

Proposal for amendments to the new UN Regulation on uniform provisions concerning the approval of vehicles with regards to Automated Lane Keeping System

This document proposes clarifications and minor amendments to the recently adopted regulatory text on Automated Lane Keeping System (ALKS – UN R157). Proposed changes to the current text of the regulation are marked in **bold** for new text, and ~~strikethrough~~ for deleted text.

I. Proposal

Paragraph 2.6., amend to read

- “2.6. “*Imminent collision risk*” describes a situation or an event which **would** 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/s²~~. **unless an emergency manoeuvre is carried out.**”

Paragraphs 5.1.9 and 7.1.4., amend to read

- “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 **the lifetime of the system.**”
- “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.~~”

Paragraph 5.2.3.3., amend to read

- “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_{ALKS} = the present speed of the ALKS vehicle in m/s
 t_{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.

The ALKS is deemed to comply with traffic rules related to the minimum following distance to the front if the system fulfills the provisions of par. 5.2.3.3.

Paragraph 5.2.5.2., amend to read

- “5.2.5.2. The activated system shall avoid a collision with a cutting in vehicle,
- provided the cutting in vehicle maintains its longitudinal speed which is lower than the longitudinal speed of the ALKS vehicle and
 - provided that the lateral movement of the cutting in vehicle has been **visible detectable** for a time of at least 0.72 seconds before the reference point for *TTCLaneIntrusion* is reached,
 - when the distance between the vehicle’s front and the cutting in vehicle’s rear corresponds to an **anticipated TTC, if the ALKS vehicle did not decelerate**, calculated by the following equation:

$$TTCLaneIntrusion > v_{rel}/(2 \cdot 6m/s^2) + 0.35s$$

Where:

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

$TTCLaneIntrusion$ = 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.”

Paragraph 6.2.5.1., amend to read

“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:

- (a) The driver overrides the system by steering while holding the steering control and this override is not suppressed, as specified in paragraph 6.3.1.; or
- (b) The driver is holding the steering control and overrides the system by braking or accelerating, as specified in paragraphs 6.3.42. and 6.3.3. below.”

Paragraph 6.2.6., amend to read

“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.~~

Upon deactivation of the system, an automatic transition to a function which provides continuous longitudinal and/or lateral movement of the vehicle (e.g. ACSF of Category B1) is permitted only if all of the following provisions are fulfilled:

- **The status indication of ALKS and that of any other function providing continuous longitudinal and/or lateral control can be clearly differentiated.**
- **The prominent status indication as required per par. 6.4.2.2. (b) is not used for any other function providing continuous lateral and/or longitudinal control other than ALKS in that vehicle.**
- **Evidence of the effectiveness of the implemented indication to the driver in ensuring mode awareness is provided to and assessed by the Technical Service at the time of type approval.**
- **The function which provides continuous longitudinal movement of the vehicle upon deactivation of the ALKS has implemented strategies to ensure controllability by the driver (e.g. with regard to acceleration) and compliance with the currently valid speed limit after the transition.**

~~Notwithstanding both paragraphs above, Any other safety system delivering longitudinal or lateral support in imminent collision 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.“~~

Paragraph 6.4.4., amend to read :

“6.4.4. Where examples are given in **paragraph 6.4. and its subparagraphs** 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.”

Annex 5, Paragraph 4., amend to read

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

At the time of type approval, the Technical Service shall conduct or shall witness at least the following tests to assess the behaviour of the ALKS:

- 4.1. Lane Keeping
 - 4.1.1. The test shall demonstrate [...]

Annex 5, Paragraph 5.2., amend to read

“5.2. Compliance with the following provisions shall be demonstrated **to the Technical Service** by the manufacturer **preferably with a test vehicle. and assessed** **The assessment** by the Technical Service at the time of type approval **shall be based on physical experience whenever necessary.**

<i>Reference in main text</i>	<i>Test/Check</i>
6.2.2.	Off mode after new engine start/run
6.2.3	System can only be activated if <ul style="list-style-type: none">(a) The driver is in driver seat & belt is fastened(b) The driver is available(c) No failures(d) DSSAD operational(e) Environmental and infrastructural cConditions are within system limits
6.2.1	Dedicated m Means of for activation and deactivation deactivating
6.2.4	Dedicated means to activate and deactivate
6.2.54.	Means of deactivation is protected against unintentional action
6.2.65.	Steering Deactivation by input to driving controls <ul style="list-style-type: none">(a) Holding wheel steering control and brake/accelerate(b) Driver holds steering wheel takes hold of steering control in response to transition and MRM(c) After deactivation Steering while holding the steering control
6.3	Means to override the system <ul style="list-style-type: none">(a) Steering control(b) Braking input higher than system(c) Accelerating to speed within system limits
6.3.1.1.	Driver attentiveness

<i>Reference in main text</i>	<i>Test/Check</i>
6.1.3.1.	Criteria for deeming driver available
5.1.3	Exercise control over systems required to support the driver support systems active
6.3.1.1.	Driver attentiveness
5.5	System behaviour during a Minimal Risk Manoeuvre
	(a) Termination only upon driver take over or standstill
	(b) Activation of hazard warning lights when reaching standstill (hazard lights)
	(c) Re-activation disabled if reached standstill MRM was triggered
5.1.4	Transition demand & behaviour/escalation
5.1.5	Driver resumes control Initiation of an MRM after Transition Demand
5.4	Without driver response (MRM) Events leading to a Transition Demand
	(a) Planned transition
	(b) Unplanned transition
6.1.2	Transition demand during operation when driver not present or unbuckled
6.1.3	Exceed system parameters
5.4.2.3.	Transition Demand in case of Failure
	(a) Detectable collision
	(b) Driver not present
5.1.1.	System reaction in case of a detectable collision
5.3	System behaviour during an for Emergency Manoeuvre
	(a) Resulting in standstill
	(b) Not resulting in standstill
7.1	System detection areas
7.1.1	Front
7.1.2	Sides
7.1.3	Visibility”

Annex 5, Paragraph 5.3., amend to read

- “5.3. Additional other ~~test cases~~ **scenarios may** shall be assessed (e.g. by physical or virtual testing or appropriate documentation) if it is deemed justified by the Technical Service. Some of the ~~cases~~ **scenarios** may include:
- (a) Y-split of highway lanes
 - (b) Vehicles entering or exiting the highway ...“

II. Justification

A. Paragraph 2.6., Definition of an imminent collision

The amendment aims to resolve a repetition, where the threshold of 5m/s² is currently used twice, once in the definition of an imminent risk of collision and additionally in the emergency manoeuvre section.

B. Paragraphs 5.1.9 and 7.1.4., Lifetime of the system

The amendments aims to clarify, that the provisions for both paragraphs refer to the lifetime of the system. While in par. 5.1.9. it is an improvement of the wording, which currently reads “of the ALKS system over lifetime”, in par. 7.1.4. it is a clarification, where currently both references “lifetime of the system/vehicle” are given.

This amendment only aims for consistency and clarity in the used language and doesn’t affect the principle, that the ALKS needs to ensure to meet the requirements of this regulation whenever it is active and needs to prevent activation as soon as it can no longer meet the requirements.

C. Paragraph 5.2.3.3., Traffic Rules and Safety Distance to the front

The amendment aims to clarify that the provisions on minimum safety distance to the front were drafted to define harmonized provisions for automated vehicles taking into account detection and braking capabilities of automated vehicles while existing traffic rules or court rulings related to the following distance assess the minimum following distance based on human reaction capabilities.

D. Paragraph 5.2.5.2. – “anticipated TTC” in cut-in scenario

The amendment aims to ensure, that the performance expectation does not depend on the ALKS’ control strategy.

All ALKS systems should be assessed in the same scenarios. If “anticipated” is not added, an ALKS that decelerates as soon as the cut-in vehicle crosses the lane marking would have to avoid a collision in a much more critical situation, because as soon as the ALKS vehicle starts braking the TTC will go up again, then a vehicle that starts decelerating only when the cut-in vehicle has crossed the lane marking by at least 30cm.

E. Paragraph 6.2.5.1., Deactivation by input to driving controls

The amendment aims to correct the references to the corresponding paragraphs on steering override, override by braking and override by accelerating.

F. Paragraph 6.2.6., Transition to assisted driving

The amendment aims to propose provisions by which an automatic activation of functions providing continuous lateral and/or longitudinal control after deactivation of the ALKS could be permitted.

The driver will still have to properly take over manual control of the vehicle as described in paragraph 6.2.5. of the ALKS regulation, but could then afterwards be automatically supported in the driving task.

The main concern that arose within the IWG ACSF while drafting ALKS with regard to this issue was that mode confusion had to be avoided. The proposed provisions (first three items) aim to address this concern by defining functional principles appropriate to ensure mode awareness by the driver upon transition to assisted driving. Additionally the fourth proposed principle aims to ensure that this transition from automated to assisted driving remains controllable, so that e.g. neither vehicle speed, distance to another vehicle ahead or acceleration of the vehicle change unexpectedly.

Why is assisted driving after deactivation of ALKS favourable?

As long as the manufacturer implements appropriate strategies to ensure mode awareness, the higher the level of support given to the driver when resuming control upon request by the ALKS, the lesser the risk that a critical situation could result. While safety systems, as permitted in the third sub-paragraph of par. 6.2.6., will only intervene when a critical situation is already imminent, support by continuous longitudinal and/or lateral control will support the driver even before a critical situation arises.

Furthermore driver studies have shown, that drivers favour the highest level of support, independent of which ADAS functions were active before ALKS was activated, because they stated they wouldn't remember what had been active before anyhow and preferred a recognizable behaviour with the highest level of support available.

So instead of prohibiting this transition to assisted driving for fear of mode confusion, clear system design principles, as proposed by this amendment, should be established, by which this transition and its potential positive impact on supporting the driver in resuming control can be permitted.

G. Paragraph 6.4.4., Examples of information to the driver

The amendment aims to clarify that this paragraph applies to all examples given in paragraph 6.4. and its subparagraphs and not only to the example given in par. 6.4.3.

H. Annex 5 – Tests

These amendments aim to clarify that there are different aspects covered by Annex 5.

Section 5.1. contains physical tests that have to be performed at the time of type approval

Section 5.2. aims to confirm at the time of type approval, that the system complies with the corresponding provisions of the main text. This confirmation shall be done by at least one physical test per provision, if possible due to the nature of the provision, and may be supported by further evidence.

Section 5.3. is a collection of additional scenarios, that the ALKS could encounter. Whether they are relevant to the ALKS depends on its ODD. So either the manufacturer explains why his system will not need to handle these scenarios, or has to explain the behaviour of the ALKS.

Furthermore the amendment aims to clarify the content of par. 5.2. by rewording the provisions similar to that of the core text.