

Proposal to amend ECE/TRANS/WP.29/GRVA/2022/03

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) up to its twelfth meeting, specifically on developing requirements for lane changing of an Automated Lane Keeping System (ALKS).

Based on ECE/TRANS/WP.29/GRVA/2022/3 the Special Interest Group has agreed on open issues and made further developments to the text. These are presented in this informal document.

ECE/TRANS/WP.29/GRVA/2022/3: 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.

GRVA-12-34: The entire text of ECE/TRANS/WP.29/GRVA/2022/3 is reproduced below. Modifications to that document are marked in **green bold** for new or **green strikethrough** for deleted characters. The remain open issues are marked in square brackets.

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.~~J~~, 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.
- 2.23. “Evading lane” is the lane into which the ALKS vehicle crosses during an evasive lane crossing.
- 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 procedure performed by the ALKS during a minimum risk manoeuvre.~~J~~
- 2.29. “Regular lane change” is any lane change procedure performed by the ALKS that is not an MRM lane change.~~J~~
- 2.30. An “Evasive Lane Crossing Change” is an emergency manoeuvre that results in the ALKS vehicle crossing a lane marking a steering manoeuvre when the ALKS vehicle cannot avoid collision by its full braking performance.~~J~~
- 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.]

2.31. “Potential Vehicle Presence Area (PVPA)” is the area in which another vehicle could be relevant to the ALKS when performing a lane change and that is enclosed by the following:

- (a) a line to the front of the vehicle, perpendicular to the direction of travel at the minimum following distance specified in paragraph 5.2.3.3. measured from the forward most point of the vehicle;
- (b) a line to the rear of the vehicle, perpendicular to the direction of travel at the critical distance established by paragraph 5.2.6.7.2.3. measured from the rearward most point of the vehicle;
- (c) a line parallel to the direction of travel along the side of the vehicle that is not adjacent to the target lane; and
- (d) a line parallel to the direction of travel along the furthest lane marking of the lane beyond to the target lane or of the target lane if there is not one beyond it.

Lines (a) and (b) change according to the speed at which the ALKS vehicle travels.”

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 detected, at least once, deleted an object at the same or a higher distance than that what has been declared as for 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.

[5.2.1.1. A vehicle with ALKS enabled is permitted to intentionally cross lane markings when it is necessary to follow applicable traffic rules or when responding to an obstacle with a preventative risk minimising strategy (e.g. to form an access corridor for emergency vehicles or for driving around an obstacle partly blocking the lane of travel in order not to disrupt the traffic flow or not to cause a risk to following traffic).

5.2.1.2. Such lane crossings are not considered to be a lane change as defined in paragraph 5.2.6. or 5.3.5. as long as the vehicle remains partly in its original lane of travel. The vehicle shall aim to return completely to its original lane of travel once the situation that required this manoeuvre has passed.

- 5.2.1.3.** These manoeuvres shall not endanger the safety of the vehicle occupants or any other road user by:
- ensuring sufficient lateral and longitudinal distance to road boundaries, vehicle and other road users;
 - the lateral acceleration not exceeding [1.0] m/s²; and
 - complying with the assessment of the target lane according to paragraph 5.2.6.7.2. and its sub-paragraphs when crossing the lane marking by more than half of the vehicle width.

- 5.2.1.4.** The system shall be equipped with a sensing system suitable to assess the criticality of such a manoeuvre.

- 5.2.1.5.** The manufacturer shall demonstrate to the Technical Service how the system fulfils the requirements of paragraphs 5.2.1.1. to 5.2.1.4..”

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 capable of performing~~ 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 ~~in the country of operation. 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 ~~may shall only~~ undertake a LCP ~~in compliance with Paragraph 5.1.2], and only if all of the following requirements conditions~~ 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 paragraphs 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 There is no failure present limiting the system's capability to perform a LCP safely;~~

- (c) ~~A gap Sufficient free space in the target lane allowing a LCM is already present available or expected to become available 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:

- ~~(e)~~(a) 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]~~ where a lane change is required by national traffic rules).
- (b) The target lane is a regular lane of travel, or hard shoulder temporarily opened up as a regular lane of travel.
- ~~(a)~~(c) 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.
- (d) ~~There is no other vehicle in the PVPA, whose priority resulting from its active direction indicators, would prevent a LCP by the ALKS.~~

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 minimise 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 minimise 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 uneritical way the system shall aim to keep the vehicle within its current lane of travel while the vehicle is stopping.]~~
- 5.2.6.5.2.3.** A lane change procedure shall not start within the first 3 seconds following the start of the MRM intervention, unless a sooner initiation is required either in order to reach a minimal risk target stop area (e.g. when the hard shoulder is ending ahead or in case of failure) or if the lane change manoeuvre can be performed with a criticality equal to that of a regular lane change.

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^2 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.]~~

The duration between initiation of the LCP and start of the LCM shall be in compliance with traffic rules in the country of operation.

- 5.2.6.6.2.** A LCM shall only be initiated when the relevant area of the target lane is expected to remain unoccupied throughout the manoeuvre (e.g. there is no other vehicle in the second to next lane expected to change lanes on a conflicting trajectory). Priority shall be given to other road users in accordance with traffic rules.

- 5.2.6.6.23.** 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.

5.1.6.6.34. 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.

5.2.6.6.5. **Lane change manoeuvre: Additional specific requirements for regular lane changes**

5.2.6.6.5.1. The system shall not cause a collision with another vehicle changing into the target lane on a conflicting trajectory.

5.2.6.6.5.1.1. Another vehicle's potential for changing into the target lane on a conflicting trajectory shall be assessed based on its direction indicator status, vehicle dynamics and the surrounding traffic.

5.2.6.6.5.1.2. If there is an area in the PVPA where the system is not able to assess the status of the direction indicator on another vehicle on the basis of the declaration in 7.1.4., a LCM shall not be initiated if there is another vehicle in that part of the PVPA, except whose movement can be assessed not to conflict with the trajectory of the ALKS vehicle, except for following vehicles at and near merging and departing lanes. In such circumstances, an approaching vehicle in the lane next to the target lane shall be treated like an approaching vehicle in the target lane.

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

5.1.6.6.46.1. 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.

5.1.6.6.46.2. 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.

5.1.6.6.46.3. ~~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.~~

5.1.6.6.46.3. When bringing the vehicle to a safe stop beside the road ~~or on a hard shoulder not wide enough to fit the entire vehicle~~, the vehicle may come to a standstill on the lane marking ~~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~~ unreasonably 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, particularly in the case where the lane change is not urgent (e.g. for the purpose of overtaking a slower moving vehicle). ~~[, but in any case it shall not be]~~ But where this is necessary due to the traffic situation, in the absence of more specific traffic rules, the approaching vehicle shall not

have to decelerate at a higher level than A m/s², 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 ALKS vehicle travels in C seconds.

With:

- (a) A equal to 3.0 m/s²
- (b) B equal to:
 - (i) 0.4 seconds after the ALKS vehicle has crossed the lane marking start of the LCM, provided there was that the full width of the approaching vehicle was detected by the ALKS vehicle during its lateral movement for 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 without an obstruction before the LCM starts; or
 - (ii) 1.4 seconds after the start of the LCM 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 assessment shall be calculated as per 5.2.6.7.2.1. with under the assumption that:

- (a) the approaching vehicle in the target lane is at a distance from the ALKS vehicle equal to the actual rearward detection range; distance and
- (b) the approaching vehicle in the target lane is travelling ~~with the allowed maximum speed + 30km/h or 430 160km/h, whichever is lower~~; and
- (c) the full width of the approaching vehicle is detected by the ALKS vehicle during its lateral movement for at least 1 second.

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 distance 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 In the absence of more specific traffic rules, an approaching vehicle in the target lane should not have to decelerate at a higher level than A m/s², B seconds after the ALKS vehicle starts crossing a lane marking the lane change manoeuvre, to ensure the distance between the two vehicles is never less than that which the lane-change ALKS vehicle travels in C seconds.~~

With:

- (a) A equal to 3.7 m/s²
- (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 the full width of the vehicle approaching from the rear was detected by the sensing system;~~
 - (ii) 0.4 seconds after the ~~ALKS vehicle has crossed the lane marking~~ start of the LCM, provided ~~there was~~ that the full width of the approaching vehicle was detected by the ALKS vehicle during its lateral movement for 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 without an obstruction~~ before the LCM starts; or
 - (iii) 1.4 seconds after the ~~start of the LCM 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; or~~
 - (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 assessment~~ shall be calculated as per 5.2.6.7.3.1. with ~~under~~ the assumption that:

- (a) the approaching vehicle in the target lane is at a distance from the ALKS vehicle equal to the ~~actual~~ rearward detection ~~distance range; and~~
- (b) the approaching vehicle in the target lane is travelling ~~{with the allowed maximum speed +30 km/h or 130 160km/h, whichever is lower, or if the target lane is a hard shoulder,}; and~~
- (e) the approaching vehicle ~~on a hard shoulder~~ is travelling ~~{at a maximum speed of 80 km/h and or has a maximum speed difference to the ALKS vehicle at the start of the LCM of 40 km/h}, whichever is the lower speed; and~~
- (c) ~~the full width of the approaching vehicle is detected by the ALKS vehicle during its lateral movement for at least 1 second.~~

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~~ ~~distance~~ 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.]~~

5.2.6.7.75. In case the ALKS decelerates the vehicle during a lane change procedure into a regular lane of traffic, this deceleration shall be factored in when assessing the distance to a vehicle approaching from the rear, and the deceleration shall ~~not exceed 2 m/s², except for the purpose of avoiding or mitigating the risk of an imminent collision /be manageable for the vehicle approaching from the rear/ or when required to ensure reaching the target stop area during an MRM.~~

How the provisions of this paragraph are implemented in the system design shall be demonstrated to the Technical Service during type approval.

5.2.6.7.86. 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, ~~when required to fulfil other requirements of this regulation (e.g., to adapt to changing speed limits, maintain sufficient following distance), or to ensure reaching the target stop area during an MRM.~~

How the provisions of this paragraph are implemented in the system design shall be demonstrated to the Technical Service during type approval.

Paragraph 5.3.2., 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 m/s² 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 motion.”~~

Paragraph 5.3.5., insert to read:

- [5.3.5.]** ~~Evasive lane crossing Lateral manoeuvre crossing lane markings to minimize the risk of a collision.]~~
- [5.3.5.1.]** An evasive lane crossing shall only be performed by the ALKS when the imminent collision risk was not present or occurring within the detection ranges declared by paragraph 7.1. before it became an imminent collision risk.]
- 5.3.5.2.** If utilising an evasive lane crossing as part of an emergency manoeuvre, the ALKS shall ensure that it is as least as safe to the vehicle occupants and other road users as avoiding the imminent collision risk with the vehicle's full braking performance.
- [5.3.5.13.]** The vehicle shall only cross lane markings in response to an ~~risk of imminent collision risk~~ 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.]
- [5.3.5.24.]** The ~~activated~~ system shall not cause a collision with another vehicle or road user in the predicted path of the vehicle when performing an evasive lane crossing ~~lane markings in response to a risk of collision.~~
- [5.3.5.35.]** The vehicle shall only perform an evasive lane crossing ~~cross-lane markings in response to a risk of collision~~ if another vehicle in the ~~evasive evading~~ 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/s², 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.]
- [5.3.5.46.]** The vehicle shall aim ~~at~~ to returning to its original lane of travel once the situation that required the ~~lateral manoeuvre~~ evasive lane crossing has passed.]
- 5.3.5.7.** An evasive lane crossing shall be indicated to other road users in accordance with national traffic rules.
In the absence of more specific traffic rules, when initiating an evasive lane crossing that intends to cross into the evading lane by more than 30cm, the system shall indicate its intention to change into the evading lane by generating the signal to activate the direction indicator.”

Paragraph 5.4.2.4., insert to read:

“~~5.4.2.4.~~ In case Where the ALKS is capable ~~to~~ of performing ~~a regular~~LCP lane change, it shall be aimed that ~~a regular~~LCP lane change is not part of the transition phase, meaning that a LCP shall not be started when a transition demand is known to occur during the procedure ~~the transition demand is not given shortly before or during a LCP.~~”

Paragraphs 5.5.1., renumbered to 5.5.2. and amended to read:

“~~5.5.4.2.~~ 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^2 .

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 **but suspended during a LCP**.

[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 5.5.2., renumber to 5.5.1. and amended to read:

“~~5.5.2.1.~~ The minimum risk manoeuvre shall bring the vehicle to standstill unless the system is deactivated by the driver during the manoeuvre.

This shall be in a target stop area considered to be the greatest minimising of risk achievable under the given circumstances (e.g. traffic situation, environmental conditions, system failures), performed according to paragraph 5.2.6., if the ALKS is capable of performing a lane change during an MRM.

Otherwise, within its current lane, or in the case the lane markings are not visible, following an appropriate trajectory taking into account surrounding traffic and road infrastructure.

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.~~**

If the ALKS is capable of performing a LCP, in addition to above, a sensing system shall be able to determine the traffic dynamics at a width of at least 9m to each side, measured from the centre of the ALKS vehicle from the limit of the forward detection range to the limit of the rearward detection range.

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 additionally 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 in paragraph 7.1.1. shall be sufficient to cover at least the target lane and the lane next to the target lane an area 9m to the side(s) to which the ALKS performs a LCP measured from the centre of the ALKS vehicle.~~

The Technical Service shall verify that the distance at which the vehicle sensing system detects a road-user vehicle 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 additionally apply to the system, if the ALKS is capable to perform a LCP.~~**

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

~~the lane next to the target lane~~ an area 9m to the side(s) to which the ALKS performs a LCP measured from the centre of the ALKS vehicle.

The Technical Service shall verify that the distance at which the vehicle sensing system detects a ~~road-user vehicle~~ 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 7.1.5. to 7.1.8.

Paragraphs 7.1.3. and 7.1.4., 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 **rearward** 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~~ an area 9m to the side(s) to which the ALKS performs a LCP measured from the centre of the ALKS vehicle.

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

7.1.4. Direction indicator status detection area

The manufacturer shall declare the area within the PVPA in which the system is able to assess the status of other vehicle's direction indicators. This shall account for the different direction indicator positions of vehicles which are normally operated in the PVPA in the system's countries of operation.

The Technical Service shall verify this area during the relevant test in Annex 5.”

Paragraph 7.1.6., amend to read:

“7.1.6. 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.”

Paragraph 8.2.1., amend to read:

8.2.1. ...

- (e) Start of Emergency Manoeuvre;
- (f) End of Emergency Manoeuvre;
 - (i) **Vehicle remained in lane;**
 - (ii) **Vehicle crossed into evading lane.**

...

- (k) Severe vehicle failure:;
- (l) **Start of Lane Change Procedure;**
- (m) **End of Lane Change Procedure.**

Annex 4, Paragraph 4.2.1., insert to read:

4.2.1 **The Type Approval Authority may verify the accuracy of simulation tools used by means of results from track and/or public road test performed under Annex 5 and/or Annex 6, and/or by performing additional tests where needed.**

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^2 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 5m/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 m/s^2 (and not 3.7 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.