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

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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 leadership of the special interest group on  
UN Regulation No. 157\***

The text reproduced below reflects the discussion state of play of the Special Interest Group on Regulation No. 157 (Automated Lane Keeping System) as presented to the Working Party on Automated/Autonomous and Connected Vehicles (GRVA) at its eleventh session. It addresses the lane change capability of Automated Lane Keeping System. The text below incorporates the contents of ECE/TRANS/WP.29/GRVA/2020/33 and ECE/TRANS/WP.29/GRVA/2021/30 and therefore replaces the aforementioned documents. The modifications to the existing text of UN Regulation No. 157 (incl. Supplement 2) are marked in bold for new or strikethrough for deleted characters. Open issues are marked in square brackets.

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\* In accordance with the programme of work of the Inland Transport Committee for 2022 as outlined in proposed programme budget for 2022 (A/76/6 (Sect.20), para 20.76), 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

Paragraph 2.8., amend to read:

- “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 and has the purpose of avoiding or mitigating a collision. **[This includes manoeuvres when a collision is already imminent as well as [those where evasive steering needs to be performed by the system in order to keep the risk of a collision at a low level / evasive steering manoeuvres that aim to avoid a collision to become imminent.]”**

Paragraphs 2.21. to [2.27. or 2.31.], 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, emergency refuge area or beside the road.
- 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 in the given order:
- (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 [or combination].
- 2.26. *“Target stop area”* means a potential stopping area (e.g. emergency lane, hard shoulder, beside the road, slowest lane of traffic, own lane of travel).
- 2.27. *“Beside the road”* means the area of road surface beyond the boundaries of the carriageway which is not a hard shoulder or refuge area.
- [2.28. *“MRM lane change”* is a lane change performed by the ALKS during a minimum risk manoeuvre.]
- [2.29. *“Regular lane change”* is any lane change performed by the ALKS that is not an MRM lane change.]
- [2.30. An *“Evasive Lane Change”* is a steering manoeuvre when the ALKS vehicle cannot avoid collision by its full braking performance.”]
- [2.31. A *“Minimum Risk Manoeuvre Lane Change Procedure (MRMLCP)”* starts when the direction indicator lamps are activated and ends when the hazard warning lamps are activated by the system. It comprises the following operations in the given order:
- (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 towards the target stop area in target lane;**
- (e) **Stop the vehicle when arrive target stop area;**
- (f) **Deactivation of direction indicator lamps and activation of hazard lamps.]”**

*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 5.2.1.*, 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 5.2.6. 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 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 3, 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. LCPs shall only be performed in an uncritical way as described in paragraphs 5.2.6.1.1. and 5.2.6.1.2.**
- 5.2.6.1.1. The intervention shall not cause a collision with another vehicle or road user in the predicted path of the vehicle during a lane change.**
- 5.2.6.1.2. A lane change procedure shall be predictable and manageable for other road users.**
- 5.2.6.2. A LCP shall be completed without undue delay.**
- 5.2.6.3. The system may perform a single or multiple lane change(s) across regular lanes of traffic and/or to the hard shoulder in accordance with national traffic rules. ~~During regular lane change, the system shall not perform a lane change to the hard shoulder which is not temporarily opened up as regular lane of travel, emergency refuge area, beside the road or other emergency lane.~~**
- 5.2.6.4. 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. The activated system shall only undertake a LCP ~~in compliance with Paragraph 5.1.2~~, and if all of the following requirements are fulfilled:**
- (a) **The vehicle is equipped with a sensing system capable of fulfilling the front, side and rearward detection range requirements as defined in paragraph 7.1., [7.1.1.1. and 7.1.2.1.] and subparagraph 7.1.3.;**
  - (b) **All system self-checks, 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.

**5.2.6.5.1. Lane Change Procedure: Additional specific requirements for regular lane changes**

The activated system shall only initiate a regular LCP if the following conditions are fulfilled:

(a) 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 (e.g. due to the surrounding traffic), it should at the next available opportunity either complete the LCP or return to its original lane.

(b) The target lane is a regular lane of travel, or hard shoulder temporarily opened up as a regular lane of travel.

(c) 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 a LCP is being undertaken as part of a MRM as a follow up of a severe failure]).

**5.2.6.5.2. Lane Change Procedure: Additional specific requirements during an MRM**

**5.2.6.5.2.1. Lane changes during an MRM shall be made only if under the traffic situation these lane changes can be considered to minimize the risk to safety of the vehicle occupants and other road users.**

**5.2.6.5.2.2. Before initiating a lane change procedure, the system shall, if deemed appropriate, reduce the vehicle speed to minimize the risk related to that lane change (e.g. by adapting the speed of the vehicle to that of other vehicles in the target lane).**

**[5.2.6.5.2.3. In case the target stop area cannot be reached in an uncritical way the system shall aim to keep the vehicle within its current lane of travel while the vehicle is stopping.]**

**5.2.6.6. Lane change manoeuvre (LCM)**

**5.2.6.6.1. 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. [During the lane change manoeuvre, the system shall aim to avoid a lateral acceleration of more than 1 m/s<sup>2</sup> in addition to the lateral acceleration generated by the lane curvature.**

**[The LCM shall not be initiated before a period of 3.0 seconds after activation of the direction indicator lamps.]**

**5.2.6.6.2. The LCM may be abandoned before being completed if the situation requires it. In this case the LCM shall be completed by steering the ALKS vehicle back into the starting lane if traffic conditions allow it.**

**The ALKS vehicle shall be in a single lane of travel at the end of the LCM.**

**5.1.6.6.3. When several consecutive lane changes are performed, the direction indicator may remain active throughout these lane changes while the lateral behaviour shall ensure that each lane change manoeuvre can be perceived as an individual manoeuvre by following traffic.**

**5.2.6.6.4. Lane change manoeuvre: Additional specific requirements in MRM**

**5.1.6.6.4.1. A lane change manoeuvre during MRM shall be indicated in advance to other road users by activating the appropriate direction indicator lamps instead of the hazard warning lights.**

- 5.1.6.6.4.2. Once the lane change manoeuvre is completed the direction indicator lamps shall be deactivated in a timely manner, and the hazard warning lights shall become active again.
- 5.1.6.6.4.3. 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.
- [5.1.6.6.4.4. When bringing the vehicle to a safe stop beside the road, the vehicle may come to a standstill on the lane mark beside the road.]
- [5.2.6.6.4.5. In addition to the provisions of paragraph 5.1.6.6.4.1., an acoustic warning may be given as warning to other road users unless traffic rules in the country prohibits using an acoustic warning.]
- 5.2.6.6.4.6. When bringing the vehicle to a stop beside the road the vehicle speed shall not exceed 10 km/h.]
- 5.2.6.7. Assessment of the target lane
- 5.2.6.7.1. A LCP shall only be initiated if [the ALKS vehicle would be able to keep a safe distance from a lead vehicle or any other obstacle in the target lane according with the provisions of paragraph 5.2.3.3. and if] an approaching vehicle in the target lane is not forced to unmanageably decelerate due to the lane change of the ALKS vehicle.
- 5.2.6.7.2. Assessment of the target lane for a regular lane change
- 5.2.6.7.2.1. When there is an approaching vehicle
- An approaching vehicle in the target lane should not have to decelerate [, but in any case it shall not be] 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 3.0 m/s<sup>2</sup>
- (b) B equal to:
- (i) 0.4 seconds 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
- (ii) 1.4 seconds after the ALKS vehicle has crossed the lane marking, provided there was not 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 before the LCM starts.
- (c) C equal to 1.0 second.
- 5.2.6.7.2.2. Determination of whether a situation is critical shall consider any deceleration or acceleration of the ALKS vehicle [~~after it has crossed the lane marking~~].
- 5.2.6.7.2.3. When there is no vehicle detected
- If no approaching vehicle is detected by the system in the target lane, the minimum gap to the rear shall be calculated under the assumption that:
- (a) The approaching vehicle in the target lane is at a distance from the ALKS vehicle equal to rearward detection distance and
- (b) The approaching vehicle in the target lane is travelling [with the allowed maximum speed or 130km/h, whichever is lower].

**5.2.6.7.2.3. When there is an equally fast or slower moving vehicle**

At the beginning of the LCM, the distance between the rear of the ALKS vehicle and the front of a vehicle following behind in the target lane at equal or lower longitudinal speed shall never be less than the speed which the following vehicle in target lane travels in 1.0 s.

**5.2.6.7.3. Assessment of the target lane for an MRM lane change****5.2.6.7.3.1. When there is an approaching vehicle**

An approaching vehicle in the target lane should not have to decelerate at a higher level than  $A \text{ m/s}^2$ ,  $B$  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  $3.7 \text{ m/s}^2$
- (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;
  - (i) 0.4 seconds 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
  - (ii) 1.4 seconds after the ALKS vehicle has crossed the lane marking, provided there was not 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 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.

**5.2.6.7.3.2. When there is no vehicle detected**

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

- (a) The approaching vehicle in the target lane is at a distance from the ALKS vehicle equal to rearward detection distance; and
- (b) The approaching vehicle in the target lane is travelling [with the allowed maximum speed or 130km/h whichever is lower]; and
- (c) The 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].

**5.2.6.7.3.3. When there is an equally fast or slower moving vehicle**

At the beginning of the LCM, the distance between the rear of the ALKS vehicle and the front of a vehicle following behind in the target lane at equal or lower longitudinal speed shall never be less than the speed which the following vehicle in target lane travels in 0.7 s.

- 5.2.6.7.4. **Determination of whether a situation is critical shall consider any deceleration or acceleration of the ALKS vehicle after it has crossed the lane marking.**
- [5.2.6.7.5. **For the duration of the lane change manoeuvre, the lane change vehicle shall observe the minimum following distance requirements in accordance with paragraph 5.2.3.3. for any lead vehicle(s) or road user(s) in the target lane of travel or the initial lane of travel.**
- The strategy shall be clearly documented to ensure that this requirement is met, whilst ensuring that all lane changes can be completed and forward collisions avoided.]**
- [5.2.6.7.6. **In the case that, in the target lane, no obstacle or road user is present within the forward detection range, the speed of the ALKS vehicle, prior to beginning the lane change manoeuvre, shall be such that the lane change manoeuvre can complete and the vehicle can be brought to a complete stop within a distance equal to the forward detection range less 2 m.]**
- 5.2.6.7.7. **In case the ALKS decelerates the vehicle during a lane change procedure, this deceleration shall be factored in when assessing the distance to a vehicle approaching from the rear, and the deceleration shall [not exceed  $2 \text{ m/s}^2$ , except for the purpose of avoiding or mitigating the risk of an imminent collision / be manageable for the vehicle approaching from the rear].**
- How the provisions of this paragraph are implemented in the system design shall be demonstrated to the Technical Service during type approval.**
- 5.2.6.7.8. **Where there is not sufficient headway time for the vehicle behind at the end of the lane change procedure, the ALKS shall not increase the rate of deceleration for [at least 2 seconds / a certain period of time] after the completion of the lane change procedure except for the purpose of avoiding or mitigating the risk of an imminent collision.**
- How the provisions of this paragraph are implemented in the system design shall be demonstrated to the Technical Service during type approval.**

*Paragraph 5.3., amend to read:*

- “5.3. **Emergency Manoeuvre (EM)**
- 5.3.1. **An Emergency Manoeuvre shall be carried out in case of an imminent collision risk [or when the vehicle needs to cross lane markings to mitigate the risk of a collision].**
- 5.3.1.1. **Any longitudinal deceleration demand of more than  $5.0 \text{ m/s}^2$  of the system shall be considered to be an emergency manoeuvre.**
- [5.3.1.2. **Any lateral manoeuvre that leads the ALKS vehicle to cross lane markings in response to a risk of collision and that is not considered a lane change according to paragraph 5.2.6. shall be considered to be an emergency manoeuvre.]**
- 5.3.2. **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) [unless the system is capable of fulfilling the provisions of paragraph 5.3.5.]**

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

- [5.3.5. **Lateral manoeuvre crossing lane markings to minimize the risk of a collision.]**
- [5.3.5.1. **The vehicle shall only cross lane markings in response to a risk of collision if the system has sufficient information about its surrounding to the front and side (as defined in paragraph 7.1.) and to the rear (according to the following paragraphs) in order to assess the criticality of crossing the lane markings.]**
- [5.3.5.2. **The activated system shall not cause a collision with another vehicle or road user in the predicted path of the vehicle when crossing lane markings in response to a risk of collision.]**
- [5.3.5.3. **The vehicle shall only cross lane markings in response to a risk of collision if another vehicle in the evasive lane is not forced to unmanageably decelerate due to that manoeuvre.]**
- [5.3.5.3.1. **When crossing the lane markings by not more than [30] cm, it shall be ensured that:**
- (a) **The distance to a vehicle following behind in the evasive lane at equal or lower speed is greater than that which the following vehicle travels in 0.5 s; [and/or]**
- (b) **A minimum lateral distance of 1m to vehicles travelling in the evasive lane is ensured.]**
- [5.3.5.3.2. **When crossing the lane markings by more than [30] cm up to [half the vehicle’s width], it shall be ensured that:**
- (a) **An approaching vehicle in the evasive lane shall not have to decelerate at a higher level than 4 m/s<sup>2</sup>, 0.4 seconds after the ALKS vehicle starts crossing the lane markings, to ensure collision avoidance between the two vehicles; and**
- (b) **The distance to a vehicle following behind in the evasive lane at equal or lower speed is greater than that which the following vehicle travels in 0.5 s; and**
- (c) **The evasive lane is unoccupied across the length of the ALKS vehicle.]**
- [5.3.5.3.3. **When crossing the lane markings by more than [half the vehicle’s width], the criticality of the situation shall be assessed according to the corresponding provisions for a LCP provisions in paragraph 5.2.6.]**
- [5.3.5.4. **The vehicle shall aim at returning to its original lane of travel once the situation that required the lateral manoeuvre has passed.]”**

*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.]”**

*Paragraphs 5.5.1., amended 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 to bring the vehicle to a safe stop outside its lane of travel.]**

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, the full width of the lane next to the target lane, up to the limit of the forward side and rearward detection range, if fitted to perform a LCP.]**

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

*Paragraph 7.1.1.1., insert to read:*

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

**The manufacturer shall declare the forward detection range measured from the most forward point of the vehicle. This declared range shall be sufficient to cover at least the target lane and the lane next to the target lane.**

**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.]”**

*Paragraph 7.1.2.1., insert to read:*

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

**The manufacturer shall declare the lateral detection range. This declared range shall be sufficient to cover at least the target lane and the lane next to the target lane.**

**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.]”**

*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. Rearward 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. This declared range shall be sufficient to cover at least the target lane and the lane next to the target lane.**

**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.]”**

*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. and subparagraphs, 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 front, side and rearward detection range at least the target lane and the lane next to the target lane.]**

- 4.6.2. The test for the forward detection
- [4.6.2.1. The requirements of this paragraph apply to the system, if the ALKS is capable to perform a LCP.**
- The test for the forward detection range shall be executed at least:**
- (a) When approaching a motorcycle target positioned at the outer edge of each target lane and the lane next to the target lane;
  - (b) When approaching a stationary pedestrian target positioned at the outer edge of each target lane and the lane next to the target lane;]
- 4.6.3. The test for the lateral detection range
- [4.6.3.1. The requirements of this paragraph apply to the system, if the ALKS is capable to perform a LCP.**
- The test for the lateral detection range shall be executed at least:**
- (a) With a motorcycle target approaching the ALKS vehicle from the left target lane and the lane next to the target lane;
  - (b) With a motorcycle target approaching the ALKS vehicle from the right target lane and the lane next to the target lane.
- 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~~ target lane and the lane next to the target lane;
  - (b) With a motorcycle approaching the ALKS from the rear in the right ~~adjacent lane~~ target lane and the lane next to the target lane.]”

*Annex 5, Tests, insert new paragraphs 4.7., 4.8. and 4.9. to read:*

- “**[4.7. Lane changing**
- Lane Change tests (only required if the ALKS is capable of performing lane changes either during an MRM, emergency situations or during regular operation)**
- The tests shall demonstrate that the ALKS does not cause an unreasonable risk to safety of the vehicle occupants and other road users during a Lane Change Procedure (LCP), is capable of correctly performing lane changes and 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.
- 4.7.2. The following on road-tests shall be executed:**
- (a) With the ALKS vehicle performing lane change in the adjacent (target) lane;
  - (b) Merging at motorway entry;

- (c) Merging at lane end;
- (d) Merging into an occupied lane.]
- [4.8. Detect and response to traffic rules and road furniture**
- 4.8.1. These tests shall ensure that the ALKS respects traffic rules, detects and adapts to a variation of permanent and temporary road furniture.**
- 4.8.2. The test shall be executed at least with the list of scenarios below, but based on the ODD of the given system:**
  - (a) Different speed limit signs, so that the ALKS vehicle has to change its speed according to the indicated values;
  - (b) Signal lights of an ending lane. The signal lights are set above the belonging lanes, and the signal lights of adjacent lanes are kept in green state, while the one of the current lane for the ALKS vehicle is kept red.;
  - (c) Driving through a tunnel: at least [X]m long section of the road with no sunlight and availability of the positioning system.
  - (d) Toll station: a section of the motorway with toll station-, speed limit signs and buildings (ticket machines, barriers, etc.).
  - (e) Temporary modifications: e.g., road maintenance operations indicated by traffic signs, cones and other modifications.
- 4.8.3. Each test shall be executed at least:**
  - (a) Without a lead vehicle;
  - (b) With a passenger car target as well as a PTW target as the lead vehicle / other vehicle.]
- [4.9. Avoid braking before a passable object in the lane**
- 4.9.1. The test shall demonstrate that the ALKS vehicle is not braking without a reason before a passable object in the lane (e.g., a manhole lid or a small branch).**
- 4.9.2. The test shall be executed at least:**
  - (a) Without a lead vehicle;
  - (b) With a passenger car target as well as a PTW target as the lead vehicle / other vehicle.]

## II. Justification and state of play

1. This proposal aims at adding the lane change capability to ALKS. It is based on ECE/TRANS/WP.29/GRVA/2020/33, presented to GRVA at its September 2020 session by the expert from Germany, as well as subsequent proposals for amendments received so far.
2. The document reflects the discussion in the SIG 157 until its 8th session of 17 September 2021. An informal document from the group is expected before the next GRVA session to close the open issues. The following points summarize discussion state of play within the group for each paragraph:
  - (a) Point of discussion for 2.8.: Homework: New text expected from industry to address comments from the 6th meeting (clear distinction between regular Lane Changes and Lane Changes during Emergency manoeuvre).
  - (b) Group conclusion on 2.21. to 2.27. agreed (reminder: it may need renumbering if merged with speed increase proposal). To be confirmed, if “combination” should be included in para. 2.25. as a follow up of the recent adoption of commercial vehicles requirements.
  - (c) Point of discussion on 2.28. and 2.29.: Proposal from industry for definitions of MRM and Regular lane changes to be confirmed.

- (d) Point of discussion on 2.30.: Japan proposal (working paper UNR157-06-05) for definition of evasive lane change to be confirmed (Reminder: may need renumbering if merged with speed increase proposal.)
- (e) Point of discussion on 2.31.: Japan proposal (working paper UNR157-07-12) for definitions of MRM lane change procedure to be confirmed (Reminder: may need renumbering if merged with speed increase proposal.)
- (f) Group conclusion on 5.1.6.: Proposal agreed.
- (g) Group conclusion on 5.2.1.: Proposal agreed.
- (h) Group conclusion on 5.2.6. to 5.2.6.2.: Proposal agreed in principle.
- (i) Homework: Japan to propose an update of Annex 3 (as it does not cover lane change today). The Chair proposes to delete the text in square brackets in para. 5.2.6.3., because the first sentence seems sufficient.
- (j) Group conclusion on 5.2.6.4.: agreed.
- (k) Group conclusion on 5.2.6.5.: it is agreed in principle. Point of discussion: text in square brackets to be confirmed in particular expanded field of view in (a), as proposed by Japan by introducing new paras. 7.1.1.1. and 7.1.1.2. (in square brackets). Item (c) also needs confirmation as the follow up of the reordering of the paragraphs made by the chair to separate regular lane changes and lane changes during MRM. United Kingdom (UK) to check whether 5.2.6.5.1. (c) is necessary and provide clarification. To be discussed in next meeting.
- (l) Group conclusion on 5.2.6.5.2. to 5.2.6.5.2.2.: agreed in principle. Renumbering of paragraphs made by the leadership.
- (m) Point of discussion on 5.2.6.5.2.3.: Leadership proposes to delete the obligation to wait for 5 seconds coming from Risk Mitigation Function (RMF) provisions, before being able to change lane because a transition demand was requested before that or a severe failure may require an immediate lane change.
- (n) Point of discussion on 5.2.6.6.: Text in square brackets to be confirmed as a follow up of the seventh meeting. (New renumbering proposed by the leadership).
- (o) Point of discussion on 5.2.6.6.4. and subparagraphs: Text to be confirmed after clean up and new numbering. In particular confirm if paras. 5.2.6.6.4.5. and 5.2.6.6.4.6. are needed (Reminder: text coming from RMF).
- (p) Point of discussion on 5.2.6.7: Text in square brackets in para. 5.2.6.7.1. is taken from working paper UNR157-03-06 (submitted by the Joint Research Center (JRC)/ European Commission (EC)) on headway; to be confirmed or check if it is already covered by paragraph 5.2.6.7.5.
- (q) Point of discussion on 5.2.6.7.2.: Confirm tentative agreement from the seventh meeting. Homework: UK's wording to express more clearly the idea is to avoid 3 m/s<sup>2</sup> deceleration as a standard practice for each LC is included in square brackets in the first paragraph.
- (r) Point of discussion for 5.2.6.7.2.2.: Tentative agreement during the seventh meeting to delete text in square brackets. Homework: UK asked to reflect and will come with new proposal if necessary.
- (s) Point of discussion for 5.2.6.7.2.3.: text to be confirmed, in particular item (b) as proposed by the Chair.
- (t) Point of discussion for 5.2.6.7.2.3.: Confirm tentative agreement.
- (u) Point of discussion for 5.2.6.7.3. and subparagraphs: Confirm tentative agreement. New para numbers to split MRM and regular lane changes. Text in square brackets to be confirmed.
- (v) Point of discussion on 5.2.6.7.5. and 5.2.6.7.6.: the text proposed by UK (informal document GRVA-07-62) to be confirmed. Link it with the text in square brackets in para 5.2.6.7. on headway.
- (w) Point of discussion on 5.2.6.7.6. to 5.2.6.7.8.: the text is taken from the RMF provisions, it needs to be confirmed with the further modification the RMF text, in square

brackets. Text in square brackets in 5.2.6.7.7. and 5.2.6.7.8. requested by industry (Imminent collision is characterized in ALKS as a situation with a deceleration  $>5\text{m/s}^2$ . If one knows the vehicle ahead decelerates, one wouldn't want to delay deceleration until the required values exceeds  $5\text{m/s}^2$ ).

(x) Point of discussion on 5.3. and subparagraphs: the text proposed by industry (in working paper UN157-05-11) needs to be confirmed. Tentative feedback from Japan: no support for the text in square brackets in para. 5.3.1. Homework: Industry was asked to come up with new text to narrow down the concept of emergency lane change and to ensure this will only be used in case of emergency situations. Furthermore, industry to provide explanation where the 0.5 s in para. 5.3.5.3.1. come from and to clarify if the two conditions must be fulfilled (decision needed: 'add' or 'or correct')? Value of  $4\text{ m/s}^2$  (and not  $3.7\text{ m/s}^2$ ) to be explained in para. 5.3.5.3.2.

(y) Point of discussion on 5.4.2.4.: Text from JRC/EC (working paper UNR157-03-06) to be confirmed (Reminder: definition for 'regular LCP' might need to be introduced, if inserted here as (new) term.).

(z) Point of discussion on 5.5.1.: Can the proposed amendments from industry be agreed and added?

(aa) Point of discussion on 6.4.1.: Can proposed amendments be agreed and added?

(ab) Point of discussion on 7.1.: Can proposed amendment be agreed and added? Underlined text based on suggestion from Japan in seventh meeting.

(ac) Point of discussion on new 7.1.1.1. and 7.1.2.1.: Can the text proposed by Japan (working paper UNR157-07-11) be agreed and added?

(ad) Point of discussion on 7.1.3.: Can the text be confirmed? (Most recent amendment proposed by Japan (underlined text, UNR157-07-11) in seventh meeting to align with proposal for para. 7.1.).

(ae) Point of discussion on 7.1.5.: to be confirmed.

(af) Point of discussion Annex 5, 4.6.: to be confirmed. (Most recent amendment proposed by Japan (underlined text, UNR157-07-11) in seventh meeting to align with the proposal for para. 7.1.)

(ag) Point of discussion on Annex 5, 4.7: to be confirmed.

(ah) Point of discussion on Annex 5, 4.8.: to be confirmed. Homework: Industry to check with para. 5.4. and 5.5. of Annexes 4 and 5.

(ai) Point of discussion for Annex 5, para.4.9.: to be confirmed.

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