

The text reproduced below consolidates the different written proposals for adding the lane change capability of ALKS into a single document. It is based on the open points list (document UNR157-05-05, column “F”).

Modifications to the existing text of UN-Regulation No. 157 (as proposed in ECE/TRANS/WP29/GRVA/2020/33 (DE)) are marked in **black bold** for new or ~~strikethrough~~ for deleted characters. Further modifications (as proposed in GRVA-07-62 (UK), ECE/TRANS/WP.29/GRVA/2021/04 (OICA/CLEPA) and UNR157-03-06 (EC)) are marked **red bold** for new or ~~strikethrough~~ for deleted characters.

Options as points of discussion are highlighted in **yellow**.

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 or emergency refuge area.**
- 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.**

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), **except during a Lane Change Manoeuvre, as part of a Lane Change Procedure.**

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 5.2.4., amend to read:

- 5.2.4. The activated system shall be able to **handle in a safe way the presence in the same lane of** ~~bring the vehicle to a complete stop behind~~ a stationary vehicle, a ~~stationary~~ road user, **a passable or unpassable obstacle [debris, lost cargo, etc.]**, or a blocked lane of travel to avoid a collision. This shall be ensured up to the maximum operational speed of the system.

Paragraph 5.2.6. and subparagraphs, insert to read:

5.2.6. Lane Change Procedure

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 **in compliance with Paragraph 5.1.2, and** if the following requirements 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~~ **All** system self-checks, as defined in paragraph 5.1.6. is positively confirmed;

(c) The assessment of the target lane as defined in paragraph 5.2.6.6. and its subparagraphs **is positively confirmed**;

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

If the LCP is being undertaken as part of a MRM, the target lane may additionally be a hard shoulder, emergency refuge area, or other emergency lane, providing there is no other vehicle travelling in that lane within the rear detection range of the ALKS vehicle.

- ~~5.2.6.3. In compliance with paragraph 5.1.2. in particular, the activated system may undertake a LCP if:~~

~~(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).~~

~~or;~~

~~The LCP is being undertaken as part of a MRM~~

~~(bg) A gap allowing a LCM is already present or expected to open up shortly.~~

- 5.2.6.43. A LCP shall be completed without undue delay.**

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. 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 shall not be initiated before a period of 3.0 seconds ~~and not later than 7.0 seconds~~ after activation of the direction indicator lamps.

The LCM may be ~~terminated~~ abandoned before being completed if the situation requires it. In this case the LCM shall be completed by steering the ALKS vehicle ~~has to be steered~~ back into the starting lane.

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.

Option 1

5.2.6.6. Assessment of the target lane

A ~~LCP~~ LCM shall only be initiated if an approaching vehicle in the target lane ~~is not~~ would not be forced to unmanageably decelerate due to the lane change of the ALKS vehicle.

Or

5.2.6.6. Assessment of the target lane

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.

5.2.6.6.1. 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, 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/s² for a regular lane change

(ii) 3.7 m/s² 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;

(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.

OR

Option 2

5.2.6.6.1. An approaching vehicle in the target lane should always have a TTC to the ALKS vehicle of at least [4] seconds at the end of the LCM.

5.2.6.6.2. Determination of whether a situation is critical shall consider any deceleration or acceleration of the ALKS vehicle after it has crossed the lane marking.

Option 1

5.2.6.6.23. If no approaching vehicle is detected by the system in the target lane, the ~~minimal~~-minimum 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~~ entry lanes) is travelling with at least the allowed ~~or the~~ advised maximum speed ~~whichever is lower~~ or, on roads where no speed limit applies, at least the advised maximum speed, or;

b) an approaching vehicle on a target lane intended for slower traffic (including exit lanes and hard shoulders temporarily opened for regular traffic) is travelling with a ~~maximum~~-speed difference of at least [20] km/h at the beginning of the LCM ~~or while not exceeding the allowed or advised maximum speed or advised maximum speed~~ is travelling with at least the allowed maximum speed or, on roads where no speed limit applies, at least the 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.

OR Option 2

5.2.6.6.2. If no approaching vehicle is detected by the system in the target lane, the conditions laid down in paragraph 5.2.6.6.1 ~~minimal gap to the rear~~ shall be ~~assessed~~ ~~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 an~~ approaching vehicle in the ~~on a~~ target lane ~~intended for faster traffic (including enter lanes)~~ is travelling with the allowed or the advised maximum speed ~~whichever is lower~~ ~~higher~~ ~~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 beginning of the LCM while not exceeding the allowed or advised maximum speed.~~

5.2.6.7. When there is an equally fast or slower moving vehicle

~~At the beginning of the LCM, t~~**The distance between the rear of the ALKS vehicle and the front of ~~to to~~ 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:**

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

5.2.6.8. For the duration of the lane change manoeuvre, the lane change vehicle shall observe the minimum following distance requirements in accordance with 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.

5.2.6.9 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 2m.

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 LCP is not part of the transition phase, meaning that the transition demand is not given shortly before or during a LCP.

Paragraphs 5.5.1-5.5.2., 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/s².

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 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.

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.

~~The vehicle manufacturer shall provide evidence that the effects of wear and ageing do not reduce the performance of the sensing system below the~~

~~minimum required value specified in this paragraph over the lifetime of the system/vehicle.~~

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., 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 paragraphs 4.7., 4.8. and 4.9. 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.**
- 4.7.2. The following 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