

## Proposal for a new UN Regulation on

### Uniform provisions concerning the approval of vehicles with regard to Automated Lane Keeping Systems

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## **Introduction**

The intention of the Regulation is .....

## 1. Scope and purpose

- 1.1. This Regulation applies to vehicles of Category M<sub>1</sub>.

## 2. Definitions

For the purposes of this Regulation:

- 2.1. “*Automated Lane Keeping System (ALKS)*” for low speed application is a system which is activated by the driver and which keeps the vehicle within its lane at the speed of 60 km/h or below by influencing the lateral movement of the vehicle and controls the longitudinal movement of the vehicle for extended periods without further driver command.
- Within this Regulation, ALKS is also referred to as “*the system*”.
- 2.1.1. “*Vehicle Type with regard to Automated Lane Keeping System (ALKS)*” means a category of vehicles which do not differ in such essential aspects as:
- (a) Vehicle features which significantly influence the performances of the Automated Lane Keeping System (ALKS),
  - (b) The design of the Automated Lane Keeping System (ALKS),
  - (c) Manufacturer’s designation of vehicle type.
- 2.2. “*Transition demand*” is a logical and intuitive procedure to transfer the Dynamic Driving Task (DDT) from automated control by the system to human driver control. This request given from the system to the human driver indicates the transition phase.
- 2.3. “*Transition phase*” means the duration of the transition demand.
- 2.4. “*Planned event*” is a situation which is known in advance, e.g. at the time of activation such as a journey point (e.g. exit of a highway) etc. and which requires a transition demand.
- 2.5. “*Unplanned event*” is a situation which is unknown in advance, but assumed as very likely in happening, e.g. [road construction, inclement weather, approaching emergency vehicle, missing lane marking, load falling from truck (collision)] and which requires a transition demand.
- 2.6. “*Imminent collision risk*” describes a situation or an event which leads to a collision of the vehicle with another road user or an obstacle which cannot be avoided by a braking demand with lower than [5 m/s<sup>2</sup>].
- 2.7. “*Minimum Risk Manoeuvre (MRM)*” means a procedure aimed at minimising risks in traffic, which is automatically performed by the system after a transition demand.
- 2.8. “*Emergency Manoeuvre (EM)*” is a manoeuvre performed by the system in case of an event in which the vehicle is at imminent collision risk with the purpose of avoiding or mitigating a collision.
- 2.9. Speed
- 2.9.1. “*Specified maximum speed*” is the speed declared by the manufacturer up to which the system operates under optimum conditions.
- 2.9.2. “*Maximum operational speed*” is the speed selected by the system up to which the system operates under current environmental and sensor conditions. It is the maximum vehicle speed at which the system may be active and shall be determined by the capability of the sensing system as well as the environmental conditions.
- 2.9.3. “*Present speed*” or “*speed*” is the current speed selected by the system due to traffic.

- 2.10. “*Detection range*” of the sensing system is the distance at which the system can reliably recognise a target, taking account of the deterioration of components of the sensing system due to time and usage throughout the lifetime of the vehicle and generate a control signal.
- 2.11. Failures
- 2.11.1. An “*ALKS failure*” is any single failure specific to the operation of the ALKS (e.g. single sensor failure, loss of necessary calculation data for the driving path of the vehicle).
- 2.11.2. “*Failure mode*” is the operation status of the system in which the system operates with an ALKS failure.
- 2.11.3. A “*severe ALKS failure*” is a failure specific to the operation of the ALKS that affects the safe operation of the system when in failure mode with a very low probability of occurrence such as generally used for essential components as e.g. an electronic control unit. Single sensor failures are only considered as such when accompanied by another influence affecting the safe operation of the system.
- 2.11.4. A “*severe vehicle failure*” is any failure of the vehicle (e.g. electrical, mechanical) that affects the ability of the ALKS to perform the DDT and would also affect the manual operation of the vehicle (e.g. loss of power supply, failure of the braking system, sudden loss of tire pressure).
- 2.12. “*Self-check*” means an integrated function which checks for any system failure and for the detection range of the sensing system on a continuous basis.
- 2.13. A “*system override*” by the driver means a situation when the driver provides an input to a control which has priority over the longitudinal or lateral control of the system, while the system is still active.
- 2.14. “*Dynamic Driving Task (DDT)*” is the control and execution of all longitudinal and lateral movements of the vehicle.
- 2.15. “*Data Storage System for Automated Driving (DSSAD)*” enables the determination of interactions between the ALKS and the human driver.<sup>1</sup>
- 2.16. “*Lifetime of the system*” is the period of time during which the ALKS system is available, as a function, on the vehicle.

### 3. Application for approval

- 3.1. The application for approval of a vehicle type with regard to the ALKS 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 2.1.1., together with a documentation package which gives access to the basic design of the ALKS 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.

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<sup>1</sup> To be revised in accordance with IWG on EDR/DSSAD.

## 4. Approval

- 4.1. If the vehicle type submitted for approval pursuant to this Regulation meets the requirements of paragraph 5 to 9 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 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;<sup>2</sup>
  - 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. System Safety and Fail-safe Response

- 5.1. General Requirements
  - 5.1.1. The activated system shall perform the DDT, manage all situations including failures, and shall not endanger the safety of the vehicle occupants or any other road users.

The activated system shall not cause any collisions that are reasonably foreseeable and preventable. If a collision can be safely avoided without causing another one, it shall be avoided. When the vehicle is involved in a detectable collision, the vehicle shall be brought to a standstill.
  - 5.1.2. The activated system shall comply with traffic rules relating to the DDT in the country of operation.

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

- 5.1.3. The activated system shall exercise control over systems required to support the driver in resuming manual control at any time (e.g. demist, windscreen wipers and lights).
- 5.1.4. A transition demand shall not endanger the safety of the vehicle occupants or other road users.
- 5.1.5. If the driver fails to resume control of the DDT during the transition phase, the system shall perform a minimum risk manoeuvre. During a minimum risk manoeuvre, the system shall minimise risks to safety of the vehicle occupants and other road users.
- 5.1.6. The system shall perform self-checks to detect the occurrence of failures and to confirm system performance at all times (e.g. after vehicle start the system has at least once detected an object at the same or a higher distance than that declared as detection range according to paragraph 7.1.).
- 5.1.7. The effectiveness of the system shall not be adversely affected by magnetic or electrical fields. This shall be demonstrated by compliance with the 05 or later series of amendments to UN Regulation No. 10.
- 5.1.8. The manufacturer shall take measures to guard against reasonably foreseeable misuse by the driver and tampering of the system.
- 5.1.9. When the system can no longer meet the requirements of this Regulation, it shall not be possible to activate the system.

The manufacturer shall declare and implement a process to manage the safety and continued compliance of the ALKS system over lifetime. The process and any measures implemented shall be demonstrated to the satisfaction of the Technical Service as part of the Annex 4 assessment.

## 5.2. Dynamic Driving Task

- 5.2.1. The activated system shall keep the vehicle inside its lane of travel and ensure that the vehicle does not cross any lane marking (outer edge of the front tyre to outer edge of the lane marking). The system shall aim to keep the vehicle in a stable lateral position inside the lane of travel to avoid confusing other road users.
- 5.2.2. The activated system shall detect a vehicle driving beside as defined in paragraph 7.1.2. and, if necessary, adjust the speed and/or the lateral position of the vehicle within its lane as appropriate.
- 5.2.3. The activated system shall control the speed of the vehicle.
- 5.2.3.1. The maximum speed up to which the system is permitted to operate is 60 km/h.
- 5.2.3.2. The activated system shall adapt the vehicle speed to infrastructural and environmental conditions (e.g. narrow curve radii, inclement weather).
- 5.2.3.3. The activated system shall detect the distance to the next vehicle in front as defined in paragraph 7.1.1. and shall adapt the vehicle speed in order to avoid collision.

While the ALKS vehicle is not at standstill, the system shall adapt the speed to adjust the distance to a vehicle in front in the same lane to be equal or greater than the minimum following distance.

In case the minimum time gap cannot be respected temporarily because of other road users (e.g. vehicle is cutting in, decelerating lead vehicle, etc.), the vehicle shall readjust the minimum following distance at the next available opportunity without any harsh braking unless an emergency manoeuvre would become necessary.

The minimum following distance shall be calculated using the formula:

$$d_{\min} = v_{\text{ALKS}} * t_{\text{front}}$$

Where:

- $d_{\min}$  = the minimum following distance
- $v_{\text{ALKS}}$  = the present speed of the ALKS vehicle in m/s
- $t_{\text{front}}$  = minimum time gap in seconds between the ALKS vehicle and a leading vehicle in front as per the table below:

<i>Present speed of the ALKS vehicle</i>		<i>Minimum time gap</i>	<i>Minimum following distance</i>
(km/h)	(m/s)	(s)	(m)
7.2	2.0	1.0	2.0
10	2.78	1.1	3.1
20	5.56	1.2	6.7
30	8.33	1.3	10.8
40	11.11	1.4	15.6
50	13.89	1.5	20.8
60	16.67	1.6	26.7

For speed values not mentioned in the table, linear interpolation shall be applied.

Notwithstanding the result of the formula above for present speeds below 2 m/s the minimum following distance shall never be less than 2 m.

5.2.4. The activated system shall be able to bring the vehicle to a complete stop behind a stationary vehicle, a road user or a blocked lane of travel. This shall be ensured up to the maximum operational speed of the system.

5.2.5. The activated system shall detect the risk of an imminent collision e.g. with another road user ahead or beside the vehicle, due to a harsh decelerating lead vehicle, a suddenly cutting in vehicle or a suddenly appearing obstacle and shall automatically perform an appropriate emergency manoeuvre as specified in paragraph 5.3.

The system shall not deactivate or unreasonably switch the control strategy under conditions not tested in Annex 5. This shall be demonstrated in accordance with Annex 4 of this Regulation.

5.2.5.1. The activated system shall avoid a collision with a leading vehicle which decelerates up to its full braking performance provided that there was no undercut of the minimum following distance the ALKS vehicle would adjust to a leading vehicle at the present speed due to a cut in manoeuvre of this lead vehicle.

5.2.5.2. The activated system shall detect the risk of an imminent collision with a suddenly cutting in vehicle and avoid a collision,

- provided the cutting in vehicle maintains its longitudinal speed and
- when the distance between the vehicle's front and the cutting in road user's rear corresponds to a TTC calculated by the following equation:

$$TTC_{LaneIntrusion} > v_{rel}/(2 \cdot 6m/s^2) + [0.35s]^3$$

Where:

- $v_{rel}$  = relative velocity between both vehicles, positive for vehicle being faster than the cutting in vehicle

<sup>3</sup> Parameters defining a manoeuvre that shall be avoided have to be reviewed.

TTCLaneIntrusion = The TTC value when the outside of the tyre of the intruding vehicle's front wheel closest to the lane markings crosses a line 0.3 m beyond the outside edge of the visible lane marking to which the intruding vehicle is being drifted.

5.2.5.3. The activated system shall detect the risk of an imminent collision with an unobstructed crossing adult pedestrian in front of the vehicle and avoid a collision. This shall be tested according to the test procedure in UN Regulation No. 152.

5.2.5.4. It is recognised that the fulfilment of the requirement in paragraph 5.2.5. may not be fully achieved in other conditions than those described 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 4 of this Regulation.

### 5.3. Emergency Manoeuvre (EM)

The fulfilment of the provisions of this paragraph shall be demonstrated by the manufacturer to the technical service during the inspection of the safety approach as part of the assessment to Annex 4 and according to the relevant tests in Annex 5.<sup>4</sup>

5.3.1. An emergency manoeuvre shall be carried out in case of an imminent collision risk as described in paragraph 5.2.5.

5.3.1.1. Any longitudinal deceleration demand of more than 5.0 m/s<sup>2</sup> of the system shall be considered to be an emergency manoeuvre.

5.3.2.<sup>5</sup> This manoeuvre shall decelerate the vehicle up to its full braking performance if necessary and/or may perform an automatic evasive manoeuvre, when appropriate.

If failures are affecting the braking or steering performance of the system, the manoeuvre shall be carried out with consideration for the remaining performance.

During the evasive manoeuvre the ALKS vehicle shall not cross the lane marking (outer edge of the front tyre to outer edge of the lane marking).

After the evasive manoeuvre the vehicle shall aim at resuming a stable position.

5.3.3. An emergency manoeuvre shall not be terminated unless the imminent collision risk disappeared or the driver deactivated the system.

5.3.3.1. After an emergency manoeuvre is terminated the system shall continue to operate.

5.3.3.2. If the emergency manoeuvre results in the vehicle being at standstill, the signal to activate the hazard warning lights shall be generated. If the vehicle automatically drives off again, the signal to deactivate the hazard warning lights shall be generated automatically.

5.3.4. The vehicle shall implement a logic signal indicating emergency braking as specified in UN Regulation No. 13-H.

### 5.4. Transition demand and system operation during transition phase

The fulfilment of the provisions of this paragraph shall be demonstrated by the manufacturer to the technical service during the inspection of the safety

<sup>4</sup> Requirement possibly moved to different section.

<sup>5</sup> Possibility of lane change is expected once appropriate technical requirements for such a function is established.

approach as part of the assessment to Annex 4 and according to the relevant tests in Annex 5.<sup>6</sup>

- 5.4.1. The activated system shall recognise all situations in which it needs to transition the control back to the driver.
- Types of situations in which the vehicle will generate a transition demand to the driver shall be declared by the vehicle manufacturer and included in the documentation package required in Annex 4.
- 5.4.2. The initiation of the transition demand shall be such that sufficient time is provided for a safe transition to manual driving.
- 5.4.2.1. In case of a planned event that would prevent the ALKS from continuing the operation, a transition demand shall be given early enough to ensure the minimal risk maneuver, in case the driver would not resume control, would bring the vehicle to standstill before the planned event occurs.
- 5.4.2.2. In case of an unplanned event, a transition demand shall be given upon detection.
- 5.4.2.3. In case of any failure affecting the operation of the system, the system shall immediately initiate a transition demand upon detection.
- 5.4.3. During the transition phase the system shall continue to operate. The system may reduce the speed of the vehicle to ensure its safe operation but shall not bring it to standstill unless required by the situation (e.g. due to vehicles or obstacles obstructing the path of the vehicle) or when caused by a haptic warning according to paragraph 6.4.1 started at speeds below 20km/h.
- 5.4.3.1. Once in standstill the vehicle may remain in this condition and shall generate the signal to activate the hazard warning lights within 5 s.
- 5.4.3.2. During the transition phase, the transition demand shall be escalated latest after 4 s after the start of the transition demand.
- 5.4.4. A transition demand shall only be terminated once the system is deactivated or a minimum risk manoeuvre has started.
- 5.4.4.1. In case the driver is not responding to a transition demand by deactivating the system (either as described in paragraph 6.2.4. or 6.2.5.), a minimum risk manoeuvre shall be started, earliest 10 s after the start of the transition demand.
- 5.4.4.1.1. Notwithstanding paragraph 5.4.4.1. a minimum risk manoeuvre may be initiated immediately in case of a severe ALKS or severe vehicle failure.
- In case of a severe ALKS or vehicle failure the ALKS may no longer be capable of fulfilling the requirements of this Regulation, but it shall aim at enabling a safe transition of control back to the driver.
- 5.4.4.1.2. The manufacturer shall declare the types of severe vehicle failures and severe ALKS failures that will lead the ALKS to initiate a MRM immediately.
- 5.5. Minimum Risk Manoeuvre (MRM)
- The fulfilment of the provisions of this paragraph shall be demonstrated by the manufacturer to the technical service during the inspection of the safety approach as part of the assessment to Annex 4 and according to the relevant tests in Annex 5.<sup>7</sup>

<sup>6</sup> Requirement possibly moved to different section.

<sup>7</sup> Requirement possibly moved to different section.

- 5.5.1.<sup>8</sup> During the minimum risk manoeuvre the vehicle shall be slowed down inside the lane or, in case the lane markings are not visible, remain on an appropriate trajectory taking into account surrounding traffic and road infrastructure, with an aim of achieving a deceleration demand not greater than 4.0 m/s<sup>2</sup>.
- Higher deceleration demand values are permissible for very short durations, e.g. as haptic warning to stimulate the driver's attention, or in case of a severe ALKS or severe vehicle failure.
- Additionally, the signal to activate the hazard warning lights shall be generated with the start of the minimum risk manoeuvre.
- 5.5.2. The minimum risk manoeuvre shall bring the vehicle to standstill unless the system is deactivated by the driver during the manoeuvre.
- 5.5.4. A minimum risk manoeuvre shall only be terminated once the system is deactivated or the system has brought the vehicle to a standstill.
- 5.5.5. The system shall be deactivated at the end of any minimum risk manoeuvre.
- The hazard warning lights shall remain activated unless deactivated manually and the vehicle shall not move away after standstill without manual input.
- 5.5.6. Reactivation of the system after the end of any minimum risk manoeuvre shall only be possible after each new engine start/run cycle.

## 6. Human Machine Interface/Operator Information

- 6.1. Driver Availability Recognition System
- The fulfilment of the provisions of this paragraph shall be demonstrated by the manufacturer to the technical service during the inspection of the safety approach as part of the assessment to Annex 4 and according to the relevant tests in Annex 5.<sup>9</sup>
- 6.1.1. The system shall comprise a driver availability recognition system.
- The driver availability recognition system shall detect if the driver is present in a driving position, if the safety belt of the driver is fastened and if the driver is available to take over the driving task.
- 6.1.2. Driver presence
- A transition demand shall be initiated according to paragraph 5.4. if any of the following conditions is met:
- When the driver is detected not to be in the seat for a period of more than 1 second; or
  - When the driver's safety belt is unbuckled.
- The second level warning of the safety-belt reminder according to UN-R16 may be used instead of an acoustic warning of the Transition Demand.
- 6.1.3. Driver availability
- The system shall detect if the driver is available and in an appropriate driving position to respond to a transition demand by monitoring the driver.
- The manufacturer shall demonstrate to the satisfaction of the technical service the vehicle's capability to detect that the driver is available to take over the driving task.

<sup>8</sup> Possibility of lane change is expected once appropriate technical requirements for such a function is established.

<sup>9</sup> Requirement possibly moved to different section.

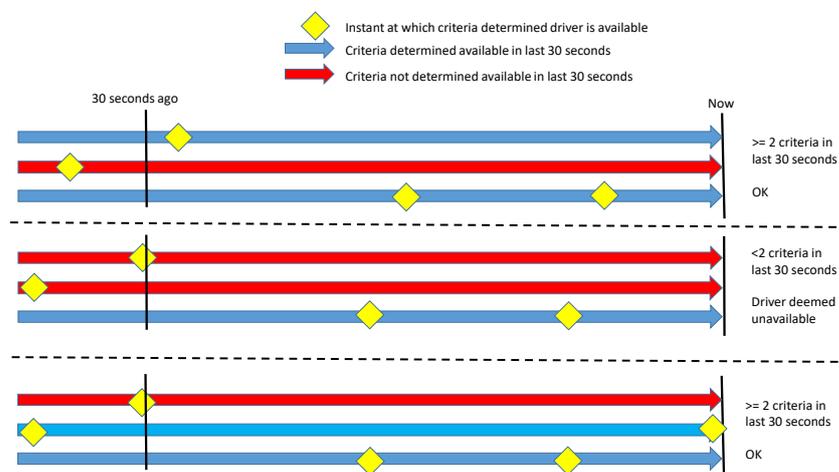
### 6.1.3.1. Criteria for deeming driver availability

The driver shall be deemed to be unavailable unless at least two availability criteria (e.g. input to driver-exclusive vehicle control, eye blinking, eye closure, conscious head or body movement) have individually determined that the driver is available in the last 30 seconds.

At any time, the system may deem the driver unavailable.

As soon as the driver is deemed to be unavailable, or fewer than two availability criteria can be monitored, the system shall immediately provide a distinctive warning until appropriate actions of the driver are detected or until a transition demand is initiated. At the latest, a transition demand shall be initiated according to paragraph 5.4. if this warning continues for [15]s.

Justification for the number and combination of availability criteria, in particular with regard to the corresponding time interval, shall be provided by the manufacturer by documented evidence. However, the time interval required for any availability criteria shall not exceed 30 seconds. This shall be demonstrated by the manufacturer and assessed by the technical service according to Annex 4.



[6.1.4. Other activities than driving that are provided by the vehicle to the driver once the ALKS is activated, shall be automatically suspended as soon as the system issues a transition demand or is deactivated whichever comes first.]<sup>10</sup>

### 6.2. Activation, Deactivation and Driver Input

The fulfilment of the provisions of this paragraph shall be demonstrated by the manufacturer to the technical service during the inspection of the safety approach as part of the assessment to Annex 4 and according to the relevant tests in Annex 5.<sup>11</sup>

6.2.1. The vehicle shall be equipped with dedicated means for the driver to activate (active mode) and deactivate (off mode) the system. This shall be permanently visible to the driver.

6.2.2. The default status of the system shall be the off mode at the initiation of each new engine start/run cycle.

This requirement does not apply when a new engine start/run cycle is performed automatically, e.g. by the operation of a stop/start system.

6.2.3. The system shall become active only upon a deliberate action by the driver and if all the following conditions are met:

<sup>10</sup> To be shared with the Global Forum for Road Traffic Safety (WP.1)

<sup>11</sup> Requirement possibly moved to different section.

- The driver is in the driver seat and the driver's safety belt is fastened according to paragraphs 6.1.1. and 6.1.2.;
- The driver is available to take over control of the DDT according to paragraph 6.1.3.;
- No failure affecting the safe operation or the functionality of the ALKS is present;
- DSSAD is operational;
- The environmental and infrastructural conditions allow the operation;
- Positive confirmation of system self-check; and
- The vehicle is on roads where pedestrians and cyclists are prohibited and which, by design, are equipped with a physical separation that divides the traffic moving in opposite directions and prevent traffic from cutting across the path of the vehicle.

If any of the above conditions is no longer fulfilled, the system shall immediately initiate a transition demand unless specified differently in this Regulation.

- 6.2.4 It shall be possible to manually deactivate (off-mode) the system by an intentional action of the driver using the same means as to activate the system, as mentioned in paragraph 6.2.1.

The means of deactivating shall provide protection against unintentional manual deactivation for example by requiring a single input exceeding a certain threshold of time or a double press, or two separate but simultaneous inputs.

Additionally, it shall be ensured the driver is in lateral control of the vehicle at the time of the deactivation, by e.g. placing the deactivation means on the steering control or confirming the driver is holding the steering control.

- 6.2.5. In addition to paragraph 6.2.4., the system shall not be deactivated by any driver input other than those described below in paragraphs 6.2.5.1. to 6.2.5.4.

- 6.2.5.1. Deactivation by input to driving controls

The system shall be deactivated when at least one of the following conditions is met:

- The driver overrides the system by steering while holding the steering control and this override is not suppressed, as specified in paragraph 6.3.; or
- The driver is holding the steering control and overrides the system by braking or accelerating, as specified in paragraph 6.3.1. below.

- 6.2.5.2. Deactivation during an ongoing transition demand or an ongoing minimum risk manoeuvre

In case a transition demand or a minimum risk manoeuvre is on-going, the system shall only be deactivated:

- As defined in paragraph 6.2.5.1. or
- Upon detection that the driver has taken hold of the steering control as a response to the transition demand or the minimum risk manoeuvre and provided the system confirms the driver is attentive as defined in paragraph 6.3.1.1.

- 6.2.5.3. Deactivation during an ongoing emergency manoeuvre

In case of an ongoing emergency manoeuvre, the deactivation of the system may be delayed until the imminent collision risk disappeared.

- 6.2.5.4. Deactivation in case of a severe vehicle failure or a severe ALKS failure

In case of a severe vehicle failure or a severe ALKS failure the ALKS may employ different strategies with regard to deactivation.

These different strategies shall be declared by the manufacturer and their effectiveness shall be assessed by the Technical Service with regard to ensuring a safe transition of control from the system to the human driver according to Annex 4.

- 6.2.6. On deactivation of the system, there shall not be an automatic transition to any function, which provides continuous longitudinal and/or lateral movement of the vehicle (e.g. ACSF of Category B1 function).

After deactivation, Corrective Steering Function (CSF) may be active with the aim at accustoming the driver to execute the lateral control task by gradually reducing lateral support.

Notwithstanding both paragraphs above, any other safety system delivering longitudinal or lateral support in accident-prone situations (e.g. Advanced Emergency Braking System (AEBS), Electronic Stability Control (ESC), Brake Assist System (BAS) or Emergency Steering Function (ESF)) shall not be deactivated in case of deactivation of ALKS.

- 6.2.7. Any deactivation shall be indicated to the driver as defined in paragraph 6.4.2.3.

- 6.3. System override

- 6.3.1. A driver input to the steering control shall override the lateral control function of the system when the input exceeds a reasonable threshold designed to prevent unintentional override.

This threshold shall include a specified force and duration and shall vary depending on parameters that include criteria used for driver attentiveness to be checked during the drivers input as defined in paragraph 6.3.1.1.

These thresholds and the rationale for any variation shall be demonstrated to the Technical Service during the assessment according to Annex 4.

- 6.3.1.1. Driver attentiveness

The system shall detect if the driver is attentive. The driver is deemed to be attentive when at least one of the following criteria is met:

- Driver gaze direction is confirmed as primarily looking at the road ahead;
- Driver gaze direction is being confirmed as looking at the rear view mirrors; or,
- Driver head movement is confirmed as primarily directed towards the driving task.

The specification for confirming these or equally safe criteria must be declared by the manufacturer and supported by documented evidence. This shall be assessed by the technical service according to Annex 4.

- 6.3.2. A driver input to the braking control resulting in a higher deceleration than that induced by the system or maintaining the vehicle in standstill by any braking system, shall override the longitudinal control function of the system.

- 6.3.3. A driver input to the accelerator control may override the longitudinal control function of the system. However, such an input shall not cause the system to no longer meet the requirements of this Regulation.

- 6.3.4. Any driver input to the accelerator or brake control shall immediately initiate a transition demand as specified in paragraph 5.4., when the input exceeds a reasonable threshold designed to prevent unintentional input.

- 6.3.5. Notwithstanding the provisions laid down in paragraphs 6.3.1. to 6.3.3., the effect of the driver input on any control may be reduced or suppressed by the system in case the system has detected an imminent collision risk due to this driver input.

- 6.3.6. In case of a severe vehicle failure or a severe ALKS failure the ALKS may employ different strategies with regard to system override. These different strategies shall be declared by the manufacturer and their effectiveness shall be assessed by the Technical Service with regard to ensuring a safe transition of control from the system to the human driver.
- 6.3.7. The fulfilment of the provisions in paragraph 6.3 and its subparagraphs shall be demonstrated by the manufacturer to the technical service during the inspection of the safety approach as part of the assessment to Annex 4.
- 6.4. Information to the driver
- 6.4.1. The following information shall be indicated to the driver:
- The system status as defined in paragraph 6.4.2.
  - Any failure affecting the operation of the system with at least an optical signal unless the system is deactivated (off mode),
  - Transition demand by at least an optical and in addition an acoustic and/or haptic warning signal.
- At the latest 4 s after the initiation of the transition demand, the transition demand shall:
- Contain a constant or intermittent haptic warning unless the vehicle is at standstill; and
  - Be escalated and remain escalated until the transition demand ends.
- Minimum risk manoeuvre by at least an optical signal and in addition an acoustic and/or a haptic warning signal and
  - Emergency manoeuvre by an optical signal
- The optical signals above shall be in an adequate size and contrast. The acoustic signals above shall be loud and clear.
- 6.4.2. System status
- 6.4.2.1. System unavailability indication
- In case activation of the system following the deliberate action of the driver is denied by the system due to system unavailability, this shall be at least visually displayed to the driver.
- 6.4.2.2. System status display when activated
- Upon activation the system status (active mode) shall be displayed by a dedicated optical signal to the driver.
- The optical signal shall contain an unambiguous indication including
- a) a steering control or a vehicle, with an additional “A” or “AUTO,” or the standardized symbols in accordance with Regulation 121, and additionally
  - b) an easily perceptible indication in the peripheral field of vision and located near the direct line of driver’s sight to the outside in front of the vehicle, e.g. prominent indication in the instrument cluster or on the steering control covering part of the outer rim perimeter facing towards the driver.
- The optical signal shall indicate the active system state until the system is deactivated (off mode).
- The optical signal shall be constant while the system is in regular operation and with the initiation of a transition demand at least the indication according to b) shall change its characteristics, e.g. to an intermittent signal or a different colour.

When an intermittent signal is used, a low frequency shall be used in order to not unreasonably alert the driver.

During the transition phase and minimum risk manoeuvre, the indication according to a) may be replaced by the instruction to take over manual control according to paragraph 6.4.3.

#### 6.4.2.3. System status display when deactivated

Upon deactivation when the system status changes from active mode to (off mode) this shall be indicated to the driver by at least an optical warning signal. This optical signal shall be realized by non-displaying the optical signal used to indicate the active mode.

Additionally, an acoustic warning signal shall be provided unless the system is deactivated following a transition demand which contained an acoustic signal.

#### 6.4.3. Transition Phase and Minimum Risk Manoeuvre

During the transition phase and the minimum risk manoeuvre, the system shall instruct the driver in an intuitive and unambiguous way to take over manual control of the vehicle. The instruction shall include a pictorial information showing hands and the steering control and may be accompanied by additional explanatory text or warning symbols, as shown in the example below.



Example 1.

Example 2.

6.4.3.2. With the start of the minimum risk manoeuvre, the given signal shall change its characteristics to emphasize the urgency of an action by the driver. e.g. by red flashing of the steering control and moving hands of the pictorial information.

6.4.4. Where examples are given above, an adequate and equally perceptible interface design for the optical signals may be used instead. This shall be demonstrated by the manufacturer and shall be supported by documented evidence. This shall be assessed by the Technical Service according to Annex 4.

#### 6.4.5. Prioritization of ALKS warnings

The warnings of an ALKS during a transition phase, a Minimal Risk Manoeuvre or an Emergency Manoeuvre may be prioritized over other warnings in the vehicle.

The prioritization of different acoustic and optical warnings during the ALKS operation shall be declared by the manufacturer to the Technical Service during Type Approval.

## 7. Object Event Detection and Response

### 7.1. Sensing requirements

The ALKS vehicle shall be equipped with a sensing system such that, it can at least determine the driving environment (e.g. road geometry ahead, lane markings) and the traffic dynamics:

- 1) across the full width of its own traffic lane, the full width of the traffic lanes immediately to its left and to its right, up to the limit of the forward detection range;
- 2) Along the full length of the vehicle and up to the limit of the lateral detection range.

The requirements of this paragraph are without prejudice to other requirements in the regulation, most notably paragraph 5.1.1.

#### 7.1.1. Forward detection range

The manufacturer shall declare the forward detection range measured from the forward most point of the vehicle. This declared value shall be at least 46 metres.

The Technical Service shall verify that the distance at which the vehicle sensing system detects a road user during the relevant test in Annex 5 is equal or greater than the declared value.

#### 7.1.2. Lateral detection range

The manufacturer shall declare the lateral detection range. The declared range shall be sufficient to cover the full width of the lane immediately to the left and of the lane immediately to the right of the vehicle.

The Technical Service shall verify that the vehicle sensing system detects vehicles during the relevant test in Annex 5. This range shall be equal or greater than the declared range.

7.1.3. The ALKS shall implement strategies to detect and compensate for environmental conditions that reduce the detection range, e.g. prevent enabling the system, disabling the system and transferring the control back to the driver, reducing the speed when visibility is too low. These strategies shall be described by the manufacturer and assessed according to Annex 4.

7.1.4. The vehicle manufacturer shall provide evidence that the effects of wear and ageing do not reduce the performance of the sensing system below the minimum required value specified in paragraph 7.1. over the lifetime of the system/vehicle.

7.1.5. The fulfilment of the provisions of paragraph 7.1. and its subparagraphs shall be demonstrated to the technical service and tested according to the relevant tests in Annex 5.

7.1.6. A single perception malfunction without failure should not induce hazardous event. The design strategies put in place shall be described by the vehicle manufacturer and their safety shall be demonstrated to the satisfaction of the technical service in accordance with Annex 4.

## 8. Data Storage for Automated Systems (DSSAD)<sup>12</sup>

8.1. Vehicles with ALKS shall be fitted with a DSSAD.

## 9. Cybersecurity and Software-Updates<sup>13</sup>

9.1. The effectiveness of the system shall not be adversely affected by cyber-attacks, cyber threats and vulnerabilities. The effectiveness of the security measures shall be demonstrated by compliance with Regulation No. [15X].

<sup>12</sup> To be revised in accordance with IWG on EDR/DSSAD and subject to GRVA decision.

<sup>13</sup> To be revised in accordance with TF CS/OTA and subject to GRVA decision.

- 9.2. If the system permits software updates, the effectiveness of the software update procedures and processes shall be demonstrated by compliance with Regulation No. [15X].

## 10. Modification of vehicle type and extension of approval

- 10.1. Every modification to an existing vehicle type shall be notified to the Type Approval Authority which approved the vehicle type.  
The Authority shall then either:
- (a) Decide, in consultation with the manufacturer, that a new type-approval is to be granted; or
  - (b) Apply the procedure contained in paragraph 10.1.1. (Revision) and, if applicable, the procedure contained in paragraph 10.1.2. (Extension).
- 10.1.1. Revision
- When particulars recorded in the information documents have changed and the Type Approval Authority considers that the modifications made are unlikely to have appreciable adverse effects and that in any case the foot controls still meet the requirements, the modification shall be designated a "revision".
- In such a case, the Type Approval Authority shall issue the revised pages of the information documents as necessary, marking each revised page to show clearly the nature of the modification and the date of re-issue.
- A consolidated, updated version of the information documents, accompanied by a detailed description of the modification, shall be deemed to meet this requirement.
- 10.1.2. Extension
- The modification shall be designated an "extension" if, in addition to the change of the particulars recorded in the information documents,
- (a) Further inspections or tests are required; or
  - (b) Any information on the communication document (with the exception of its attachments) has changed; or
  - (c) Approval to a later series of amendments is requested after its entry into force.
- 10.2. Confirmation or refusal of approval, specifying the alteration, shall be communicated by the procedure specified in paragraph 4.3. above to the Contracting Parties to the Agreement applying this Regulation. In addition, the index to the information documents and to the test reports, attached to the communication document of Annex 1, shall be amended accordingly to show the date of the most recent revision or extension.
- 10.3. The competent authority issuing the extension of approval shall assign a serial number to each communication form drawn up for such an extension.

## 11. Conformity of production

- 11.1. 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:
- 11.2. A vehicle approved pursuant to this Regulation shall be so manufactured as to conform to the type approved by meeting the requirements of this regulation;

- 11.3. 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.

## **12. Penalties for non-conformity of production**

- 12.1. 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.
- 12.2. 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.

## **13. 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.

## **14. Names and addresses of technical series 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<sup>14</sup> 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.

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<sup>14</sup> Through the online platform (“/343 Application”) provided by UNECE and dedicated to the exchange of such information: <https://www.unece.org/trans/main/wp29/datasharing.html>

## Annex 1<sup>1</sup>

### Communication

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

<sup>2</sup>



issued by:

Name of administration:

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

Concerning:<sup>3</sup>

- Approval granted
- Approval extended
- Approval refused
- Approval withdrawn
- Production definitively discontinued

of a vehicle type with regard to steering equipment pursuant to UN Regulation No. [15X]

Approval No. ....

Reason for extension or revision: .....

1. Trade name or mark of vehicle .....
2. Vehicle type .....
3. Manufacturer's name and address .....
4. If applicable, name and address of manufacturer's representative .....
5. General construction characteristics of the vehicle:
  - 5.1 Photographs and/or drawings of a representative vehicle: .....
6. Description and/or drawing of the ALKS including:
  - 6.1. Specified maximum speed of the ALKS declared by the manufacturer: .....
  - 6.2. Sensing system (incl. components): .....
  - 6.3. Installation of the ALKS sensing system: .....
  - 6.4. Software Identification of the ALKS (if applicable): .....
7. Written description and/or drawing of the ALKS Human Machine Interface including:

<sup>1</sup> Needs revision and consistency check.

<sup>2</sup> Distinguishing number of the country which has granted/extended/refused/withdrawn approval (see approval provisions in this Regulation).

<sup>3</sup> Strike out what does not apply.

- 7.1. Methods to detect driver availability .....
- 7.2. Means to activate/deactivate the system .....
- 7.3. Methods to determine driver attentiveness .....
8. Written description and/or drawing of the information given to the driver including:
  - 8.1. System status: .....
  - 8.2. Transition demand: .....
  - 8.3. Minimum Risk Manoeuvre: .....
  - 8.4. Emergency Manoeuvre: .....
9. Data Storage for Automated Systems (DSSAD):
  - 9.1. DSSAD Type Approval Number<sup>4</sup>.....
10. Cyber Security and Software updates<sup>5</sup>
  - 10.1 Cyber Security Type Approval Number (if applicable): .....
  - 10.2 Software Update Type approval number (if applicable): .....
11. Special requirements to be applied to the safety aspects of electronic control systems (Annex 4)
  - 11.1 Manufacturers document reference for Annex 4 (including version number): .....
12. Technical Service responsible for conducting approval tests .....
- 12.1. Date of report issued by that service .....
- 12.2. Number of report issued by that service .....
13. Approval granted/extended/revised/refused/withdrawn<sup>2</sup>
14. Position of approval mark on vehicle.....
15. Place.....
16. Date.....
17. Signature .....
18. Annexed to this communication is a list of documents in the approval file deposited at the administration services having delivered the approval and which can be obtained upon request.

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<sup>4</sup> Align with work of IWG on EDR/DSSAD

<sup>5</sup> Align with work of TF on CS/OTA

## Appendix

### **Addendum to Type approval Communication No ... concerning the type approval of a vehicle type with regard to ALKS pursuant to Regulation No. [15X]**

#### 1. Additional information

1.1 Contracting Party regions where the ALKS has been assessed to comply with local traffic rules:

<i>Country</i>	<i>Assessed</i>	<i>Comments on any restrictions</i>
E 1 Germany	Yes/No	
E 2 France		
E 3 Italy		
E 4 Netherlands		
E 5 Sweden		
E 6 Belgium		
E 7 Hungary		
E 8 Czech Republic		
E 9 Spain		
E 10 Serbia		
E 11 United Kingdom		
E 12 Austria		
E 13 Luxembourg		
E 14 Switzerland		
E 16 Norway		
E 17 Finland		
E 18 Denmark		
E 19 Romania		
E 20 Poland		
E 21 Portugal		
E 22 Russian Federation		
E 23 Greece		
E 24 Ireland		

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<i>Country</i>	<i>Assessed</i>	<i>Comments on any restrictions</i>
E 25 Croatia		
E 26 Slovenia		
E 27 Slovakia		
E 28 Belarus		
E 29 Estonia		
E 30 Republic of Moldova		
E 31 Bosnia and Herzegovina		
E 32 Latvia		
E 34 Bulgaria		
E 35 Kazakhstan		
E 36 Lithuania		
E 37 Turkey		
E 39 Azerbaijan		
E 40 North Macedonia		
E 43 Japan		
E 45 Australia		
E 46 Ukraine		
E 47 South Africa		
E 48 New Zealand		
E 49 Cyprus		
E 50 Malta		
E 51 Republic of Korea		
E 52 Malaysia		
E 53 Thailand		
E 54 Albania		
E 55 Armenia		
E 56 Montenegro		
E 57 San Marino		
E 58 Tunisia		
E 60 Georgia		
E 62 Egypt		

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<i>Country</i>	<i>Assessed</i>	<i>Comments on any restrictions</i>
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E 63 Nigeria

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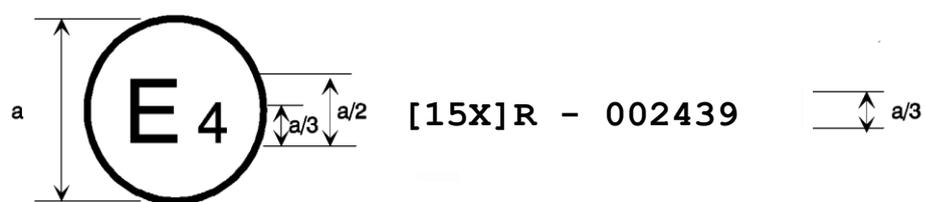
\* The list of Contracting Parties applying UN Regulation No. [15X] is available online:  
[https://treaties.un.org/Pages/ViewDetails.aspx?src=TREATY&mtdsg\\_no=XI-B-16-\[15X\]&chapter=11&clang=\\_en](https://treaties.un.org/Pages/ViewDetails.aspx?src=TREATY&mtdsg_no=XI-B-16-[15X]&chapter=11&clang=_en)

## Annex 2

### Arrangements of approval marks

#### Model A

(See paragraph 4.4. of this Regulation)

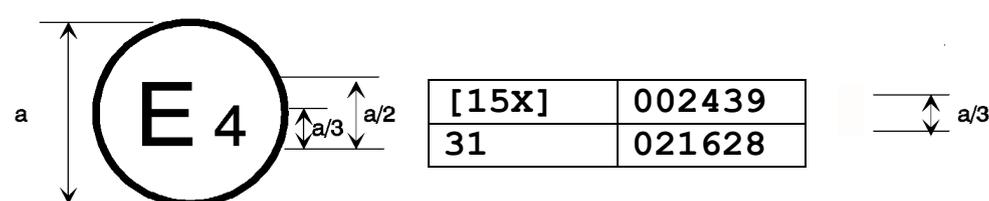


a = 8 mm min

The above approval mark affixed to a vehicle shows that the vehicle type concerned has, with regard to ALKS, been approved in the Netherlands (E 4) pursuant to UN Regulation No. [15X] under approval No. 002439. The approval number indicates that the approval was granted in accordance with the requirements of UN Regulation No. [15X].

#### Model B

(See paragraph 4.5. of this Regulation)



a = 8 mm min

The above approval mark affixed to a vehicle shows that the vehicle type concerned has been approved in the Netherlands (E 4) pursuant to Regulations Nos. [15X] and 31.<sup>1</sup> The approval numbers indicate that, at the dates when the respective approvals were given, UN Regulation No. [15X] was in its original form and UN Regulation No. 31 included the 02 series of amendments.

<sup>1</sup> The second number is given merely as an example.

## Annex 3

### System information data

The following data shall be provided, together with the documentation package required in Annex 3.2.1. of this UN Regulation, to the Technical Service at the time of type approval.

- 1.1. A list of types of situations in which the vehicle may generate a transition demand to the driver.
- 1.2. Information about how the system detects that the driver is available to take over the control.<sup>1</sup>
- 1.3. The means to monitor the driving environment.
- 1.4. The means to activate, override or deactivate the system including the strategy how the system is protected against unintentional deactivation, the threshold values for a steering override and how the system assesses that the driver has directed his gaze to the driving task.
- 1.5.<sup>2</sup> Information about how the software version(s) and the failure warning signal status can be readable in a standardized way via the use of an electronic communication interface, at least be the standard interface (OBD port).
- 1.6. Description of the types of severe vehicle failures and severe ALKS failures that will lead the ALKS to initiate a MRM immediately.
- 1.7. For driving situations not covered by the tests of Annex 5, the safe operation of the system shall be demonstrated by the vehicle manufacturer on the base of Annex 4 of this Regulation.
- 1.8. Installation  

The manufacturer shall provide information regarding the installation options that will be employed for the individual components that comprise the sensing system. These options shall include, but are not limited to, the location of the component in/on the vehicle, the material(s) surrounding the component, the dimensioning and geometry of the material surrounding the component, and the surface finish of the materials surrounding the component, once installed in the vehicle. The information shall also include installation specifications that are critical to the system's performance, e.g. tolerances on installation angle.

Changes to the individual components of the sensing system, or the installation options, shall be notified to the Type Approval Authority and be subject to further assessment.
- 1.9. The system behaviour during a MRM.
- 1.10. The system behaviour during an EM.

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<sup>1</sup> Could also be part of Annex 4.

<sup>2</sup> Reference with regard to RxSWIN will be added when relevant UN Regulation is adopted.

## **Annex 4**

### **Special requirements to be applied to the safety aspects of electronic control systems [and Audit]<sup>1</sup>**

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<sup>1</sup> To be revised in accordance with IWG on VMAD and subject to GRVA decision.

## Annex 5

### Test Specifications for ALKS

#### 1. Introduction

This annex defines tests with the purpose to verify the technical requirements on Automated Lane Keeping Systems (ALKS).

Until such time that specific test provisions have been agreed, the Technical Service shall ensure that the ALKS is subject to at least the tests outlined in Annex 5. The specific test parameters for each test shall be selected by the Technical Service and shall be recorded in the test report in such a manner that allows traceability and repeatability of the test setup.

Pass- and Fail-Criteria for tests are derived solely from the technical requirements in sections 5 to 7 of the Regulation. These requirements are worded in a way that they allow the derivation of pass-fail-criteria not only for a given set of test parameters, but for any combination of parameters in which the system is designed to work (e.g. operating speed range, operating lateral acceleration range, curvature range as contained in the system boundaries).

The test specifications in this document are meant to be a minimum set of tests, the technical service authorities may perform any other test within the system boundaries and may then compare the measured results against the requirements (concrete: expected test outcome).

#### 2. Definitions

For the purposes of this Annex,

- 2.1. “*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
- 2.2. “*Offset*” means the distance between the vehicle’s and the respective target’s longitudinal median plane in driving direction, measured on the ground, normalized by the half the vehicle width excluding devices for indirect vision and corrected by adding 50 %.
- 2.3. “*Pedestrian Target*” means a soft target that represents a pedestrian.
- 2.4. “*Vehicle Target*” means a target that represents a vehicle (passenger car).
- 2.5. “*Powered Two-Wheeler Target*” means a combination of a motorcycle and motorcyclist, a test device according to ISO [CD] 19206-5. The reference point for the location of the motorcycle shall be the most backward point on the centreline of the motorcycle

#### 3. General Principles

- 3.1. Test conditions

- 3.1.1. The tests shall be performed under conditions (e.g. environmental, road geometry) that allow the activation of the ALKS.
- 3.1.2. If system modifications are required in order to allow testing, e.g. road type assessment criteria or road type information (map data), it shall be ensured that these modifications don't have an effect on the test results. These modifications shall in principle be documented and annexed to the test report. The description and the evidence of influence (if any) of these modifications shall be documented and annexed to the test report.
- 3.1.3. The test surface shall afford at least the adhesion required by the scenario in order to achieve the expected test result.
- 3.1.4. Test Targets
- 3.1.4.1. The target used for the vehicle detection tests shall be a regular high volume series production vehicle of Category M or N or alternatively a [3-D] "soft target" representative of a vehicle in terms of its identification characteristics applicable to the sensor system of the ALKS under test according to ISO 19206-3:2018. The reference point for the location of the vehicle shall be the most rearward point on the centreline of the vehicle.
- 3.1.4.2. The target used for the Powered-Two-wheeler tests shall be a combination of a motorcycle and motorcyclist, a test device according to ISO [CD] 19206-5:20xx or a series production two-wheeled motorcycle of category L3. The reference point for the location of the motorcycle shall be the most backward point on the centreline of the motorcycle
- 3.1.4.3. The target used for the pedestrian detection tests shall be an adult "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.
- 3.1.4.4. Details that enable the target(s) to be specifically identified and reproduced shall be recorded in the vehicle type approval documentation.
- 3.2. Test parameter variation
- The manufacturer shall declare the system boundaries to the Technical Service. The Technical Service shall define different combinations of test parameters (e.g. present speed of the ALKS vehicle, type and offset of target, curvature of lane) which cover the following conditions for each test scenario as specified in the Appendix of this Annex.
- A collision is avoided by regular manoeuvre,
  - A collision is avoided by emergency manoeuvre,
  - A collision cannot be avoided but emergency manoeuvre is executed.
- If this is deemed justified, the Technical Service may test additionally any other combination of parameters.
- If a collision cannot be avoided for some test parameters, the manufacturer shall demonstrate either by documentation or if possible by [verification/testing] that the system doesn't unreasonably switch its control strategy.

#### **4. Test scenarios to assess the performance of the system with regard to the dynamic driving task**

- 4.1. Lane Keeping

- 4.1.1. The test shall demonstrate that the ALKS does not leave its lane and maintains a stable position inside its ego lane across the speed range and different curvatures within its system boundaries.<sup>1</sup>
- 4.1.2. The test shall be executed at least:
- With a minimum test duration of 5 minutes.
- 4.2. Avoid a collision with a road user or object blocking the lane
- 4.2.1. The test shall demonstrate that the ALKS avoids a collision with a stationary vehicle, road user or fully or partially blocked lane up to the maximum specified speed of the system.
- 4.2.2. This test shall be executed at least
- With a stationary vehicle target
  - With a stationary powered two wheeler target
  - With a stationary adult pedestrian target
  - With an adult pedestrian target crossing the lane with a speed of 5 km/h
  - With a target representing a blocked lane
  - With multiple consecutive obstacles blocking the lane (e.g. in the following order: ego-vehicle -motorcycle - car)
  - On a curved section of road
- 4.3. Following a lead vehicle
- 4.3.1. The test shall demonstrate that the ALKS is able to maintain and restore the required safety distance to a vehicle in front and is able to avoid a collision with a lead vehicle which decelerates up to its maximum deceleration.
- 4.3.2. This test shall be executed at least:
- Across the entire speed range of the ALKS
  - For constant and varying lead vehicle velocities (e.g. following a realistic speed profile from existing driving database)
  - For straight and curved sections of road
  - With a deceleration of the lead vehicle of at least  $6\text{m/s}^2$  mean fully developed deceleration until standstill.
- 4.4. Lane change of another vehicle into lane
- 4.4.1. The test shall demonstrate that the ALKS is capable of avoiding a collision with a vehicle cutting into the lane of the ALKS vehicle up to a certain criticality of the cut-in manoeuvre.
- 4.4.2. The criticality of the cut-in manoeuvre shall be determined according to TTC, longitudinal distance between rear-most point of the cutting in vehicle and front-most point of the ALKS vehicle, the lateral velocity of the cutting-in vehicle and the longitudinal movement of the cutting-in vehicle, as defined in paragraph 5.2.5. of this Regulation.

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<sup>1</sup> Add a criteria that vehicle is stable in the lane if another vehicle beside is very close to the lane marking.

- 4.4.3. This test shall be executed taking into consideration at least the following conditions:
- For different TTC, distance and relative velocity values of the cut-in manoeuvre
  - For cutting-in vehicles travelling at constant longitudinal speed, accelerating and decelerating
  - For different lateral velocities, lateral accelerations of the cut-in vehicle
- 4.5. Stationary obstacle after lane change of the lead vehicle
- 4.5.1. The test shall demonstrate that the ALKS is capable of avoiding a collision with a stationary vehicle, road user or blocked lane that becomes visible after a preceding vehicle avoided a collision by an evasive manoeuvre.
- 4.5.2. The test shall be executed at least:
- With a stationary vehicle target centred in lane
  - With a powered two-wheeler target centred in lane
  - With a stationary adult pedestrian target centred in lane
  - With a target representing a blocked lane centred in lane

## 5. Additional verification

- 5.1. The Technical Service shall assess the detection areas of the ALKS to the side and to the front according to paragraphs 7.1.2. and 7.1.1. of this Regulation.
- 5.2. Compliance with the following provisions shall be demonstrated by the manufacturer and assessed by the Technical Service at the time of type approval:

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*Test/Check*

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- 6.2.2. Off mode after new engine start/run
- 6.2.3 System can only be activated if
- The driver is in driver seat & belt is fastened
  - The driver is available
  - No failures
  - DSSAD operational
  - Conditions are within system limits
- 6.2.1 Means of deactivating
- 6.2.4 Dedicated means to activate and deactivate
- 6.2.5 protected against unintentional action
- 6.2.6 Steering
- Holding wheel and brake/accelerate
- Driver holds steering wheel in response to transition and MRM

<i>Test/Check</i>	
	After deactivation
6.3	Means to override the system
	Steering control
	Braking input higher than system
	Accelerating to speed within system limits
6.1.3.1.	Criteria for deeming driver available
5.1.3	Driver support systems active
6.3.1.1.	Driver attentiveness
5.5	System behaviour during a Minimal Risk Manoeuvre
	Driver take over
	Standstill (harzard lights)
	Re-activation disabled if reached standstill
5.1.4	Transition demand & behaviour/escalation
5.1.5	Driver resumes control
5.4	Without driver response (MRM)
	Planned transition
	Unplanned transition
6.1.2	Transition demand during operation
6.1.3	Exceed system parameters
5.4.	Failure
	Detectable collision
	Driver not present
5.3	System behaviour for Emergency Manoeuvre
	Resulting in standstill
	Not resulting in standstill
7.1	System detection areas
7.1.1	Front
7.1.2	Sides
7.1.3	Visibility
5.3.	Additional other test cases may be assessed if it is deemed justified by the Technical Service. Some of the cases may include:
	- Y-split of highway lanes

- Vehicles entering or exiting the highway
- Partially blocked ego lane, tunnel
- Traffic lights
- Emergency vehicles
- Construction zones
- Faded/erased/hidden lane markings
- Emergency/Service personnel directing traffic
- Change in road characteristics (no longer divided, pedestrians permitted, roundabout, intersection)
- Normal traffic flow resumed (i.e. all vehicles moving > 60km/h)

#### 5.4. Real-world test

The Technical Service shall conduct, or shall witness, an assessment of the system, in a fault-free condition, in the presence of traffic (a 'real-world' test). The purpose of this test is to support the Technical Service in understanding the functionality of the system in its operating environment and to complement the assessment of the documentation provided under Annex 4.

Together, the assessment of Annex 4 and the real-world test shall enable the Technical Service to identify areas of system performance that may require further assessment, either through testing or further review of Annex 4.

During the real-world assessment, the Technical Service shall assess at least:

- 1) Prevention of activation when the system is outside of its technical boundaries/requirements for ALKS
- 2) No violation of traffic rules
- 3) Response to a planned event
- 4) Response to an unplanned event
- 5) Detection of the presence of other road users within the frontal and lateral detection ranges
- 6) Vehicle behaviour in response to other road users (following distance, cut-in scenario, cut-out scenario etc).
- 7) System override

The location and selection of the test route, time-of-day and environmental conditions shall be determined by the Technical Service.

The test drive shall be recorded and the test vehicle instrumented with non-perturbing equipment. The Technical Service may log, or request logs of any data channels used or generated by the system as deemed necessary for post-test evaluation.

It is recommended that the real-world test is undertaken once the system has passed all of the other tests outlined in this Annex and upon completion of a risk assessment by the Technical Service.

## Annex 5 - Appendix

Para	Description	No Object	Passenger Car			Powered Two Wheeler			Pedestrian			Obstacle		
		RM	RM	EM	NAS	RM	EM	NAS	RM	EM	NAS	RM	EM	NAS
<b>4.1 Lane Keeping</b>														
	Lane Keeping and stability	X												
	Parallel vehicle drifting towards ego vehicle		X			X								
<b>4.2 Avoid a collision with a road user or object blocking the lane</b>														
	Stationary vehicle					X								
	Stationary adult pedestrian								X					
	Adult pedestrian crossing the lane								X	[X]				
	Object representing a blocked lane											X		
	Object partially blocking the lane											X		
	Multiple obstacles in the lane					X								
<b>4.3 Following a lead vehicle</b>														
	Following Distance Test		X	X		[X]	[X]							
	[Following Stability Test (lateral offset)]		X			[X]								
<b>4.4 Lane Change of another vehicle into the lane</b>														
	Cut in Tests with an accelerating cut in vehicle		X			[X]								
	Cut in Tests with a constant speed cut in vehicle		X	X		[X]	[X]							
	Cut in Tests with a decelerating cut in vehicle		X	X	X	[X]	[X]							
<b>4.5 Stationary obstacle after lane change of the lead vehicle</b>														
	Cut out Tests		X	X		X	X		X	X		X	X	
<b>4.6. Field of view</b>														
	[Dynamic Field of View Tests (Forward)]					[X]			[X]					
	[Dynamic Field of View Test (Lateral)]					[X]								

Note:

RM	Regular Manoeuvre.
EM	Emergency Manoeuvre.
NAS	Non-Avoidable Situation.

	Potential test area that can be selected by the technical service in addition to the mandatory testing. Note pass/fail criteria for NAS tests does not apply, mitigation strategy will be assessed by the technical service.
X	Mandatory test area to be tested by the technical service. Each 'X' indicates that a mandatory single test is to be carried out. Additional testing may be carried out in this area at the request of the technical service with varied parameters compared to the testing already performed.
X	Mandatory test area to be tested by the technical service. Each 'X' indicates that a mandatory single test is to be carried out. Additional testing may be carried out in this area at the request of the technical service with varied parameters compared to the testing already performed. Pass/fail criteria detailed within this regulation does not apply. However, the ALKS mitigation strategy will be assessed by the technical service.

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