UN Regulation No. 131

Uniform provisions concerning the approval of motor vehicles with regard to the Advanced Emergency Braking System (AEBS) for M_2, M_3, N_2 and N_3 vehicles

Industry proposals in purple text

Contents

Introduction

The [SP1]intention of the original Regulation ~~is~~ was to establish uniform provisions for advanced emergency braking systems (AEBS) fitted to motor vehicles of the categories M2, M3, N2 and N3 primarily used under monotonous highway driving conditions. This new upgraded regulation extends the scope to new scenarios like city driving and secondary roads.

While[TP2], in general, those vehicle categories will benefit from the fitment of an AEBS, there are sub-groups where the benefit is rather uncertain (e.g. buses with standing passengers i.e. Classes I, II and A [1], category G vehicles [1], construction vehicles, etc.). Regardless from the benefit, there are other sub-groups where the installation of AEBS would be technically difficult or not feasible (e.g. position of the sensor on vehicles of category G [1], construction vehicles mainly used in offroad areas and gravel tracks, special purpose vehicles and vehicles with front mounted equipment, etc.). In some cases there may be a possibility of false emergency braking events because of vehicle design constraints.

The system shall automatically detect a potential forward collision with another vehicle or a pedestrian crossing the path of the vehicle, provide the driver with a warning ~~if time permits~~ [TP3]and activate the vehicle braking system to decelerate the vehicle with the purpose of avoiding or mitigating the severity of a collision~~, even if the driver does not respond to the warning~~[TP4].

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

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

The system shall provide as a minimum an acoustic or haptic warning, which may also be a sharp deceleration, so that an inattentive driver is made aware of a critical situation, if time permits. There are, however, situations where a warning cannot be given in time for the driver to appropriately react, such as pedestrian collisions or collisions with strongly decelerating ~~preceeding~~ preceding vehicles. In these cases, the warning may be given at the time that an ~~automated~~ emergency brake intervention starts.

During any action taken by the system (the warning and emergency braking phases), the driver can, at any time through a conscious action like an accelerator kick-down or a swerving action that results in enough change of direction to not hit the target, take control and override the system.

While from a traffic safety perspective, it would be appreciable to require automated collision avoidance for all heavy vehicles up to their maximum driving speed, it is acknowledged that the ~~avoidance~~ increased risk of false positive reactions at higher speed as well as constraints such as for example ~~imperfect~~ sensor systems limitations limit the possible performance. ~~However,~~ even if active safety systems in general have made a giant leap over the last decade with respect to their performance in avoiding or mitigating accidents with an ever increasing variety of collision partners, there will always remain an intrinsic limitation to the AEBS strategy (provide an emergency braking at the latest point possible) which may only be overcome with some more intrusive control strategies the driver may not accept.

Therefore However, there shall should be an ambition to produce active safety systems that go beyond what is required in this revision the minimum requirements of Regulation 131, namely: to avoid accidents with other vehicles up to the maximum driving speed, avoid accidents with pedestrians up to speeds comparable to those required from passenger cars (see Regulation 152), and finally to introduce automated braking systems avoiding bicycle accidents for heavy vehicles. To support this ambition, the state of technology should be closely monitored and requirements in this regulation appropriately ~~adopted~~ adapted.

1. Scope

This Regulation applies to the approval of vehicles of Category M_2, M_3, N_2 and N_3[1] with regard to an on-board system to

(a) Avoid or mitigate the severity of a rear-end in lane collision with a preceding vehicle,

(b) Avoid or mitigate the severity of an impact with a pedestrian. */

*/ For vehicles of category M2, and for those of category M3/N2 with a maximum weight below or equal to 8t, equipped with hydraulic braking, Contracting Parties that are signatories to both Regulation No. 152 and this Regulation shall recognize approvals to either Regulation as equally valid.

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. "V*ehicle 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.

2.15. "*Initialisation*" means the process of setting-up the operation of the system after switching ON the vehicle until it is fully functioning.

[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 - www.unece.org/trans/main/wp29/wp29wgs/wp29gen/wp29resolutions.html

2.16. "*Mass of a vehicle in running order*" means the mass of an unladen vehicle with bodywork and/or coupling device, as relevant (e.g. if fitted by the manufacturer), including coolant, oils, at least 90 per cent of fuel, 100 per cent of other liquids except used waters, driver (75 kg), tools, spare wheel, and, for buses and coaches, the mass of the crew member (75 kg) if there is a crew seat in the vehicle.

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).

~~2.18~~ ~~[TP5]~~ ~~"*Derived from M1/N1*" means vehicles where …~~

~~2.19~~ ~~[TP6]~~ ~~"*Derived from M3/N3*" means vehicles where …~~

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]

[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

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. 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 Vehicle to vehicle scenario;

5.1.1.3. of paragraph 5.2.2. of this Regulation for vehicles submitted to approval for Vehicle to pedestrian scenario.

5.1.1.4. of paragraph 5.2.3. of this Regulation for vehicles submitted to approval for Vehicle 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 and information

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.~~3~~2. 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. If the system has not been initialised after a cumulative driving time of ~~[~~15~~]~~ seconds above a speed of ~~[~~10km/h~~]~~[SP7], information of this status shall be indicated to the driver. This information shall exist until the system has been successfully initialised.

ECE/TRANS/WP.29/78/Rev.6, Annex 3 - www.unece.org/trans/main/wp29/wp29wgs/wp29gen/wp29resolutions.html

5.1.4.~~2~~3. 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.[SP8]

5.1.7. Any vehicle fitted with an AEBS shall meet the performance requirements of UN Regulation No. 13 in its 11 series of amendments for vehicles of Category M_2, M_3, N_2, N_3 and shall be equipped with an anti-lock braking function in accordance with the performance requirements of Annex 13 to UN Regulation No. 13 in its 11 series of amendments.

5.1.8. In situations where the deceleration is limited in empty load conditions, and provided this would be demonstrated by the vehicle manufacturer to the technical services, the requirements applicable to the vehicle with a mass in running order in the tables of paragraphs 5.2.1.4., 5.2.2.4. and 5.2.3.4. shall be deemed fulfilled if the impact speed requirements are met with an added mass on the rear axle, calculated to implement an α value between 1.3 and 1.5,

with $\alpha = W_r/W \times L/H$, where :

(a) W_r is the rear axle load.
(b) W is the subject vehicle mass.
(c) L is the subject vehicle wheelbase.
(d) H is the subject vehicle centre of gravity height in running order.

Additionally, the relative impact speed shall be measured with a vehicle mass in running order, and the result appended to the test report. The unladen/mass in running order vehicle shall reach a relative avoidance speed reduced by $\alpha/1.3$.

5.2. Specific Requirements

5.2.1. Vehicle to vehicle scenario

5.2.1.1. Collision warning

When a collision with a preceding vehicle of category M, N or O is detected in the same lane with a relative speed above that speed up to which the subject vehicle is able to avoid the collision (within the conditions specified in paragraph 5.2.1.4), 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 as specified in paragraph 5.5.1. shall be provided no later than the start of the emergency braking.

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

This shall be verified according to paragraphs 6.4. and 6.5. ~~Additionally, the specifications not covered in paragraphs 6.4. and 6.5. may be verified with an (reproduceable and repeatable) appropriate test method.~~[TP9]

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 4 m/s² to the service braking system of the vehicle. This does not prohibit higher deceleration demand values than 4 m/s² during the collision warning for very short durations, e.g. as haptic warning to stimulate the driver's attention.

This shall be verified according to paragraphs 6.4. and 6.5. ~~Additionally, the specifications not covered in paragraphs 6.4. and 6.5. may be verified with an (reproduceable and repeatable) appropriate test method.~~

The emergency braking may be aborted or the deceleration demand reduced below the threshold above (as relevant) if the conditions prevailing a collision are no longer present or the risk of a collision has decreased.

5.2.1.3. Speed range

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

5.2.1.4. [[SP10]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[TP11] and constantly travelling or stationary ~~targets~~ **vehicles of category M, N, O3/O4**[TP12];

(b) On flat, horizontal and dry roads affording good adhesion;

(c) No trailer is coupled to the motor vehicle and the mass of the motor vehicle is between maximum mass and mass in running order conditions;[SP13]

(d) In situations where the anticipated impact point is displaced by not more than [0.2][SP14] m compared to the vehicle longitudinal centre plane;

(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

~~[(h) In unambiguous situations (e.g. not with **no** multiple potential targets)~~[TP15]

(i) In absence of conditions resulting from the usage of the vehicle which are directly affecting the braking performance (e.g. brake temperature, severe uneven load distribution) [SP16]

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 [SP17] relative [TP18] Impact Speed (km/h) (regardless whether target stationary or moving)*

Relative Speed (km/h)	*M2, M3≤ 8t and N2≤ 8t* ~~*M_2N_2, M_3 < 8t with hydraulic brake*~~			*M3>8t, N2>8t, N3* ~~*M_3N_3 (without M_3 < 8 ton with hydraulic brake)*~~
		Other vehicles		
	Vehicle derived from M1/N1 **	*Vehicles **not equipped with hydraulic braking (e.g. pneumatic, AOH)*** ~~*derived from M3/N3 & pneumatic brake*~~	*Vehicles **with hydraulic braking*** ~~*derived from M3/N**3 & hydraulic brake, M_3 & hydraulic brake*~~	
10	0	0	**0**	0
20	0	0	**0**	0
30	0	0	**0**	0
35	0	0	**0**	0
40	0	0	**15**	0
50	0	0	**28**	0
60	25	0	**40**	0
70	37	**0**	**50**	0
80	49	**28**	**61**	28
90	60	**42**	**71**	42
100	71	**54**	**82**	54*** ~~**(only for M3)**~~ [TP19]

All values in km/h

* For relative speeds between the listed values (e.g. [53] km/h **for a Vehicle derived from M1/N1**), the maximum relative impact speed (i.e. [~~30/30~~ **25**] km/h) assigned to the next higher relative speed (i.e. [~~55~~ **60**] km/h) shall apply.

** The vehicle manufacturer shall demonstrate to the technical service that the vehicles are derived one from the other.**[TP20]**

***** This value only applies to M3**

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

New industry proposal [TP21]:

Notwithstanding the table above, for those vehicles able to detect urban areas where the speed is limited to 60kph or below, the speed reduction when the vehicle is driven in such urban area shall not be lower than 40 kph (unless a lower value is specified in the table)~~, for actual vehicle speed between 10 and 60kph~~ [TP22][SP23][TP24]. In this case, the means used by the vehicle to detect the urban areas as specified above shall be described by the vehicle manufacturer, and the safety concept assessed by the Technical Service according to Annex 3 of this regulation.

[Notwithstanding the table above, for those vehicles driving in urban

areas where the speed is limited to 60kph or below, the speed reduction shall not be lower than 40 kph (unless a lower value is specified in the table). The safety concept shall be described by the vehicle manufacturer and assessed by the Technical Service according to Annex 3 of this regulation.][SP25]

5.2.2. Vehicle to pedestrian scenario

5.2.2.1.[SP26] Collision warning

When the AEBS has detected the possibility of a collision with a pedestrian crossing the road at a constant speed of not more than 5 km/h, within the conditions specified in paragraph 5.2.2.4., a collision warning as specified in paragraph 5.5.1. shall be provided no later than the start of the emergency braking.

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

5.2.2.2.[SP27] Emergency braking

When the system has detected the possibility of an imminent collision, there shall be a braking demand of at least 4 m/s² to the service braking system of the vehicle. This does not prohibit higher deceleration demand values than 4 m/s² during the collision warning for very short durations, e.g. as haptic warning to stimulate the driver's attention.

The emergency braking may be aborted or the deceleration demand reduced below the threshold above (as relevant) if the conditions prevailing a collision are no longer present or the risk of a collision has decreased.

This shall be verified according to paragraph 6.6. ~~Additionally, the specifications not covered in paragraph 6.6. may be verified with an (reproduceable and repeatable) appropriate test method.~~

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.

[[SP28]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:

(a) With unobstructed perpendicularly crossing pedestrians with a lateral speed component of not more than 5 km/h;

(b) In unambiguous situations (e.g. not multiple pedestrians);

(c) On flat, horizontal and dry roads affording good adhesion;

(d) No trailer is coupled to the motor vehicle and the mass of the motor vehicle is between maximum mass and mass in running order conditions;[SP29]

(e) In situations where the anticipated impact point is displaced by not more than [0.2 m][SP30] 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 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.

(i) In absence of situations resulting from the usage of the vehicle which are directly affecting the braking performance (e.g. brake temperature, severe uneven load distribution) [SP31]

It is recognised that the performances required in this table may not be fully achieved in other conditions than those listed. 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 [SP32] **Impact Speed in the direction of travel of the vehicle (km/h) ***

Relative Speed (km/h)	***M2, M3≤ 8t and N2≤ 8t*** ~~*M_2N_2, M_3 < 8t with hydraulic brake*~~			***M3>8t, N2>8t, N3*** ~~*M_3N_3 (without M_3 < 8 ton with hydraulic brake)*~~
		Other vehicles		
	Vehicle derived from M1/N1 **	*Vehicles* ***not equipped with hydraulic braking (e.g. pneumatic, AOH)*** ~~*derived from M3/N3 & pneumatic brake*~~	*Vehicles* ***with hydraulic braking*** ~~*derived from M3/N**3 & hydraulic brake, M_3 & hydraulic brake*~~	
20	**0**	**0**	**0**	**0**
26	**0**	**13**	**13**	**13**
30	**11**	**18**	**18**	**18**
40	**24**	**29**	**29**	**29**
50	**35**	**39**	**39**	**39**
60	**46**	**49**	**49**	**49**

All values in km/h

* 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.

** The vehicle manufacturer shall demonstrate to the technical service that the vehicles are derived one from the other.] **[TP33]**

5.3. Interruption by the Driver

5.3.1. The AEBS ~~shall~~ [SP34] **may** [TP35] provide the means for the driver to interrupt the collision warning~~.~~ **However, when a vehicle braking system is used to provide a haptic warning, the system shall provide the driver with a means to interrupt the warning braking.**

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. 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.

5.4.1.2. The AEBS deactivation control shall be designed a in such a way that manual deactivation shall not be possible with less than two deliberate actions.

5.4.1.3. The location of AEBS deactivation control shall 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.

[[SP36]5.4.1.4. It shall not be possible to manually deactivate the AEBS at a speed above 10 km/h. **However this requirement does not apply when the AEBS is automatically reinstated after a cumulated time of 10 minutes above 70km/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.[TP37][SP38] 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.

[SP39]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.[TP40][SP41] The road test surface shall ~~have a nominal[1] peak braking coefficient (PBC) of 0.9.~~ **permit a mean fully developed deceleration of at least 9m/s^2** , unless otherwise specified~~.~~, when measured using either:

6.1.1.~~2.~~**1.1.** ~~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~~ **The following method to calculate/measure */ the mean fully developed deceleration (dm):**

dm shall be calculated as the deceleration averaged with respect to distance over the interval v_b to v_e, according to the following formula:

$$d_m = \frac{v_b^2 - v_e^2}{25.92(s_e - s_b)}$$

Where:

v_o = initial vehicle speed in km/h,

v_b = vehicle speed at 0.8 v_o in km/h,

v_e = vehicle speed at 0.1 v_o in km/h,

s_b = distance travelled between v_o and v_b in metres,

s_e = distance travelled between v_o and v_e in metres.

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

Footnote */ the vehicle used for the measurement may be a vehicle of the type to be approved or any other vehicle specified by the vehicle manufacturer (e.g. a high volume passenger car of cat. M1).[TP42]

6.1.1.~~3.~~**1.2.** The k-test method specified in Appendix 2 to Annex 13 of Regulation No. 13.

6.1.1.~~4.~~**2.** 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 vehicle to ~~car~~ **vehicle** [TP43][SP44]scenario as stipulated in paragraph 5.2.1. and of 2000 lux in the case of vehicle to pedestrian scenario as stipulated in paragraph 5.2.2. and of 2000 lux in the case of vehicle 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

[1] The "nominal" value is understood as being the minimum theoretical target value.

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[TP45][SP46] [TP47]

The vehicle shall be tested:

(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 %.

We will update the conditions of mass for the categories of 2 and 3.

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~~ **below** 100°C[TP48][SP49] 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.

Confirmation of pre-test method for the large vehicle.

6.3. Test Targets

6.3.1. [TP50] The target used for the vehicle detection tests shall be a regular high-volume series production passenger car of Category M_1 ~~AA saloon.~~ or alternatively a "soft target" representative of ~~such~~ a **passenger** vehicle in terms of its identification characteristics applicable to the sensor system of the AEBS under test according to ~~ISO 19206-3:2020~~ **ISO 19206-3:2021**. 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.

6.4. 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[TP51][SP52].

Tests shall be conducted with a vehicle travelling at speeds shown in tables below for respectively M_2, M_3, N_2 and N_3 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 M_2 and M_3 vehicle in stationary target scenario

M_2			*M_3*		
Maximum mass	*Mass in running order*	*Tolerance*	*Maximum mass*	*Mass in running order*	*Tolerance*

All values in km/h

Discussion point:
Table will be update based on the requirement table.
The test confirms the minimum speed, the maximum collision avoidance, the maximum speed in R152.

Subject vehicle test speed for N_2 and N_3 vehicle in stationary target scenario

N_2			*N_3*		
Maximum mass	*Mass in running order*	*Tolerance*	*Maximum mass*	*Mass in running order*	*Tolerance*

All values in km/h

Discussion point:
Table will be update based on the requirement table.
The test confirms the minimum speed, the maximum collision avoidance, the maximum speed in R152.

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. [SP53]

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[TP54][SP55].

Tests shall be conducted with a vehicle travelling at speeds shown in tables below for respectively M_2, M_3, N_2 and N_3 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 M_2 and M_3 vehicle in moving target scenario

M_2			*M_3*		
Maximum mass	*Mass in running order*	*Tolerance*	*Maximum mass*	*Mass in running order*	*Tolerance*

All values in km/h

Discussion point:
Table will be update based on the requirement table.
The test confirms the minimum speed, the maximum collision avoidance, the maximum speed in R152.

Subject vehicle test speed for N_2 and N_3 vehicle in moving target scenario

N_2			*N_3*		
Maximum mass	*Mass in running order*	*Tolerance*	*Maximum mass*	*Mass in running order*	*Tolerance*

All values in km/h

Discussion point:
Table will be update based on the requirement table.
The test confirms the minimum speed, the maximum collision avoidance, the maximum speed in R152.

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.[TP56][SP57]

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/-0.4 km/h, starting not before the functional part of the test has started. The pedestrian target's positioning shall ...

Tests shall be conducted with a vehicle travelling at speeds shown in tables below for respectively M_2, M_3, N_2 and N_3 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 M_2 and M_3 vehicle in pedestrian target scenario

M_2			*M_3*		
Maximum mass	*Mass in running order*	*Tolerance*	*Maximum mass*	*Mass in running order*	*Tolerance*

All values in km/h

Discussion point:
Table will be update based on the requirement table.
The test confirms the minimum speed, the maximum collision avoidance, the maximum speed in R152.

Subject vehicle test speed for N_2 and N_3 vehicle in pedestrian target scenario

N_2			*N_3*		
Maximum mass	*Mass in running order*	*Tolerance*	*Maximum mass*	*Mass in running order*	*Tolerance*

All values in km/h

Discussion point:
Table will be update based on the requirement table.
The test confirms the minimum speed, the maximum collision avoidance, the maximum speed in R152.

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[TP58][SP59].

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 +0/-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 M_2, M_3, N_2 and N_3 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 M_2 and M_3 vehicle in bicycle target scenario

M_2			*M_3*		
Maximum mass	*Mass in running order*	*Tolerance*	*Maximum mass*	*Mass in running order*	*Tolerance*

All values in km/h

Discussion point:
Table will be update based on the requirement table.
The test confirms the minimum speed, the maximum collision avoidance, the maximum speed in R152.

Subject vehicle test speed for N_2 and N_3 vehicle in bicycle target scenario

N_2			*N_3*		
Maximum mass	*Mass in running order*	*Tolerance*	*Maximum mass*	*Mass in running order*	*Tolerance*

All values in km/h

Discussion point:
Table will be update based on the requirement table.
The test confirms the minimum speed, the maximum collision avoidance, the maximum speed in R152.

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 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. [TP60][SP61] 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 (Vehicle to ~~Car~~**Vehicle**,[TP62][SP63] Vehicle to Pedestrian, Vehicle 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 Vehicle to ~~Car~~ **Vehicle** tests;

(b) 10.0 per cent of the performed test runs for the Vehicle to Pedestrian tests; and

(c) 20.0 per cent of the performed test runs for the Vehicle 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 Secretariat[3] 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.

[3] 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. 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 the 01 series of amendments to this Regulation, shall refuse to grant type approvals in accordance with the 01 series of amendments of this Regulation.

12.1.2. As from the date of entry into force of the 01 series of amendments to this Regulation, Contracting Parties applying this Regulation may continue granting type approvals and extensions of type approvals to the 00 series of amendments to this Regulation.

In accordance with Article 12 of the 1958 Agreement, the 00 series of amendments may be used as an alternative to the 01 series. Contracting Parties shall notify to the Secretariat General which alternative they apply. In the absence of notification of Contracting Parties to the United Nations Secretary-General, Contracting Parties will be considered to apply the 01 series.

12.1.3. As from the date of entry into force of the 01 series of amendments, no Contracting Party applying this Regulation shall refuse national or regional type approval of a vehicle type approved to the 01 series of amendments to this Regulation.

12.1.4. Until 1 November 2016[SP64], no Contracting Party applying this Regulation shall refuse national or regional type approval of a vehicle type approved to the 00 series of amendments to this Regulation.

12.1.5. As from 1 November 2016, Contracting Parties applying the 01 series of amendments to this Regulation shall not be obliged to accept, for the purpose of national or regional type approval, a vehicle type approved to the 00 series of amendments to this Regulation.

12.2. Transitional provisions applicable to the 02 series of amendments

Discussion point:
Adjust transitional provisions.

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. 131

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:.....

   Mass in running order: …. kg

   Maximum mass: …. kg[TP65]
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 vehicle to ~~car~~ **vehicle** scenario granted/refused/extended/withdrawn:[2]

10.2. to vehicle to pedestrian scenario granted/refused/extended/withdrawn:[2]

10.3. to vehicle 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: .....

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

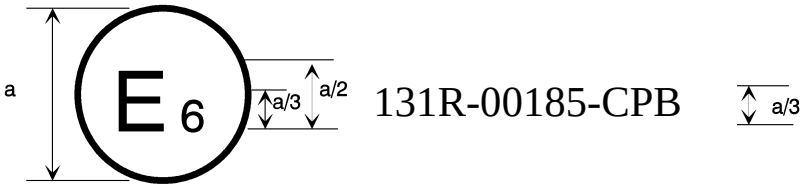
[2] Strike out what does not apply.

15. Any remarks:.....

Annex 2

Arrangements of approval marks

(see paragraphs 4.4. to 4.4.2. 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 Belgium (E 6) with regard to the Advanced Emergency Braking Systems (AEBS) pursuant to UN Regulation No. 131 (marked with C for Vehicle to ~~Car~~**Vehicle**. P for Vehicle to Pedestrian. B for Vehicle 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. 131 in its original form.

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. 131: .....

3.9. Results of safety concept verification test, as per para. 4.1.2. of Annex 3 to UN Regulation No. 131: .....

3.10. Date of test: .....

3.11. This test has been carried out and the results reported in accordance with ….. to UN Regulation No. 131 as last amended by the ..... series of amendments.

Technical Service[1] carrying out the test
Signed: ..... Date: .....

~~3.12.~~[TP66][SP67] ~~Type Approval Authority[1]~~
~~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[TP68][SP69]

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.

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

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.

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

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

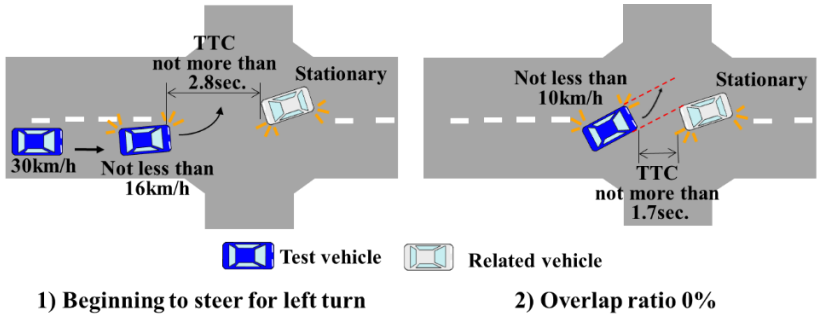
1.1. In this scenario, the subject vehicle passes by a left turn or right turn in front of an oncoming vehicle that is stopped to make a left turn or right turn at an intersection.

1.2. An example of the detail scenario:

The subject vehicle drives at a speed of 30 km/h (with a tolerance of +0/-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 %.

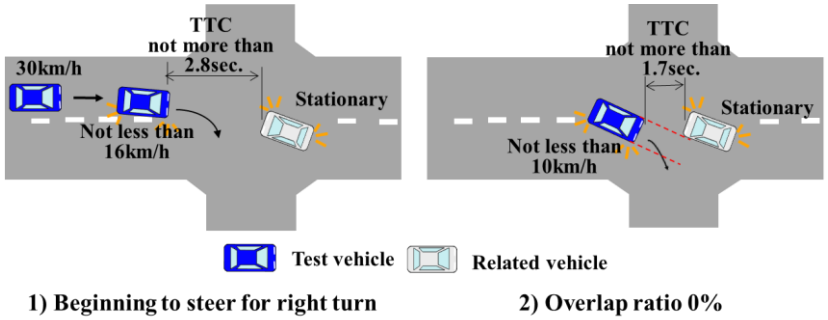
Figure 1:
Left turn or right turn at the intersection

(A) Driving on right side of the road



1) Beginning to steer for left turn **2) Overlap ratio 0%**

(B) Driving on left side of the road



1) Beginning to steer for right turn **2) Overlap ratio 0%**

The blue car needs to be changed from passenger vehicle to large vehicle.

Scenario 2

Right turn or Left turn of a forward vehicle

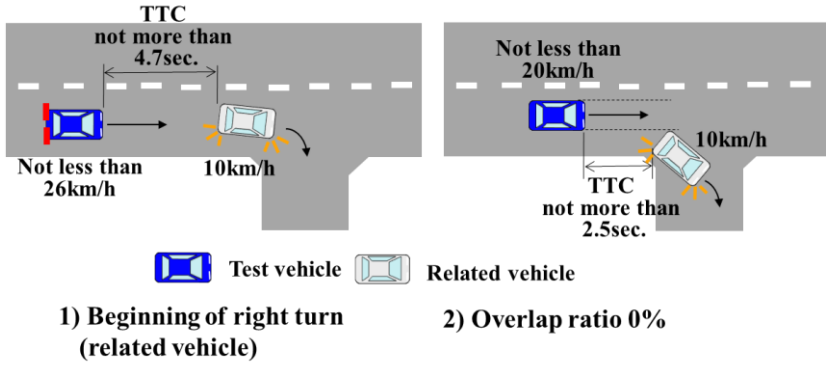
2.1. In this scenario, the subject vehicle follows a forward vehicle. After that, the forward vehicle turns right or left at a corner, and the subject vehicle goes straight.

2.2. An example of the detail scenario:

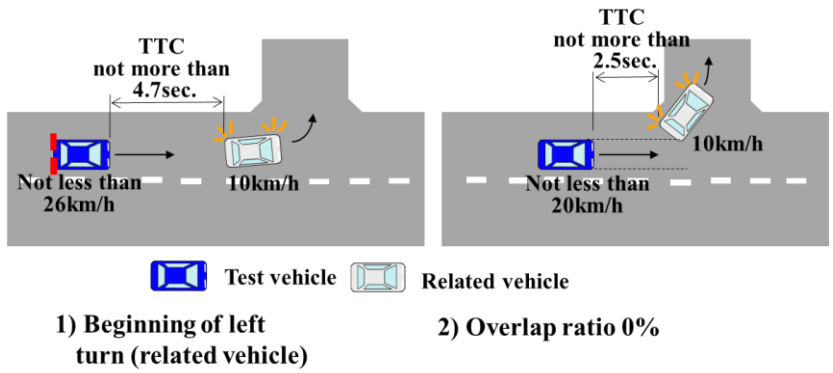
Both the forward vehicle and the subject vehicle drive at a speed of 40 km/h (with a tolerance of +0/-2 km/h) on the straight road. The forward vehicle decelerates by braking to a speed of 10 km/h (with a tolerance of +0/-2 km/h) in order to turn right or left at the corner, and the subject vehicle also 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 %.

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



The blue car needs to be changed from passenger vehicle to large vehicle.

Scenario 3

Curved road with guard pipes and a stationary object

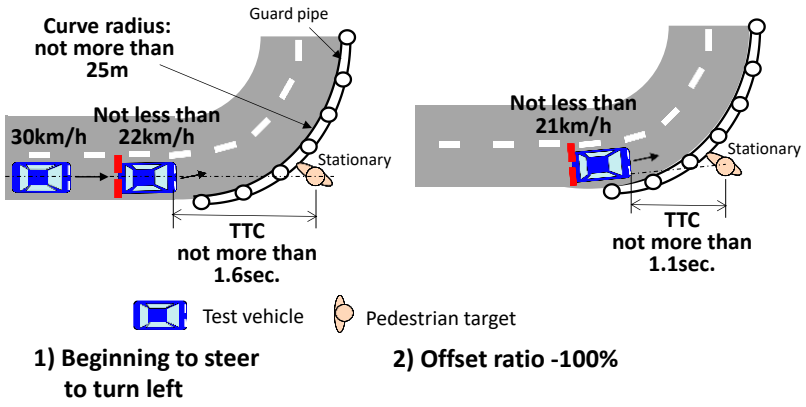
3.1. In this scenario, the subject vehicle drives a small radius curved road of which the guard pipes are constructed to the outer side, and a stationary vehicle (M_1 category), a stationary pedestrian target or a stationary bicycle target is positioned just outside of the guard pipes and where on the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

3.2. An example of the detail scenario:

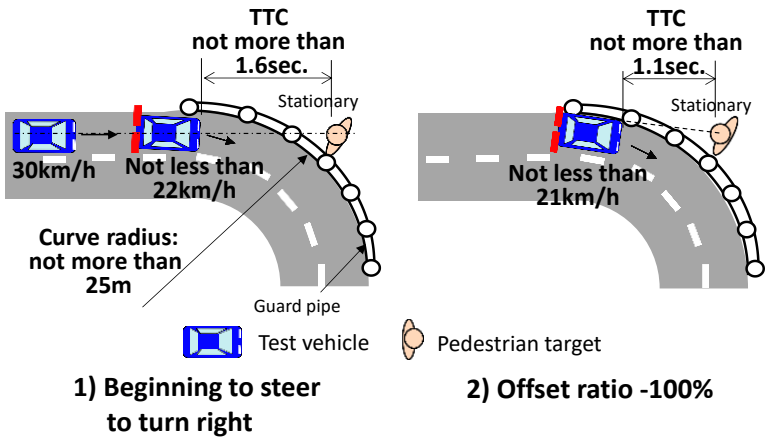
The subject vehicle drives at a speed of 30 (with a tolerance of +0/-2 km/h) km/h toward the curve of which the radius is not more than 25 m at the outer side of the road, and decelerates by braking to a speed of not less than 22 km/h at a point where the subject vehicle enters the curve. The TTC to 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%, 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%.

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



The blue car needs to be changed from passenger vehicle to large vehicle.

Scenario 4

Lane change due to road construction

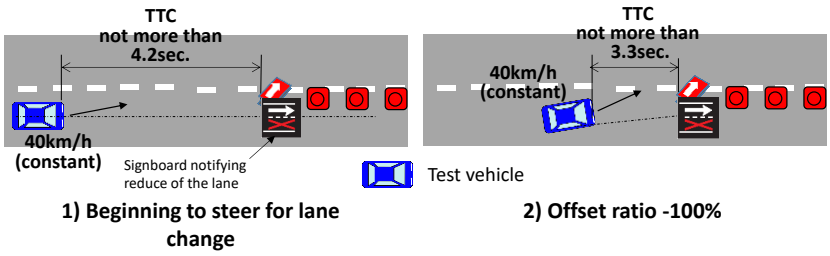
4.1. In this scenario, the subject vehicle changes the lane in front of the signboard which is positioned in the centre of the lane and notifies the driver that the lane is reduced.

4.2. An example of the detail scenario:

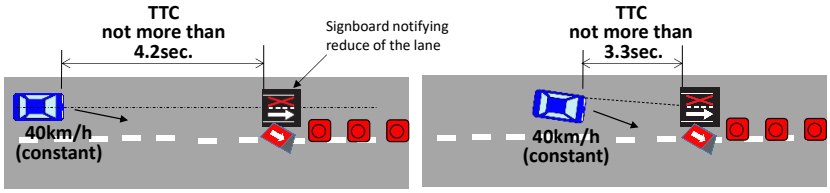
The subject vehicle drives a straight road at a speed of 40 km/h (with a tolerance of +0/-2 km/h) and begins to steer in order to change the lane in front of the signboard which notifies reducing the lane. No other vehicles approach the subject vehicle. The TTC to the signboard is not more than 4.2 seconds 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%.

Figure 4:
Lane change due to road construction

(A) Driving on right side of the road



(B) Driving on left side of the road



1) Beginning to steer for lane change

2) Offset ratio -100%

The blue car needs to be changed from passenger vehicle to large vehicle.