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**Economic Commission for Europe**

Inland Transport Committee

**World Forum for Harmonization of Vehicle Regulations****Working Party on Automated/Autonomous and Connected Vehicles****Ninth session**

Item 4 (d) of the provisional agenda

**Automated/autonomous and connected vehicles:****UN Regulation on Automated Lane Keeping System****Proposal for amendments to UN Regulation No. [157]  
(Automated Lane Keeping System)****Submitted by the experts from the International Organization of Motor Vehicle Manufacturers and the European Association of Automotive Suppliers \***

This proposal was prepared by the experts from the International Organization of Motor Vehicle Manufacturers (OICA) and the European Association of Automotive Suppliers (CLEPA). It is based on ECE/TRANS/WP.29/GRVA/2020/33, tabled by the expert from Germany and includes amendments proposed in informal document GRVA-07-66. The modifications of the existing Regulation are marked in bold for new or strikethrough for deleted characters.

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\* In accordance with the programme of work of the Inland Transport Committee for 2021 as outlined in proposed programme budget for 2021 (A/75/6 (Sect.20), para 20.51), the World Forum will develop, harmonize and update UN Regulations in order to enhance the performance of vehicles. The present document is submitted in conformity with that mandate.



## I. Proposal

Paragraphs 2.21. to 2.25., insert to read:

- 2.21. **“Starting lane” is the lane out of which the ALKS vehicle intends to manoeuvre.**
- 2.22. **“Target lane” is the lane into which the ALKS vehicle intends to manoeuvre. The target lane can be a regular lane of travel, an enter lane, an exit lane or a hard shoulder.**
- 2.24. **A “Lane Change Procedure (LCP)” starts when the direction indicator lamps are activated and ends when the direction indicator lamps are deactivated by the system. It comprises the following operations:**
- (a) **Activation of the direction indicator lamps;**
  - (b) **Temporary suspension of the mandatory lane keeping functionality of the ALKS;**
  - (c) **Lateral movement of the vehicle towards the lane boundary;**
  - (d) **Lane Change Manoeuvre;**
  - (e) **Resumption of the mandatory lane keeping function of the ALKS;**
  - (f) **Deactivation of direction indicator lamps.**
- 2.25. **A “Lane Change Manoeuvre (LCM)” is part of the LCP and:**
- (a) **Starts when the outside edge of the tyre tread of the vehicle’s front wheel closest to the lane markings crosses the outside edge of the lane marking to which the vehicle is being manoeuvred; and**
  - (b) **Ends when the rear wheels of the vehicle have fully crossed the lane marking.**

Paragraph 5.2.1., amend to read:

- 5.2.1. The activated system shall keep the vehicle inside its lane of travel and ensure that the vehicle does not **unintentionally** 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.

Paragraph 5.1.6., amend to read:

- 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 ranges according to paragraph 7.1. **and its subparagraphs**).

Paragraph 5.2.6. and subparagraphs, insert to read:

- 5.2.6. **Lane Change Procedure (LCP)**
- The requirements of this paragraph and its subparagraphs apply to the system, if additionally fitted to perform a LCP.**
- The fulfilment of the provisions of this paragraph and its subparagraphs shall be demonstrated by the manufacturer to the satisfaction of the technical services during the assessment of Annex 4 and according to the relevant tests in Annex 5.**
- 5.2.6.1. **A LCP shall not cause an unreasonable risk to safety of the vehicle occupants and other road users.**
- 5.2.6.2. **The activated system shall only undertake a LCP if the following conditions are fulfilled:**

- (a) The vehicle is equipped with a sensing system capable of fulfilling the rearward detection range requirements as defined in paragraph 7.1. and subparagraph 7.1.3.;
- (b) The system self-check, as defined in paragraph 5.1.6., is positively confirmed;
- (c) A gap allowing a LCM is already present or expected to open up shortly;
- (d) The LCP is anticipated to be completed before the ALKS vehicle comes to standstill (i.e. in order to avoid coming to standstill while in the middle of two regular lanes due to stopped traffic ahead). In case the ALKS vehicle becomes stationary between two regular lanes during the LCM nonetheless (e.g. due to the surrounding traffic), it should at the next available opportunity either complete the LCP or return to its original lane.
- (e) There is a reason for a lane change (e.g. Operation cannot be continued in the current lane, for the purpose of overtaking a slower moving vehicle, to prevent violation of the obligation to drive in the slowest lane when possible or during a minimal risk manoeuvre).

**5.2.6.4. A LCP shall be completed without undue delay.**

The system shall generate the signal to activate and deactivate the direction indicator signal. The direction indicator shall remain active throughout the whole period of the LCP and shall be deactivated by the system in a timely manner once the lane keeping functionality is resumed.

**5.2.6.5. Specific requirements for LCM**

The lateral movement to approach the lane marking in the starting lane and the lateral movement necessary to complete the LCM shall aim to be one continuous movement.

The LCM may be terminated before being completed if the situation requires it.

In case of a regular lane change upon termination of the LCM, the ALKS vehicle has to be steered back into the starting lane and the ALKS vehicle shall be in a single lane of travel at the end of the LCM.

In case of a lane change during a minimal risk manoeuvre upon termination of the LCM the ALKS shall aim to bring the vehicle in a position that reduces the risk to the vehicle occupants and other road users.

**5.2.6.6. Assessment of the target lane**

A LCM shall only be started if there is a sufficient gap, so that a vehicle in the target lane is not forced to unmanageably decelerate due to the lane change of the ALKS vehicle.

**5.2.6.6.1. When there is an approaching vehicle**

An approaching vehicle in the target lane should not have to decelerate at a higher level than A m/s<sup>2</sup>, B seconds after the ALKS vehicle starts crossing a lane marking, to ensure the distance between the two vehicles is never less than that which the lane change vehicle travels in C seconds.

With:

- (a) A equal to:
  - (i) 3.0 m/s<sup>2</sup> for a regular lane change
  - (ii) 3.7 m/s<sup>2</sup> for a lane change during a minimal risk manoeuvre
- (b) B equal to:

- (i) 0.0 second, if during a minimal risk manoeuvre the lateral movement of the ALKS vehicle continued for at least 1 second while the vehicle had not yet crossed the lane marking and the direction indicator had been active for at least 3.0 seconds prior to crossing of the lane markings while a vehicle approaching from the rear was detected by the sensing system;
  - (ii) 0.4 second after the ALKS vehicle has crossed the lane marking, provided there was at least 1.0 s lateral movement of the ALKS vehicle within the starting lane in principle visible to an approaching vehicle from the rear without an obstruction before the LCM starts; or
  - (iii) 1.4 seconds after the ALKS vehicle has crossed the lane marking, provided there was not at least 1.0 second lateral movement of the ALKS vehicle within the starting lane in principle visible to an approaching vehicle from the rear before the LCM starts.
- (c) C equal to:
- (i) 0.5 second, if the lane change is performed towards a lane intended for slower traffic or towards the hard shoulder during a minimal risk manoeuvre;
  - (ii) 1.0 second for all other conditions.

#### 5.2.6.6.2. When there is no vehicle detected

If no vehicle is detected by the system in the target lane, the minimal gap to the rear shall be calculated under the assumption that:

- (a) An approaching vehicle on a target lane intended for faster traffic (including enter lanes) is travelling with the allowed or the advised maximum speed whichever is lower; or
- (b) An approaching vehicle on a target lane intended for slower traffic (including exit lanes and shoulders temporarily opened for regular traffic) is travelling with a maximum speed difference of 20 km/h at the start of the LCM while not exceeding the allowed or advised maximum speed.
- (c) An approaching vehicle on a hard shoulder is travelling at a maximum speed of 80 km/h and a maximum speed difference to the ALKS vehicle at the start of the LCM of 40 km/h.

#### 5.2.6.6.3. When there is an equally fast or slower moving vehicle

The distance to a vehicle following behind in the target lane at equal or lower speed at the start of the LCM shall not be less than the distance which the following vehicle travels in

- (a) 0.7s for a lane change during a minimal risk manoeuvre
- (b) 1.0s for a regular lane change.

*Paragraph 5.4.2.4., insert to read:*

- 5.4.2.4. In case the ALKS is capable to perform a regular LCP, it shall be aimed that a regular LCP is not part of the transition phase, meaning that the transition demand is not given shortly before or during a LCP.**

*Paragraph 5.5.1., amend to read:*

- 5.5.1. 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. **The ALKS shall either:**

- (a) **Keep the vehicle 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; or,**
- (b) **Bring the vehicle to a safe stop outside of its lane of travel, when:**
  - (i) **ALKS is capable of performing a lane change according to paragraph 5.2.6.; and**
  - (ii) **A lane change can be safely performed under the current conditions.**

Additionally, the signal to activate the hazard warning lights shall be generated with the start of the minimum risk manoeuvre.

**If a lane change procedure is performed during the minimal risk manoeuvre, the signal to activate the hazard warning lights shall be generated again once the vehicle has reached its target lane.**

*Paragraph 6.4.1., amend to read:*

6.4.1. The following information shall be indicated to the driver:

- (a) The system status as defined in paragraph 6.4.2.
- (b) Any failure affecting the operation of the system with at least an optical signal unless the system is deactivated (off mode),
- (c) 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:

- (i) Contain a constant or intermittent haptic warning unless the vehicle is at standstill; and
- (ii) Be escalated and remain escalated until the transition demand ends;
- (d) Minimum risk manoeuvre by at least an optical signal and in addition an acoustic and/or a haptic warning signal; and
- (e) Emergency manoeuvre by an optical signal;
- (f) **A LCP, if the ALKS is capable of performing a LCP, by at least an optical signal.**

The optical signals above shall be adequate in size and contrast. The acoustic signals above shall be loud and clear.”

*Paragraph 7.1. amend to read:*

7.1. Sensing requirements

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.

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:

- (a) 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;
- (b) Along the full length of the vehicle and up to the limit of the lateral detection range;

(c) **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 rear detection range, if the ALKS is capable to perform a LCP.**

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

*Renumber paragraphs 7.1.3. to 7.1.6. into 7.1.4. to 7.1.7.*

*Paragraph 7.1.3., insert to read:*

**7.1.3. Rear detection range**

**The requirements of this paragraph apply to the system, if the ALKS is capable to perform a LCP.**

**The manufacturer shall declare the rear detection range measured from the most rearward point of the vehicle.**

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

*Paragraph 7.1.5., amend to read:*

7.1.5. 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 values specified in paragraph 7.1. over the lifetime of the system/vehicle.

*Annex 5, Tests, paragraph 4.6., amend to read:*

4.6. Field of View test

4.6.1. The test shall demonstrate that the ALKS is capable of detecting another road user within the forward detection area up to the declared forward detection range and a vehicle beside within the lateral detection area up to at least the full width of the adjacent lane. **If the ALKS is capable of performing lane changes, it shall additionally demonstrate that the ALKS is capable of detecting another vehicle within the rear detection range.**

4.6.2. The test for the forward detection ...

4.6.3. The test for the lateral detection range ...

**4.6.4. The test for the rear detection range shall be executed at least:**

- (a) **With a motorcycle approaching the ALKS from the rear in the left adjacent lane;**
- (b) **With a motorcycle approaching the ALKS from the rear in the right adjacent lane.**

*Annex 5, Tests, insert a new paragraph 4.7. to read:*

**4.7. Lane Change tests (only required if the ALKS is capable of performing lane changes either during an MRM or during regular operation)**

**The test shall demonstrate that the ALKS, if designed to be capable of performing lane changes, is able to assess the criticality of the situation before starting the LCM.**

**4.7.1. The test shall be executed at least:**

- (a) **With different vehicles, including a motorcycle approaching from the rear;**
- (b) **In a scenario where a LCM in regular operation is possible and executed;**
- (c) **In a scenario where the LCM in regular operation is not possible due to a vehicle approaching from the rear;**

- (d) **With an equally fast vehicle following behind in the adjacent lane at a distance of less than that which the following vehicle travels in 1.0 second preventing a lane change;**
- (e) **With a vehicle driving beside in the adjacent lane preventing a lane change;**
- (f) **In a scenario where a LCM during a minimal risk manoeuvre is possible and executed.**

## II. Justification

1. The proposed amendments aim to introduce the provisions for a regular lane change during Automated Lane Keeping Function (ALKS) operation as originally proposed in ECE/TRANS/WP.29/GRVA/2020/33, in order to permit lane changes, during a Minimum Risk Manoeuvre (MRM) as well.

2. The provisions proposed in ECE/TRANS/WP.29/GRVA/2020/33 on lane changes in general can almost completely be applied to lane changes during an MRM as well.

3. Amendments are needed where lane changes during an MRM deviate from regular lane changes:

(a) The end position in case of termination of a lane change manoeuvre (paragraph 5.2.6.5.) can differentiate between a regular lane change and that during an MRM. While for a regular lane change the vehicle should return to its original lane, during an MRM a position as far off the road as possible (e.g. half-way onto the hard shoulder) might still be the scenario that poses the lowest risk.

(b) Parameters defining an unmanageable deceleration of another vehicle (paragraph 6.2.6.6.): During an MRM, which is before the lane change already indicated by active hazard warning lamps to other road users, a higher deceleration of other vehicles and smaller remaining gap can be assumed to correspond with the urgency of the situation. The proposed values correspond to those proposed for a Risk Mitigation Function (RMF) in UN Regulation No. 79.

(c) The provisions on MRM need to be amended in order to permit the ALKS to change lanes during an MRM (paragraph 5.5.1.). Additionally, once the MRM lane change is complete and the ALKS vehicle continues to be slowed down in the target lane, the hazard warning lamps should be re-activated.

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