

## Base document for ALKS for low speed application Proposal from the Small Drafting Group

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Text agreed in the informal group in black with green background

Text suggested from the small drafting group in blue

Text suggested from Germany (not discussed up to now) in red

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Comment & Text from Republic Of Korea with sky blue background

## Proposal for Technical Requirements for an Automated Lane Keeping System

\*\*\* SPECIFIC REQUIREMENTS \*\*\*

### 2.1 Scope [KATRI1]

The following set of requirements applies to “Automated Lane Keeping System (ALKS) for low speed application”, a system which is initiated/activated by the driver and which keeps the vehicle within its lane by influencing the lateral movement of the vehicle and controls the longitudinal movement of the vehicle for extended periods without further driver command/confirmation at the speed of [60] km/h or below.

2.1.1. This system applies to vehicles of categories M<sub>1</sub>.

2.2. Definitions

2.2.1. “*Transition demand*” is a logical and intuitive procedure to transfer the dynamic driving task from automated control by the system to human driver control. This request given from the system to the human driver indicates the transition phase.

2.2.2. “*Transition phase*” means the duration of the transition demand.

2.2.3. “*Planned event*” is a situation which is known in advance, e.g. at the time of activation such as a journey point (e.g. exit of a highway) etc. and which requires a transition demand.

2.2.4. “*Unplanned event*” is a situation which is unknown in advance, but assumed as very likely in happening, e.g. [road construction, inclement weather, approaching emergency vehicle [KATRI2], missing lane marking, load falling from truck (collision)] and which requires a transition demand.

2.2.5. “*Imminent collision risk*” describes a situation or an event which leads to a collision of the vehicle with another road user or an obstacle unless an emergency manoeuvre is executed.

- 2.2.6. "Minimum risk manoeuvre" means a procedure aimed at minimising risks in traffic, which is automatically performed by the system after a transition demand.
- 2.2.7. "Emergency Manoeuvre" is a manoeuvre performed by the system in case of a sudden unplanned event in which the vehicle is at imminent risk of a collision [and in case of insufficient lead time to transition the control back to the driver,] with the purpose of avoiding or mitigating a collision.
- 2.2.8. "Operational speed" is the maximum vehicle speed at which the system may be active [and shall be determined by the capability of the system's sensing technology].
- 2.2.9. "Detection range" of the sensing system is the distance at which the system can reliably recognise a target and generate an appropriate control signal.
- [2.2.10. "Operating range" shall be determined from the value of the verified detection range after taking account of the deterioration of components of the sensing system due to time and usage throughout the normal life of a vehicle.]
- [2.2.11. "Normal life" of a vehicle is understood to be [10] years or [160 000] kilometres.][SR(3)]
- [2.2.12. A "severe ALKS failure" is a failure specific to the operation of the ALKS that affects the safe operation of the system with an acceptable occurrence or when accompanied by another influence affecting the safe operation of the system, e.g. unsuitable environmental conditions, a second failure of the ALKS or of another component in the vehicle.]
- The occurrence of a severe ALKS failure is deemed acceptable if it is comparable to similar failures in other well-established and well trusted safety systems (e.g. braking or steering systems).
- [2.2.13. A "severe vehicle failure" is any failure in the vehicle (e.g. electrical, mechanical) that affects the dynamic driving task [and would also leave the manually driven vehicle in a state unfit to drive] (e.g. loss of power supply, failure of the braking system, sudden loss of tire pressure).]
- 2.2.14. A "system override" by the driver means a situation when the driver provides an input to a control which has priority over the longitudinal or lateral control of the system, while the system is still active.
- [2.2.15. The "Dynamic Driving task" means the control of all longitudinal and lateral movements of the vehicle.]

Alternative German proposal covering also 2.2.8

- 2.2.x Speeds
- 2.2.x.1 "Specified maximum speed" is the speed declared by the manufacturer up to which the system operates under optimum conditions ( $v_{smax}$ ).
- 2.2.x.2 "Maximum operational speed" is the speed selected by the system up to which the system operates under current environmental and sensor conditions ( $v_{now\_max}$ ). It is the maximum vehicle speed at which the system may be active and shall be determined by the capability of the sensing system.
- 2.2.x.3 "Set speed" is the speed selected by the driver for the active ALKS system, which defines an upper limit for  $v_{now}$  ( $v_{set}$ ). [KATRI4]

2.2.x.4 “Present speed” is the current speed selected by the system due to traffic ( $V_{now}$ ).

### 2.3. General Requirements [KT(5)]

2.3.1 The system shall have the capability to detect failures affecting the safe operation or the functionality of the ALKS and/or implement safe strategies until the detection is completed.

2.3.2. [SR(6)] The activated system shall cope with all dynamic driving tasks and with any situation or shall otherwise transition the control back to the driver offering sufficient lead time.

Any type of situation in which the vehicle will generate a transition demand to the driver shall be declared by the vehicle manufacturer and explained by documentation shall be provided together with the documentation package required in Annex [X] [CEL].

[2.3.3. The activated system shall comply with all applicable traffic rules [KATRI7] in the country of operation.]

### 2.4. Activation, Deactivation and Driver Input

2.4.1. The vehicle shall be equipped with a means for the driver to activate (active mode) and deactivate (off mode) the system.

2.4.2. The default status of the system shall be the off mode at the initiation of each new engine start/run cycle. This requirement does not apply when a new engine start/run cycle is performed automatically, e.g. by the operation of a stop/start system.

2.4.3. The system shall become active only upon a deliberate action by the driver.

Activation of the system shall only be possible if [KATRI8]:

- The driver is in the driver seat and his seatbelt is fastened,
- the driver is detected to be available to take over control of the driving task on request,
- the system has ensured that no failure affecting the safe operation or the functionality of the ALKS is present
- the [actual] environmental and infrastructural conditions allow the operation and
- the vehicle is on roads where pedestrians and cyclists are prohibited and which, by design, are equipped with a physical separation that divides the traffic moving in opposite directions.
- [after ignition on the system has at least once detected an object at the same or a higher distance than that declared as detection range according to paragraph 2.5.6.2. [SR(9)]

### 2.4.4. Manual Deactivation

It shall be possible to manually deactivate (off-mode) the system by a deliberate action of the driver using the same means as to activate per paragraph 2.4.1..

The system shall provide protection against unintentional manual deactivation. A manual deactivation by the driver is deemed intentional either if it requires a single action exceeding a certain threshold for a reasonable amount of time or if it requires two independent actions.

#### 2.4.5. Automatic Deactivation

The system shall be deactivated automatically when at least one of the following conditions is met.

- The driver maintains the vehicle in standstill for at least [1] s by any braking system.
- The driver overrides the system by steering and this override is not suppressed, as specified in paragraph 2.4.8.
- The driver is holding the steering control and overrides the system by braking or accelerating, as specified in paragraph of 2.4.8.

[In case of an on-going transition demand, the system [shall/may] be deactivated automatically once the driver has responded to the transition demand by taking hold and then continue to hold the steering control for at least [1]s[KATRI10].]

The system shall not be automatically deactivated as long as none of the conditions above in this paragraph is met. [KATRI11]

#### 2.4.6. Following a deactivation, the driver may only be supported in his driving task by any driver assistance function which was active at the time of the activation of the ALKS or which was activated during the operation of the ALKS, [except such driver assistance functions which allow the driver make his/her hands be off from the steering control, or his/her foot be off from both the accelerator control and the braking control].

[The manufacturer shall provide evidence that suitable information is provided to the driver to ensure mode awareness when changing from ALKS to assisted driving mode.]

[Any longitudinal control that will be active after the deactivation of the ALKS shall not exceed upon [automatic] activation the speed limit valid at the time of deactivation of the ALKS.]

#### ALTERNATIVE from Germany for paragraph 2.4.6

When deactivated (off mode) the system shall not provide any continuous control of either longitudinal or lateral movement of the vehicle.

After deactivation, CSF may be active with the aim at accustoming the driver to execute the lateral control task by gradually reducing lateral support.

Notwithstanding both paragraphs above, any other safety system delivering longitudinal or lateral support [in accident-prone situations like e.g. AEBS, EVSC, ESC, BAS, ESF] shall not be deactivated in case of deactivation of ALKS.

#### 2.4.7. An automatic deactivation shall be indicated to the driver by an optical and an acoustic signal. The acoustic signal is not required when the deactivation occurs following a transition demand which contains an acoustic signal.

#### 2.4.8. System override

- [2.4.8.1. A driver input to the steering control shall override the lateral control function of the system when the input exceeds a reasonable threshold (e.g. based on force and duration) designed to prevent unintentional override.
- This threshold including a possible variation depending on parameters like speed, gaze direction of the driver, or a second deliberate action (e.g. the use of the turn indicator accompanying the steering input) and the rationale for the variation shall be provided to the Technical Service during the assessment according to Annex X (CEL). ]
- 2.4.8.2. A driver input to the braking control resulting in a higher deceleration than that induced by the system shall override the longitudinal control function of the system[KATRI12].
- 2.4.8.3. A driver input to the accelerator control may override the longitudinal control function of the system. However, such an input shall not cause the system to no longer meet the requirements of this regulation[KATRI13], unless the driver is holding the steering control [, or the input exceeds [90]% of the maximum accelerator input for more than [1]s (e.g. kick-down)].
- [2.4.8.4. Notwithstanding the provisions laid down in paragraphs 2.4.8.1. to 2.4.8.3., the effect of the driver input on any control may be reduced or suppressed by the system in case the system has detected the risk of a collision due to this driver input.]
- [2.4.8.5. Notwithstanding the provisions laid down in paragraphs 2.4.8.1. to 2.4.8.3., the driver input may permanently be ignored by the system if the system by design can cope with all dynamic driving tasks by continuing the operation.]
- 2.4.8.6. Any system override due to driver input to the accelerator or brake control shall immediately initiate a transition demand as specified in paragraph 2.7.
- [2.4.9. SR(14) It is recognized that in case of a severe vehicle failure or a severe ALKS failure the ALKS may employ different strategies with regard to deactivation and override. These different strategies shall be declared by the manufacturer and their efficiency with regard to ensuring a safe transition of control back to the driver shall be assessed by the Technical Service.]
- 2.4.10. The fulfilment of the provisions in paragraph 2.4 and its subparagraphs shall be demonstrated by the manufacturer to the technical service during the inspection of the safety approach as part of the assessment to Annex X [CEL].

## 2.5. Dynamic Driving Task, and Sensing Capabilities

- 2.5.1. The activated system shall keep the vehicle inside its lane of travel and ensure that the vehicle does not cross any 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.
- [2.5.2]SR(15). The activated system shall detect a vehicle driving beside[KATRI16] and if necessary adjust speed and/or the lateral position of the vehicle within its lane as appropriate.]
- 2.5.3. The activated system shall control the longitudinal speed of the vehicle.
- 2.5.3.1. The activated system shall adapt the vehicle speed to infrastructural and environmental conditions (e.g. narrow curve radii, inclement weather).

2.5.3.2[SR(17)] The activated system shall detect the distance to another road user in front located within the operating range as defined in paragraph 2.5.6.2..

While the ALKS vehicle is not at standstill, the system shall adapt the speed to adjust the distance to a vehicle in front in the same lane to be equal or greater than the minimum following distance.

In case of a lead vehicle decelerating or cutting in, there shall not be an appreciable time interval between the detection of a following distance below the required minimum distance and the start of the adjustment process.

The minimum following distance shall be calculated using the formula:

$$d_{\min} = v_{\text{ALKS}} * t_{\text{front}}$$

Where:

- $d_{\min}$  = the minimum following distance
- $v_{\text{ALKS}}$  = the actual speed of the ALKS vehicle in [m/s];
- $t_{\text{front}}$  = minimum time gap in seconds between the ALKS vehicle and the a leading vehicle in front as per the table [SR(18)] below:

Actual travel speed of the ALKS vehicle is greater than ...		Minimum time gap in seconds
km/h	m/s	[s]
0	0	[1,0]
10	2,78	[1,1]
20	5,56	[1,2]
30	8,33	[1,3]
40	11,11	[1,4]
50	13,89	[1,5]
60	16,67	[1,6]
[70]	[19,44]	[1,7]
[80]	[22,22]	[1,8]
[90]	[25,00]	[1,9]
[100]	[27,78]	[2,0]

<Korean text> [KATRI19]

$$d_{\min} = \max(\min(v_{\text{ALKS}} * t_{\text{front1}}, v_{\text{ALKS}} * t_{\text{front2}}), 2)$$

Where:

- $d_{\min}$  = the minimum following distance
- $v_{\text{ALKS}}$  = the actual speed of the ALKS vehicle in [m/s];
- $t_{\text{front1}}$  = minimum time gap in seconds between the ALKS vehicle and a leading vehicle in front =  $0.2 + \frac{2.9 * v_{\text{ALKS}}}{36.1}$
- $t_{\text{front2}}$  = minimum time gap of 2 seconds between the ALKS vehicle and a leading vehicle in front

Notwithstanding the result of the formula above for actual speeds below 24m/s the minimum following distance shall never be less than 2 m.

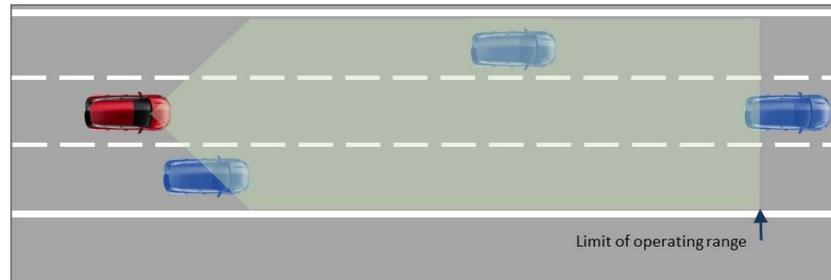
2.5.4. The activated system shall be able to bring the vehicle to a complete stop behind a stationary vehicle blocking its lane of travel. This shall be ensured

up to the maximum operational speed of the system, as defined in paragraph 2.5.7.

2.5.5. The activated system shall detect the risk of an imminent collision e.g. [with another road user ahead or beside the vehicle,] due to a decelerating lead vehicle, a cutting in vehicle or a suddenly appearing obstacle after a lane change of a leading vehicle and shall automatically perform an appropriate emergency manoeuvre as specified in paragraph 2.10.

2.5.6. Sensing system

The ALKS vehicle shall be equipped with a sensing system such that it can determine the driving environment (e.g. road geometry ahead, lane markings) and the traffic dynamics across its own traffic lane, the traffic lane immediately to its left and to its right up to the limit of the operating range.



Schematics of the Sensing System of the ALKS [KATRI20]

2.5.6.1 Detection range of the sensing system to the front [SR(21)] [KATRI22]

The detection range of the sensing system shall be declared by the vehicle manufacturer and shall be at least [46] [SR(23)] meters measured from the most forward point of the ALKS vehicle.

The Technical Service shall verify the distance at which the vehicle sensing system detects a leading vehicle during the relevant test in Par x.x.x in Annex [X], [using a two-wheeled motor vehicle of category L3 as the vehicle in front].

The measured value shall be equal to or higher than the declared value.

2.5.6.2. [SR(24)] The ALKS shall implement strategies to detect and cope with environmental conditions which might reduce the detection range of the sensing system, e.g. prevent enabling the system, disabling the system and transferring the control back to the driver, reducing the speed when visibility is too low.

These strategies shall be described by the vehicle manufacturer and assessed according to the Annex X (CEL).

2.5.6.3. The vehicle manufacturer shall provide evidence (e.g. test reports) that the effect of wear/ageing does not reduce the performance of the sensing system below the minimum required value specified in paragraph 2.5.6.1. over the lifetime of the system/vehicle.

2.5.7 Maximum Operational Speed

The maximum speed up to which the system is permitted to operate is 60 km/h.

**Formula approach as ALTERNATIVE [KATRI25]**

The maximum speed up to which the system is permitted to operate shall be calculated with the formula below:

$$V_{max-ALKS} = -a_{ALKS} * t_{system} + \sqrt{(a_{ALKS} * t_{system})^2 + 2a_{ALKS} * D_{range}}$$

Where:

$V_{max-ALKS}$  = Maximum operational speed of the system

$a_{ALKS}$  = ~~3,7 [KATRI26]~~ 8,4 m/s<sup>2</sup> = feasible deceleration under wet conditions <sup>1</sup>

$t_{system}$  = System delay of ~~0,5~~ 0,3 s until deceleration level is reached

$D_{range}$  = Detection range [m] determined according to paragraph 2.5.6.1.

The manufacturer shall declare the speed up to which the system will operate. This declared speed shall be less or equal to the value calculated by the formula above.

Notwithstanding the result of the formula above the maximum operational speed the manufacturer might declare is limited to ~~60~~ km/h.

**ALTERNATIVE from GERMANY**

**2.5.7. Speeds**

The specified maximum speed shall not be higher than 60 km/h.

The maximum operational speed shall not exceed the maximum specified speed.

The set speed shall not exceed the maximum operational speed.

The present speed shall not exceed the maximum operational speed and shall not contradict traffic law.

**2.5.8**

The fulfilment of the provisions of paragraph 2.5. and its subparagraphs shall be demonstrated to the technical service and tested according to the relevant tests in Annex [X].

**2.6. Driver Availability Recognition System**

**The system shall comprise a driver availability recognition system.**

<sup>1</sup>Unless a higher value is declared by the manufacturer and verified during type approval to the satisfaction of and in agreement with the technical service.

The driver availability recognition system shall detect that the driver is present in the driver seat, the safety belt of the driver is fastened and that the driver is available to take over the driving task.

2.6.1. Driver not present in the driver seat

[Whenever the driver is not present in the driver seat [SR(27)] or the safety belt of the driver is not fastened while the ALKS is active [and the vehicle is not at standstill], the system shall provide a distinctive acoustic warning. For this purpose a given audible signal of the second level warning of the safety-belt reminder according to UN-R16 is deemed to be sufficient.]

A transition demand shall be initiated according to paragraph 2.7. if one of the following conditions is met:

- When the driver is detected not to be in the seat for a period of more than [1] second or
- When the driver's safety belt is unbuckled [while the vehicle is not at standstill].

The second level warning of the safety-belt reminder according to UN-R16 may be used instead of an acoustic warning of the Transition Demand.

Homework to the US: rework 2.6.2.

2.6.2. Driver availability

The system shall detect if the driver is available to take over the driving task by continuously monitoring the driver. The manufacturer shall declare to the technical service the vehicle's capability to detect that the driver is available to take over the driving task.

2.6.2.1 Criteria for deeming Driver availability [KATRI28]

The driver shall be considered available by the system when:

The driver is present in the driving seat with safety belt fastened, and at least one of the following conditions are met:

- Input to any driver-exclusive vehicle controls during the last [180]s
- [Driver has blinked at least [3 4] times during the last [60]s]

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- Driver shows conscious head or body movements during the last [30 35]s
- Driver has been talking during the last [30]s

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- The driver did not have his eyes continuously closed for the last [30 4]s

Latest when the driver does not show any signs of the above activities, but as soon as the system has detected the driver to no longer be available, the system shall provide a distinctive acoustic [KATRI29] warning until appropriate actions of the driver are detected or until a transition demand is initiated.

Latest when the system does not detect appropriate actions from the driver during the a distinctive acoustic [KATRI30] warning for a period of more than [15]s a transition demand shall be initiated according to paragraph 2.7.

## 2.7. Transition Demand and System Operation during Transition

2.7.1. The activated system shall recognise situations in which it needs to transition the control back to the driver.

2.7.2. The timing of the transition demand shall be such that sufficient time is provided for a safe transition to manual driving.

2.7.2.1. In case of a planned event, a transition demand shall be given latest [15] seconds before the event occurs.

2.7.2.2. In case of an unplanned event, a transition demand shall be given upon detection.

2.7.2.3. In case of any failure of the system or of any function needed for the operation, the system shall immediately initiate a transition demand upon detection.

2.7.3. During the transition phase the system shall continue to operate. The system may reduce the speed of the vehicle to ensure its safe operation but shall not bring it to standstill unless required by the situation (e.g. due to vehicles or obstacles obstructing the path of the vehicle).

Once in standstill the vehicle [may [KATRI31] / shall] remain in this condition and shall activate the hazard warning lights [if the driver has not deactivated the system] latest [5] s after the start of the transition demand.

2.7.4. A transition demand shall only be terminated once the system is deactivated or a minimum risk manoeuvre has started.

2.7.4.1. In case the driver is not responding to a transition demand by deactivating the system either manually as per paragraph 2.4.4. or automatically as per paragraph 2.4.5, a minimum risk manoeuvre shall be started automatically, earliest [10 s] after the start of the transition demand.

[2.7.4.1.1. Notwithstanding paragraph 2.7.4.1. a MRM may be initiated immediately in case of a severe vehicle failure. It is recognized that in case of a severe vehicle failure the ALKS may no longer be capable of fulfilling the requirements of this Regulation, but it shall aim at enabling a safe transition of control back to the driver.]

[2.7.4.1.2. Notwithstanding xxx a MRM may be initiated immediately in case of a severe ALKS failure.]

[2.7.4.1.3. The manufacturer shall declare the types of severe vehicle failures and severe ALKS failures that will lead the ALKS to initiate a MRM immediately.]

[2.7.5.]<sup>[SR(32)]</sup> The system shall be deactivated at the end of any transition phase, unless a minimum risk manoeuvre needs to be performed.

## 2.8. Information to the driver

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

- the system status “active” by at least an optical signal, [containing an unique indication [with a [green] steering wheel control][KATRI33] or a vehicle with an additional “A” or “AUTO”].],
- any failure of the system with at least an optical signal unless the system is manually deactivated (off mode),
- transition demand by at least an optical and in addition an acoustic and/or haptic warning signal. The warning shall be escalated latest [4]s after the initiation [and contain a haptic warning [when the vehicle is moving faster than [20]km/h]].
- minimum risk manoeuvre by an optical signal and either an acoustic or a haptic signal and
- emergency manoeuvre by an optical signal [and either an acoustic or a haptic signal].

ALTERNATIVE section from GERMANY to replace the first bullet point[KATRI34]:

2.8.1.1. System status

2.8.1.1.1 System unavailability indication

In case activation of the system following the deliberate action of the driver is denied by the system due to system unavailability, this shall be at least visually displayed to the driver.

2.8.1.1.2 System status display when activated

Upon activation the system status (active mode) shall be displayed continuously by an optical signal to the driver.

The optical signal shall be unambiguous and indicate the active system state until the system is deactivated (off mode).

The optical signal shall fulfill the following minimum requirements:

- dedicated colour displayed on the steering control covering at least [40] % of the outer rim perimeter facing towards the driver,
- adequate size (easily readable from permitted seating position),
- colors of indicators contrast adequately from background colour and conform to convention or stereotypes and
- commonly accepted or standardized symbols are used.

### 2.8.1.1.3 System status display when deactivated

Upon deactivation the system status (off mode) shall be indicated to the driver by at least an optical and acoustic signal.

The optical and acoustical signals shall meet the following minimum requirements:

- adequate size (easily readable from permitted seating position),
- colours of indicators contrast adequately from background colour and conform to convention or stereotypes,
- commonly accepted or standardized symbols are used and
- acoustic signal should raise attention (loud and clear).

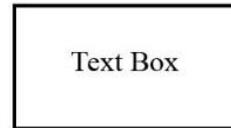
2.8.2. During the transition phase and the minimum risk manoeuvre, the system shall instruct the driver in an intuitive and unambiguous way to take over manual control of the vehicle. The instruction shall include a pictorial information showing hands and the steering control and may be accompanied by additional explanatory text or warning symbols, as shown in the example below.



Example 1.



Example 2.



[2.8.2.1. To visually emphasize and escalate the optical warning symbol a yellow steering control with moving hands shall be used during the transition phase.

2.8.2.2. With the start of the minimum risk manoeuvre, the given signal shall change its characteristics to a red flashing steering control with moving hands to emphasize the urgency of an action through the driver.] [KATRI35]

#### ALTERNATIVE

[With the start of the minimum risk manoeuvre, the given signal shall change its characteristics to emphasize the urgency of an action through the driver and at least the hands or the steering control shall be turned to red.]

2.8.3. The warnings of an ALKS during a transition phase, a Minimal Risk Manoeuvre or an Emergency Manoeuvre may be prioritized over other warnings in the vehicle [KATRI36].

The prioritization of different acoustic and optical warnings during the ALKS operation shall be declared by the manufacturer to the Technical Service during Type Approval.

- 2.9. Minimum Risk Manoeuvre (as risk mitigation strategy)
- 2.9.1. 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 a deceleration demand not greater than [4] 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 system failure. Additionally, the hazard warning lights shall be activated not later than [4] seconds after the start of the minimum risk manoeuvre or once the vehicle comes to standstill whichever is earlier.
- 2.9.2. The minimum risk manoeuvre shall bring the vehicle to standstill unless the system is deactivated during the manoeuvre.
- [2.9.3. In case the ALKS [is designed to / intends to] perform lane change manoeuvres during the MRM, including to the hard shoulder, this shall only be permitted if the situation is not critical. Such lane changes are deemed critical either if there is a risk of a collision with another vehicle in the target lane, or if an approaching vehicle in the target lane would have to decelerate at a higher level than 3m/s<sup>2</sup>, 0.4 seconds after the ALKS vehicle has crossed the lane marking, to ensure the distance between the two vehicles is never less than that which the ALKS vehicle travels in 1 second.]
- 2.9.4. A minimum risk manoeuvre shall only be terminated once the system is deactivated or the system has brought the vehicle to a standstill.
- 2.9.5. The system shall be deactivated at the end of any minimum risk manoeuvre.  
The hazard warning lights shall remain activated [unless deactivated manually] and the vehicle shall not move away after standstill without manual input. [KATRI37]
- 2.9.6. Reactivation of the system after the end of any minimum risk manoeuvre shall only be possible after each new engine start/run cycle, except when a new engine start/run cycle is performed automatically, e.g. by the operation of a stop/start system.

## 2.10. Emergency Manoeuvre (as collision mitigation strategy)

- 2.10.1. An emergency manoeuvre shall be carried out only in case of [an imminent collision risk / paragraph 2.5.5].
- 2.10.2. This manoeuvre shall decelerate the vehicle up to its full braking performance [KATRI38] if necessary and/or perform an automatic evasive manoeuvre, whichever is the most appropriate.  
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 confirming and has confirmed that no critical situation would result from this manoeuvre].  
The situation is deemed critical either if there is a risk of a collision with another vehicle in the evasive path, or if a vehicle approaching from the rear in the evasive lane with the allowed or advised maximum speed would be

forced to decelerate more than [4] m/s<sup>2</sup> in order to maintain a safety distance of [1]s to the ALKS vehicle once it has crossed the lane marking.

After the evasive manoeuvre the vehicle shall aim at resuming a stable position either in its original or the adjacent lane of travel.

The system shall demonstrate its capabilities to assess the criticality of an evasive manoeuvre crossing lane markings according to the relevant test in Annex X.]

2.10.3. An emergency manoeuvre shall only be terminated as soon as the collision risk disappeared [or in case of a system override by the driver].

2.10.3.1 After an Emergency Manoeuvre [KATRI39] the system shall [continue to operate/initiate a transition demand][KATRI40].

2.10.3.2 Once the Emergency Manoeuvre has led the vehicle to standstill, the hazard warning lights shall be activated unless the ALKS will drive-off without a manual input. In case the vehicle will not drive-off without manual input [a transition demand shall be initiated / an appropriate information shall be given to the driver].

[2.10.4. The vehicle shall implement a logic signal indicating emergency braking as specified in UN R13H [or UN R13 as appropriate].]

2.11. System information data

2.11.1. The following data shall be provided, together with the documentation package required in Annex [X] of this UN Regulation, to the Technical Service at the time of type approval.

2.11.2. A list of situations in which the vehicle may generate a transition demand to the driver.

2.11.3. Information about how the system detects that the driver is available to take over the control.

2.11.4. The means to monitor the driving environment.

2.11.5. The means to activate, override or deactivate the system (as relevant) including the strategy how the system is protected against unintentional deactivation, the threshold values for a steering override [and how the system assesses that the driver has directed his gaze to the driving task].

2.11.6. Information about how the failure warning signal status and the confirmation of the valid software version related system performance can be checked via the use of an electronic communication interface.\*

\* This paragraph shall be reviewed once the Task Force on Cyber Security and Over the Air issues (TF CS/OTA) reporting to the World Forum for the Harmonization of Vehicle Regulations (WP.29) Informal Working Group on Intelligent Transport Systems / Automated Driving has finalized its work on measures for software identification and, if necessary, amended accordingly.

2.11.7. Description of the types of severe vehicle failures and severe ALKS failures that will lead the ALKS to initiate a MRM immediately.

~~2.11.8[SR(41)] Information on the sensor range over lifetime. The sensor range shall be specified in such way that any influence on deterioration of the sensor shall not affect the fulfilment of paragraphs 2.5.6. and 2.5.10. of this Annex.~~

2.11.8. For driving situations not covered by the tests of Annex [X], the safe operation of the system shall be demonstrated by the vehicle manufacturer on the base of Annex X of this Regulation.

2.11.9. Installation

The manufacturer shall provide information regarding the installation options that will be employed for the individual components that comprise the sensing system. These options shall include, but are not limited to, the location of the component in/on the vehicle, the material(s) surrounding the component, the dimensioning and geometry of the material surrounding the component, and the surface finish of the materials surrounding the component, once installed in the vehicle. The information shall also include installation specifications that are critical to the system's performance, e.g. tolerances on installation angle.

Changes to the individual components of the sensing system, or the installation options, shall be notified to the Type Approval Authority and be subject to further assessment.

2.11.10. The system behaviour during a MRM.

\*\*\* TESTS \*\*\*

The width of a traffic lane shall be considered to be 3.65m.

Lane Keeping Functionality Test:

- approach curve with narrow (minimum) radius with the maximum operational speed
- swerving test: stable lateral position in straight lane
- driver availability test: detecting that the driver is not available to take-over the control

Following Distance Test:

- approach a slower lead vehicle which is on constant speed
- follow a leading vehicle which starts slightly decelerating

Blocked Lane Test:

- approach a stationary target in the lane of travel with the maximum operational speed

Deceleration Tests

- Lead vehicle performs an emergency braking
- Cutting in vehicle
- Deceleration during minimal risk manoeuvre is below [4m/s<sup>2</sup>]
- Maximum deceleration during emergency manoeuvre (inclusive full braking performance manually by the driver as a reference)

Maximum Operational Speed Test

- Sensor performance test
- Maximum speed test (with and without leading vehicle)

DETAILS TO BE DEFINED ONCE THE REQUIREMENTS ARE  
AGREED