collision and take control of the situation, and shall also avoid nuisance for the driver by too early or too frequent warnings. This shall be tested in accordance with the provisions of paragraphs 6.6.2. and 6.7.2.

Justification:

“Provided” is more appropriate and consistent with ECE Reg.13 and “selected” is a grammar improvement.

- 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 5.2.1.2. 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” 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 and yellow in colour. The failure warning signal specified in paragraph 5.5.4. may be used for this purpose.

5.6. Provisions for the periodic technical inspection

5.6.1. At a periodic technical inspection the AEBS shall pass/fail as a result of a visible observation of the failure warning signal status, following a "power-ON".

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 unauthorized 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.

6.1.2. 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.

Re-number 6.3. Test course

The course shall be a segment of straight road of sufficient length in order to maintain the subject vehicle speeds required below and to allow the detection of the target(s) and the braking of the subject vehicle up to collision avoidance or mitigation.

6.4. Vehicle conditions

6.4.1. Test weight

The vehicle shall be tested in a condition of load to be agreed between the manufacturer and the Technical Service. No alteration shall be made once the test procedure has begun.

6.5. Test targets

- 6.5.1. The target used for the 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 ^{1/}

^{1/} The identification characteristics of the soft target shall be agreed between the Technical Service and the vehicle manufacturer as being equivalent to a passenger car of category M1 AA saloon, e.g. 2 reflectors each of less than 15 dBsm in the case of a 77 GHz radar.

Justification:

Although the values are provided as an example, it can be misleading as they could be taken as being typical and some significantly different may be rejected by a Technical Service. Therefore, it is safer to provide no figures. If it is deemed to be necessary to provide an example, then the values should be taken from a recognised standard, e.g. ISO 22179 (full speed range adaptive cruise control).

6.5.2. Stationary target

The stationary target shall be positioned [such that its component nearest to the subject vehicle is positioned at the expected collision point] on the axis of the test course.

Justification:

Provides no additional information as it is already covered in paragraph 2.6.

6.5.3. Moving target

The moving target shall be moving on the axis centre of the test course at a constant speed of [30^{+4/-0} km/h for the vehicles of categories M₃ and N₃ and XXX^{+4/-0} km/h for the vehicles of categories M₂ and N₂].

Justification:

Other than the speed requirement there is no additional information to that given in paragraph 2.5. Therefore, by moving the speed requirement to paragraph 6.7.1., which brings all the information necessary for conducting the test together, this paragraph can be deleted.

6.5.4.1.1. Details that enable the targets to be specifically identified shall be recorded in the vehicle type-approval documentation.

Justification:

It is necessary to record sufficient details that enable the used targets to be evaluated/duplicated by a Technical Service at a time other than that of the original type-approval. Adding the paragraph as a sub-paragraph of 6.5.1. improves the document structure.

6.6. Warning and activation test with a stationary target

- 6.6.1. 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 0.5m.

The functional part of the test shall start when the subject vehicle is travelling at a speed of 80 ± 2 km/h and is at a distance of at least 120 m from the target.

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

6.6.2. The timing for the collision warning modes referred to in paragraph 5.5.1. shall comply with the following:

~~6.6.2.1. Where the warning signals are provided in a cascade,~~

- (a) ~~the first of the 2 warning modes at least one haptic or acoustic warning mode shall be provided no later than $[2.0 / 1.5 / 1.4 / 0.8]$ s; [and shall occur not earlier than $[2.5]$ s] and~~
- (b) ~~the last of the 2 warning modes the last warning mode shall be provided no later than $[0.8]$ s~~

~~before the start of the Emergency Braking phase.~~

6.6.2.1. At least one haptic or acoustic warning mode shall be ~~provided~~ provided generated not later than $[1.4]$ s before the start of the Emergency Braking phase.

Justification:

“Provided” is more appropriate and consistent with ECE Reg.13.

6.6.2.2. ~~No~~ At least two warning modes shall be generated provided not later than $[0.8]$ s before the start of the Emergency Braking phase.

Justification:

Clarification, and “provided” is more appropriate and consistent with ECE Reg.13.

~~6.6.2.2. Where the warning signals are not provided in a cascade, the 2 warning modes shall be provided no later than $[2.0 / 1.5 / 1.4 / 0.8]$ s [and shall occur not earlier than $[2.5]$ s] before the start of the Emergency Braking phase.~~

~~6.6.2.3.~~ When the AEBS applies the service braking during the warning phase, the speed reduction demanded by the AEBS shall not exceed ~~$[7 / 10]$ km/h.~~

Justification:

An action to warn an inattentive driver so that he/she can take control of the situation should not result in the creation of an undue hazard for other road users. A high speed reduction, as a warning, for a situation that is not yet critical could create an over reaction from a following driver which results in an accident. Therefore, a maximum speed reduction should be specified and while CLEPA proposes a 10 km/h value, 7 km/h can be accepted. The difference of 3 km/h is considered useful in terms of energy dissipation without significantly increasing the risk for a following driver. Also, higher speed reductions could be used by the driver as a automatic driving/braking system.

6.6.3. The speed reduction of the subject vehicle at the time of the impact with the stationary target shall be:

6.6.3.1. not less than ~~[40]~~ 20 km/h for a vehicle of Category N₃;

6.6.3.2. ~~not less than [40] km/h for a vehicle of Category M₂~~

Justification:

A 20 km/h reduction is achievable with today's technology.

6.6.3.3. ~~not less than [X₁] km/h for a vehicle of Category N₂;~~

6.6.3.4. ~~not less than [X₂] km/h for a vehicle of Category M₂;~~

~~6.6.4. The Emergency braking phase shall not start before TTC reaches down to 3.0 seconds.~~

Justification:

Not necessary as the 4 m/s² deceleration definition of emergency braking covers this. (80 to 0 km/h at 4 m/s² is a TTC of 2.9s).

6.7. Warning and activation test with a moving target

6.7.1. 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 0.5m.

The functional part of the test shall start with the subject vehicle travelling at a speed of 80 ± 2 km/h, the moving target at ~~the relevant speed indicated in Paragraph 6.5.3.~~ a speed of 15 km/h and a separation distance of at least 120 m between them.

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.

Justification:

Addition of the word "subject" and replacement of "/" by "to" is a clarification. Moving the target speed to this paragraph brings all the test characteristics together.

6.7.2. The timing for the collision warning modes referred to in paragraph 5.5.1. shall comply with the following:

~~6.7.2.1. Where the warning signals are provided in a cascade,~~

(a) ~~the first of the 2 warning modes at least one haptic or acoustic warning mode shall be provided no later than [2.0 / 1.5 / 1.4 / 0.8] s; [and shall occur not earlier than [2.5] s] and~~

(b) ~~the last of the 2 warning modes the last warning mode shall be provided no later than [0.8] s~~

~~before the start of the Emergency Braking phase.~~

6.7.2.1. At least one haptic or acoustic warning mode shall be ~~[provided]~~ provided generated not later than ~~[1.4]~~ 2.0s before the start of the Emergency Braking phase.

Justification:

“Provided” is more appropriate and consistent with ECE Reg.13. It is possible to have a longer warning time as the current technology can recognise and evaluate moving targets and thereby provide the driver with more decision time without increasing false warnings.

6.7.2.2. No At least two warning modes shall be generated provided not later than [0.8]s before the start of the Emergency Braking phase.

Justification:

Clarification, and “provided” is more appropriate and consistent with ECE Reg.13.

~~6.7.2.2. Where the warning signals are not provided in a cascade, the 2 warning modes shall be provided no later than [2.0 / 1.5 / 1.4 / 0.8] s [and shall occur not earlier than [2.5] s] before the start of the Emergency Braking phase.~~

~~6.7.2.3. When the AEBS applies the service braking during the warning phase, the speed reduction demanded by the AEBS shall not exceed [7 / 10] km/h.~~

Justification:

An action to warn an inattentive driver so that he/she can take control of the situation should not result in the creation of an undue hazard for other road users. A high speed reduction, as a warning, for a situation that is not yet critical could create an over reaction from a following driver which results in an accident. Therefore, a maximum speed reduction should be specified and while CLEPA proposes a 10 km/h value, 7 km/h can be accepted. The difference of 3 km/h is considered useful in terms of energy dissipation without significantly increasing the risk for a following driver. Also, higher speed reductions could be used by the driver as a automatic driving/braking system.

~~6.7.3. The emergency braking phase shall result in the subject vehicle not impacting the moving target.~~

Justification:

Collision avoidance is technically possible.

~~6.7.3. the speed reduction of the subject vehicle for the moving target shall be:*~~

~~6.7.3.1. not less than [50] km/h for a vehicle of Category N₃₅~~

~~6.7.3.2. not less than [50] km/h for a vehicle of Category M₃₅~~

~~6.7.3.3. not less than [Y₁] km/h for a vehicle of Category N₂₅~~

~~6.7.3.4. not less than [Y₂] km/h for a vehicle for Category M₂₅~~

~~6.7.4. The Emergency braking phase shall not start before TTC reaches down to 3.0 seconds.~~

Justification:

~~[* When the relative speed has reached to 0km/h during the test, AEBS-M is deemed to be satisfied with this requirement.]~~

Not necessary as the 4 m/s² deceleration definition of emergency braking covers this. (80 to 0 km/h at 4 m/s² is a TTC of 2.9s).

- 6.8. Failure detection test
- 6.8.1. Simulate an electrical failure, for example by disconnecting the power source to any AEBS component, 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. nor the optional manual AEBS deactivation control of paragraph 5.4. shall be disconnected.
- 6.8.2. The failure warning signal mentioned in paragraph 5.5.4. shall be activated and remain activated not later than 10 seconds after the vehicle has been being driven at a speed greater than 15 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 deactivate the AEBS, turn the ignition (start) switch to the “on” (run) position and deactivate the AEBS. The warning signal mentioned in paragraph 5.4.2. 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. If the ignition system is activated by means of a “key”, the above requirement shall be fulfilled without removing the key.
- 6.10. False ~~reaction~~ warning and false braking test
- ~~6.10.1. Stationary obstacles~~
- 6.10.1.1. ~~The obstacles outside lane shall be two stationary vehicles of category M₁ AA saloon having their central longitudinal axis oriented parallel to the direction of the axis of the test course in both right and left lanes. The width of a each lane is shall be 3.5m; each vehicle is being located on the centre of the respective outside lane.~~
- Two stationary vehicles, of category M1 AA saloon, shall be positioned;
- with the vehicle centre line in the centre of a lane to the right and left of the subject vehicle lane,
 - so as to face in the same direction of travel as the subject vehicle,
 - with the rear of each vehicle aligned with the other,
- where all three lanes are 3.5m wide.
- Justification:
Improved wording with no change in objective.
- 6.10.1.2. ~~Drive from more than 60m behind the obstacles outside the central lane and trace the centre of the lane at the constant speed of 50 +/- 2km/h, until passing over the obstacles outside the lane.~~
- The subject vehicle shall travel for a distance of at least 60m, at a constant speed of 50 ± 2 km/h, in a straight line, in the centre of the centre lane before passing between the 2 stationary vehicles.

During the test there shall be no adjustment of any subject vehicle control other than slight steering adjustments to counteract any drifting.

Justification:

Improved wording with no change in objective.

- 6.10.1.3. The AEBS shall not provide a warning or initiate the emergency braking phase.

Justification:

Minimize driver annoyance.

~~6.10.2. Moving obstacles~~

~~6.10.2.1. The obstacles outside the central lane shall be two vehicles of category M₁ AA saloon travelling in the same direction as the subject vehicle in both right and left lanes. The velocity of each vehicle is 30+/- 2km/h. The width of each lane shall be 3.5m; each vehicle shall be driven on the centre of the respective outside lane.~~

~~6.10.2.2. Drive from more than 60m behind the obstacles outside the central lane and trace the centre of the lane at the constant speed of 50+/- 2km/h, until passing over the obstacles outside the lane.~~

~~6.10.2.3. The AEBS shall not initiate the emergency braking phase.]~~

Justification:

Moving test brings no additional benefit – stationary test is more severe.

~~[6.10. Unintended [false] activation of the driver warning and the service brakes by the AEBS,~~

~~6.10.1 The Technical Service shall undertake two out of the three of the following tests to demonstrate that the system has been designed to avoid activation of the warning or braking system during normal driving. The manufacturer shall provide documentation to the Technical Service to demonstrate compliance in other situations.~~

~~6.10.2. Test 1 Passing stationary vehicles in adjacent lanes~~

~~6.10.2.1. Two stationary target vehicles of category M₁ AA saloon shall be located either side of the subject vehicle's lane of travel. The target vehicles shall be positioned in the same direction of travel in both adjacent right and left hand lanes.~~

~~The width of the lanes shall be 3.5m; each vehicle's longitudinal centre line shall be aligned with the centre line of the lane.~~

~~6.10.2.2. The test shall commence with the subject vehicle positioned greater than 60 m behind the target vehicles. The subject vehicle shall follow the centre line of the subject vehicle lane passing between the target vehicles at a constant speed of [50+/- 2km/h].~~

~~6.10.2.3. The AEBS shall not initiate a driver warning phase or emergency braking.~~

6.10.3. — Test 2 Overhead Bridge / Gantry test

6.10.3.1. — The test may be conducted using a bridge structure (Ref. xxxx) offering a minimum clearance between the vehicle and target of [1 m]. It shall have a maximum height of [5.0m] or with the following target.

6.10.3.2 — A representative road sign measuring at least the width of the lane shall be placed at a height of [5.0m] above the lane of travel of the subject vehicle.

6.10.3.3. — The test shall commence with the subject vehicle positioned greater than 60 m behind the target vehicles. The subject vehicle shall follow the centre line of the subject vehicle lane passing under the target at a constant speed of [50+/- 2km/h].

6.10.3.3. — The AEBS shall not initiate a driver warning phase or emergency braking.

6.10.4 — Test 3 Adjacent vehicle in a curve test

6.10.4.1 — The test shall be carried out on two adjacent lanes, the inner marking of the inside lane shall have a radius of curvature of [not less than 125m]. The width of each lane is 3.5m and the vehicles shall be driven in the centre of the lanes.

6.10.4.2 — The target vehicle shall be travelling in the outside lane at a speed of [30 km/h].

6.10.4.3 — The subject vehicle shall be driven in the centre of the inside lane at [50 km/h] and shall approach and pass the target vehicle.

6.10.4.4 — The AEBS shall not initiate a driver warning phase or emergency braking.

6.10.4.5 — The manufacturer shall provide as part of the documentation to the Technical Service the evidence that the vehicle will pass the test when the target vehicle is travelling in the opposite direction.]

Justification:

The “overhead bridge” and the alternative “gantry road sign” are considered to add complexity without adding real world benefits. Both the “overhead bridge” and the “gantry road sign” would need to be specified so as to provide a common understanding of the structures for the Technical Services, the vehicle manufacturers and the system suppliers. While the system suppliers will design the AEBS to cope with all types of bridge design – flat, arch supported, solid, open, steel, pre-stressed concrete, etc. – the definition of a single representative structure would be a complex issue. There would also be similar difficulties in defining a representative gantry road sign. Therefore, as the false warning/false braking test(s) can only be indicative no matter how many there are, CLEPA is of the opinion that the consideration of such structures as overhead bridges and gantry road signs should be covered in the specification text or in a general introduction.

The “adjacent vehicle in a curve test” proposal is similar to one of the 3 false warning tests proposed by CLEPA in document AEBS/LDWS-TF02-06. In discussing the proposed test it was acknowledged that the test is relatively difficult to conduct on a consistent basis and the availability of suitable type-approval facilities could be a problem. As a result CLEPA withdrew the “curve” and “alley way” false warning tests in favour of the “overtaking” test. Subsequent comment with regard to difficulties of conducting the overtaking test on a consistent basis resulted in CLEPA moving to the alley way test, as it is a simple test that can be consistently reproduced. In reviewing this series of events CLEPA feels, as mentioned above,

that whatever test(s) are chosen it/they can only be indicative and that an alley way test is appropriate as it is simple to conduct and is representative of a real world situation.

~~[6.10. Test of a false warning and a false activation of the service brakes of AEBS-M/A.~~

~~6.10.1 The obstacles either side of the lane of travel of the subject vehicle shall be the two stationary vehicles of category M₁-AA saloon. They shall be parked in the same direction in both right and left hand lanes. The width of a lane is 3.5m; each vehicle is located at the borderline closest to the lane of travel of the subject vehicle.~~

~~6.10.2 A road sign measuring at least the width of the lane shall be placed at a height of [4.0m] above the lane of travel of the subject vehicle.~~

~~6.10.3 Travelling in the centre lane, drive the subject vehicle from more than 60m behind the targets in the centre of the lane at the constant speed of [50 +/- 2km/h], and pass through the targets.~~

~~6.10.4 The AEBS-M/A shall not initiate the warning phase or the emergency braking phase.]~~

Justification:

See the above “overhead bridge” and the alternative “gantry road sign” comments.

7. Modification of vehicle type and extension of approval

7.1. Every modification of the vehicle type as defined in paragraph 2.2. above shall be notified to the Administrative Department which approved the vehicle type. The department 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 Administrative Department shall inform the other Contracting Parties of the extension by means of the communication form which appears in Annex 2 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 conform to the general provisions defined in Appendix 2 to the Agreement (E/ECE/324-E/ECE/TRANS/505/Rev.2) 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 Administrative Department 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 definitely 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 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 Administrative Departments
- 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 the Administrative Departments which grant approval and to which forms certifying approval or extension or refusal or withdrawal of approval are to be sent.

Annex 1

Communication

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



3

issued by :

Name of administration:

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

Concerning:⁴

APPROVAL GRANTED
APPROVAL EXTENDED
APPROVAL REFUSED
APPROVAL WITHDRAWN
PRODUCTION DEFINITELY DISCONTINUED

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

Approval No.: Extension 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. Data to enable the identification of the type of AEBS:
7. Date of submission of vehicle for approval:
8. Technical Service performing the approval tests:
9. Date of report issued by that service:
10. Number of report issued by that service:
11. Approval with regard to the AEBS is granted/refused:²
12. Place:
13. Date:
14. Signature:
15. Annexed to this communication are the following documents, bearing the approval number indicated above:

³ Distinguishing number of the country which has granted/extended/refused/withdrawn an approval (see approval provisions in the Regulation).

⁴ Delete what does not apply.

List of the positive actions enabling the driver to interrupt the braking phase

Description of the AEBS warning strategy

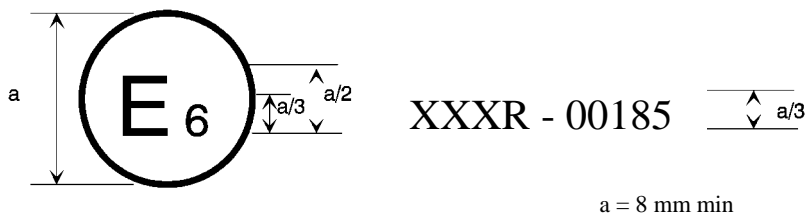
[Details which enable the targets to be specifically identified]

17. Any remarks:

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 (E6) with regard to the AEBS pursuant to Regulation No. XXX. The first two digits of the approval number indicate that the approval was granted in accordance with the requirements of Regulation No. XXX in its original form.

Annex 3

Special requirements to be applied to the safety aspects of complex electronic vehicle 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 (definition 2.3. below) as far as this Regulation is concerned.

This annex may also be called, by special paragraphs in this Regulation, for safety related functions which are controlled by electronic system(s).

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

This information shall show that “The System” respects, under normal and fault conditions, all the appropriate performance requirements specified elsewhere in this Regulation.

2. Definitions

For the purposes of this annex,

- 2.1. “*Safety concept*” is a description of the measures designed into the system, for example within the electronic units, so as to address system integrity and thereby ensure safe operation even in the event of an electrical failure.

The possibility of a fall-back to partial operation or even to a back-up system for vital vehicle functions may be a part of the safety concept.

- 2.2. “*Electronic control system*” means a combination of units, designed to co-operate in the production of the stated 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.

“*The System*”, referred to herein, is the one for which type approval is being sought.

- 2.3. “*Complex electronic vehicle control systems*” are those electronic control systems which are subject to a hierarchy of control in which a controlled function may be over-ridden by a higher level electronic control system/function.

A function which is over-ridden becomes part of the complex system.

- 2.4. “*Higher-level control*” systems/functions are those which employ additional processing and/or sensing provisions to modify vehicle behaviour by commanding variations in the normal 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.

- 2.5. “Units” are the smallest divisions of system components which will be considered in this annex, since these combinations of components will be treated as single entities for purposes of identification, analysis or replacement.

- 2.6. “Transmission links” are the means used for inter-connecting distributed units for the purpose of conveying signals, operating data or an energy supply.

This equipment is generally electrical but may, in some part, be mechanical, pneumatic, hydraulic or optical.

- 2.7. “Range of control” refers to an output variable and defines the range over which the system is likely to exercise control.

- 2.8. “Boundary of functional operation” defines the boundaries of the external physical limits within which the system is able to maintain control.

3. Documentation

3.1. Requirements

The manufacturer shall 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.

- 3.1.1. Documentation shall be made available in 2 parts:

- (a) The formal documentation package for the approval, containing the material listed in Section 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 will be taken as the basic reference for the verification process set out in paragraph 4. of this annex.
- (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.

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.

- 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 2.7.) exercised on each such variable shall be defined.
- 3.2.3. Limits defining the boundaries of functional operation (paragraph 2.8.) shall be stated where appropriate to system performance.
- 3.3. System layout and schematics
- 3.3.1. Inventory of components
- A list shall be 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 an optical-fiber diagram for optical links, by a piping diagram for pneumatic or hydraulic transmission equipment and by a simplified diagrammatic layout for mechanical linkages.
- 3.3.4. Signal flow and priorities
- There shall be a clear correspondence between these transmission links and the signals carried between units.
- Priorities of signals on multiplexed data paths shall be stated, wherever priority may be an issue affecting performance or safety as far as this 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 systems which are subject to the prescriptions of this Regulation.
- 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 be prepared, if required, to show some 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 authorities 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 realize 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 one of those specified faults which will have a bearing on vehicle control performance or safety.
- This may be based on a Failure Mode and Effect Analysis (FMEA), a Fault Tree Analysis (FTA) or any similar process appropriate to system safety considerations.
- 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.
- 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. above, the warning signal to be given to the driver and/or to service/technical inspection personnel.

4. Verification and Test

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

4.1.1. Verification of the function of “The System”

As the means of establishing the normal operational levels, verification of the performance of the vehicle system under non-fault conditions shall be conducted against the manufacturer's basic benchmark specification unless this is subject to a specified performance test as part of the approval procedure of this or another Regulation.

4.1.2. Verification of the safety concept of paragraph 3.4.

The reaction of “The System” shall, at the discretion of the type approval authority, 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 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.
