

## Annex X

## Test Specifications for Automated Lane Keeping Systems (ALKS)

### 1. General

This annex defines tests with the purpose to verify the technical requirements on Automated Lane Keeping Systems (ALKS).

Pass- and Fail-Criteria for tests are derived solely from the technical requirements in section 2 of the regulation. These requirements are worded in a way that they allow the derivation of pass-fail-criteria not only for a given set of test parameters, but for any combination of parameters in which the system is designed to work (e.g. operating speed range, operating lateral acceleration range, curvature range as contained in the operational design domain).

The test specifications in this document are meant to be a minimum set of tests, the technical service authorities may perform any other test within the operational design domain and may then compare the measured results against the requirements (concrete: expected test outcome).

The process for a technical service to perform approval tests shall fulfill the following points :

- Imposed scenarios : each scenario of the current annex shall be tested
- Imposed parameters sets : for each scenario of the previous point and for each target (if applicable), a minimum of two parameter sets in accordance with the specified parameters and corresponding to each intended situation (regular maneuver, emergency maneuver, not avoidable) shall be tested (if applicable).
- Random scenarios and parameters : in addition to the previous point, a minimum of [10] additional tests shall be performed with different parameters sets or scenarios not already covered in this annex.
- Critical scenarios and parameters : included into the minimum of [10] tests from the previous random scenarios and parameters, the technical service can define specific scenarios or parameters tests in order to adapt it to the dedicated system to be approved.

While all defined test cases can be conducted with state of the art equipment such as surrogate targets and moving platforms, some extreme test parameters might require the use of real vehicles (preferably in a driverless test setup to not endanger the staff carrying out the tests).

### 2. Definitions

For the purposes of this annex,

- 2.1. "Time to Collision" (TTC) : means the value of time obtained by dividing the longitudinal distance (in the direction of travel of the subject vehicle) between the subject vehicle and the target by the longitudinal relative speed of the subject vehicle and the target, at any instant in time

**Kommentiert [NMR1]:** To allow regular maneuver test in real world environment?

**Kommentiert [児島亨2]:** The purpose of Annex X is to define the minimum sets of test necessary to confirm the compliance with the technical requirements. Since technologies adopted for ALKS, e.g. installed sensors would differ from system to system, the appropriate scenario and the number of tests depends on each system and those should be defined and agreed between technical service and manufacturer.

**Kommentiert [N3]:** Necessity of the new definitions shall be discussed along with the test methods. If confirmed necessary, they should be introduced in the definition section in the Regulation, not in this annex.

- 2.2. “Offset” means the distance between the vehicle’s and the respective target’s longitudinal median plane in driving direction, measured on the ground, normalized by the half the vehicle width excluding devices for indirect vision and corrected by adding 50 %.
- 2.3. “Pedestrian Target” : means a soft target that represents a pedestrian
- 2.4. “Vehicle Target” : means a target that represents a vehicle
- 2.6. “Powered Two-Wheeler Target” : means a combination of a motorcycle and motorcyclist, a test device according to ISO [CD] 19206-5. The reference point for the location of the motorcycle shall be the most backward point on the centreline of the motorcycle
- 2.7. “ $v_{max}$ ” The maximum speed the automated lane keeping system is able to operate with.
- 2.8. “Road user” is any vehicle including Two-Wheelers which are permitted to use the road the ALKS is able to operate on.

### 3. Test Area

- 3.1. ~~Testing conditions. Except otherwise noted, all tests shall be carried out on a road that is recognized and classified as an authorised road by the ALKS.~~
  - 3.1.1. ~~The test shall be performed on a flat, dry concrete or asphalt surface affording good adhesion.~~
    - 3.1.1.1. ~~The road test surface shall have a nominal<sup>1</sup> peak braking coefficient (PBC) of 0.9, unless otherwise specified, when measured using either:~~
      - 3.1.1.2. ~~The American Society for Testing and Materials (ASTM) E1136 standard reference test tyre, in accordance with ASTM Method E1337-90, at a speed of 40 mph; or~~
      - 3.1.1.3. ~~The k-test method specified in Appendix 2 to Annex 6 of Regulation No. 13-H.~~
      - 3.1.1.4. ~~The test surface has a consistent slope between level and 1 per cent.~~
    - 3.1.2. ~~The ambient temperature shall be between 0°C and 45°C.~~
    - 3.1.3. ~~The horizontal visibility range shall allow the target to be observed throughout the test.~~
    - 3.1.4. ~~The tests shall be performed when there is no wind liable to affect the results.~~
  - 3.2. ~~Except otherwise noted, tests should be carried out on a clearly marked lane that conforms to the requirements from section XXX and the operational design domain of the vehicle. In the case of lane positioning tests in section X, X, X, the marked lane shall have a width of no less than 3.5 m between the lane markings.~~
  - 3.3. ~~Except otherwise noted, the test surface may shall provide a friction that is not lower than the friction of paragraph 3.1.1, which is specified in the operational design domain.~~

Kommentiert [N4]: As for the test road condition, it seems sufficient to simply specify typical conditions, i.e. 'a flat, dry asphalt or concrete surface affording good adhesion'.

<sup>1</sup> The "nominal" value is understood as being the theoretical target value.

- 3.4. The lane shall have a sufficient long straight section (~~curvature 0-1/m~~) and a curved section with a curvature not higher than the curvature specified ~~by manufacturer in the operational design domain~~.

[4. Functional Tests

The functional ~~or dysfunctional~~ requirements must be tested by the technical service.

The verifications can be done by simple observations (test ok or not ok), or by test with measurements or specific tests that need to be explained or described as indicated in the following board.

**Kommentiert [見島亨5]:** It is considered that this word is not suitable for UN regulation. "Functional" already covers dysfunctional modes in UN regulation.

Topic	Simple tests	Measurement tests	Tests to be defined in annex [X]	Remarks
Dedicated means to activate and deactivate	2.4.1			
Default status of new engine start/run	2.4.2			
System active if driver is in driver seat & belt is fastened	2.4.3a			
System active if driver is available		2.4.3b		see 2.6.0
System active if no failure	2.4.3c			see 2.12.1 Telltale?
System active if DSSAD is operational	2.4.3d			
System active if environment and infrastructure OK			2.4.3e	
System active if vehicle is on a right road			2.4.3f	
Same dedicated means to activate and deactivate manually	2.4.4a			
Means of desactivating protected against unintentional action	2.4.4b			See 2.11.5 and [CEL]

**Kommentiert [N6]:** Criteria for driver availability vary depending on the manufacturer; possible to confirm by simple tests.

**Kommentiert [N7]:** 'Environment and infrastructure' condition vary depending on the manufacturer; assessment under CEL is adequate.

**Kommentiert [N8]:** Simple tests on test track is difficult; assessment under CEL is adequate.

At time of deactivation driver must be in lateral control	2.4.4c			See 2.11.5 and [CEL]
Desactivation by input to driving controls <del>(2.4.5.1)</del>	<del>2.4.5.1</del>			See 2.4.8
Desactivation during an ongoing transition demand	2.4.5.2			See 2.4.8 & 2.6.3
Desactivation during an ongoing emergency manoeuvre			2.4.5.3 tbi in 2.10.1	[CEL]
Desactivation in case of severe failure	2.4.5.4			[CEL]
<u>At time of deactivation the system shall not provide any continuous control of either longitudinal or lateral movement of the vehicle</u>	2.4.6.			
<u>Indication of any deactivation</u>	2.4.7.			see 2.8.2.3.
<u>Override by a driver input to the steering control</u>	2.4.8.1.			
<u>Override by a driver input to the braking control</u>	2.4.8.2.			[CEL]
<u>Override by a driver input to the accelerator control</u>	2.4.8.3.			
<u>Initiation of a transition demand by any driver input to the accelerator or brake control</u>	2.4.8.4.			
<u>Reduction or suppression of the effect of the driver input on any control in case the system has detected an imminent collision</u>				2.4.8.5. [CEL]
<u>ALKS control strategies in case of a severe vehicle failure or a severe ALKS failure</u>				2.4.8.6. [CEL]
	2.5.1. 2.5.2. 2.5.3.			
<u>Dynamic driving task of ALKS</u>				
<u>Adaptation of the vehicle speed to infrastructural and environmental conditions</u>				2.5.3.1. [CEL]
<u>Minimum following distance</u>		2.5.3.2.	2.5.3.2.	
<u>Capability of bring the vehicle to a complete stop behind a stationary vehicle.</u>		2.5.4.	2.5.4.	
			2.5.5.	
<u>Emergency manoeuver after detection of imminent collision</u>			Tested in 2.10	
<u>Detection range of the sensing system to the front</u>		2.5.6.1.	2.5.6.1.	[CEL]
<u>Strategies to detect and cope with environmental and technical conditions which might reduce the detection range of the sensing system</u>				2.5.6.2. [CEL]
<u>Evidence that the effects of wear and ageing do 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.</u>				2.5.6.3. [CEL]
<u>Design strategies in case of a single perception malfunction without failure</u>				2.5.8. [CEL]
<u>Driver presence</u>			2.6.1.	
<u>Criteria for deeming driver availability</u>		2.6.2.1.	2.6.2.1.	
				2.6.3. [CEL]
<u>Driver attentiveness</u>				
<u>Transition demand in case of a planned event</u>		2.7.2.1.	2.7.2.1.	
<u>Transition demand in case of a unplanned event</u>		2.7.2.2.	2.7.2.2.	
<u>Transition demand in case of any failure of the system or of any function needed for the operation</u>			2.7.2.3.	
			2.7.3.	
<u>Continuous operation of ALKS during transition phase</u>			Checked with	

Kommentiert [N9]: Simple tests on test track is difficult; assessment under CEL is adequate.

Kommentiert [N10]: assessment under CEL is adequate

Kommentiert [N11]: assessment under CEL is adequate

			<a href="#">2.7.2.1. or 2.7.2.2.</a>		
<a href="#">Activation of the hazard warning lights after standstill</a>		<a href="#">2.7.3.1.</a>	<a href="#">2.7.3.1.</a>		
		<a href="#">2.7.3.2.</a>	<a href="#">2.7.3.2.</a>		
<a href="#">Escalation after the start of the transition demand</a>		<a href="#">Test in 2.7.2.1 or 2.7.2.2 or 2.7.2.3</a>	<a href="#">Test in 2.7.2.1 or 2.7.2.2 or 2.7.2.3</a>		
<a href="#">Termination of transition demand by ALKS deactivation or MRM initiation</a>		<a href="#">2.7.4.</a>	<a href="#">2.7.4.</a>		
<a href="#">Minimum Risk Manoeuvre operation in case the driver is not responding to a transition demand by deactivating the system</a>		<a href="#">2.7.4.1.</a>	<a href="#">2.7.4.1.</a>		
<a href="#">Minimum risk manoeuvre operation in case of a severe ALKS or severe vehicle failure.</a>				<a href="#">2.7.4.2.</a>	
				<a href="#">[CEL]</a>	
<a href="#">Information to the driver</a>		<a href="#">2.8.1.</a>	<a href="#">2.8.1.</a>		
<a href="#">Minimum risk manoeuvre</a>		<a href="#">2.9.1.</a>	<a href="#">2.9.1.</a>		
	<a href="#">2.9.4.</a>				
		<a href="#">2.10.1.</a>			
		<a href="#">2.10.3.1.</a>			
<a href="#">Emergency manoeuvre</a>		<a href="#">2.10.3.2.</a>			

~~4.1. The system shall be active only after a deliberate action by the driver.~~

**Kommentiert [児島亨12]:** This part is not necessary because observation check is applied.

~~[2.4.3.b] The driver is detected to ready to take over control on request,~~

- ~~• Pass/Fail criteria: OK/NOK if driver's eyes have been detected continuously closed for a rolling interval of 4 s, no input to any driver-exclusive vehicle controls during a rolling interval of 30 s, no conscious head or body movements of the driver during a rolling interval of 35 s.~~

~~all functions needed for the operation are working properly~~

- ~~• Pass/Fail criteria: OK/NOK if one sensor is (partly) covered?~~

~~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.~~

~~The tests shall be done at least on two different roads; one where ALKS is authorized and one where ALKS is forbidden (for example roads with no physical separations, or roads with physical separation but where cyclists are not prohibited).~~

~~XXX~~

**Kommentiert [児島亨13]:** The manufacturer shall demonstrate to the Technical Service how to assess the driver availability together with appropriate criteria according to the requirements in ACSF-25-03. Thus, these specified test cannot be applied to all cases. Alternative tests for driver availability in line with the requirements are proposed at the bottom of this document.

#### 5. Tests for the dynamic driving function

The tests specified in this section are meant to be the minimum set of tests required for type approval. If this is deemed justified, the technical service or the relevant authorities may perform additional tests with other parameters as

long as the parameters are included in the operational design domain of the vehicle, except where it is clearly noted.

~~Pass fail criteria for these additional tests shall be calculated using the performance requirements in the referenced paragraphs. This also includes performing tests at different environmental or friction conditions that are contained in the operational design domain.~~

~~The manufacturer shall demonstrate through appropriate documentation that these conditions are fulfilled throughout the ALKS operation range and all ODD. This may be achieved on the basis of appropriate documentation appended to the test report.~~

Kommentiert [児島亨14]: This part should be covered by Annex CEL.

Kommentiert [児島亨15]: This part should be covered by Annex CEL.

5.1. Overriding test

The vehicle shall be driven in a curved lane or a straight lane at the constant speed  $v_{max}$  ~~with the aim to approach the maximum lateral acceleration as selected specified by the technical service manufacturer~~ with the automated lane keeping function activated and the vehicle driver having the hands and feet off the vehicle controls.

Kommentiert [NMR16]: Why overriding of acceleration/deceleration is not considered?

Kommentiert [児島亨17]: Currently, there is no requirement regarding maximum lateral acceleration, because ALKS shall have the capability of lane keeping including curved roads. If the maximum value is added, the appropriate value should be discussed with reasonable justification.

The driver shall then apply a force on the concerned driving control(s) (steering, accelerator and/or parking depending on the system definition) to override the automated lane keeping function and leave the lane. The force applied by the driver on the driving control, synchronized to the status of the automated lane keeping function, shall be recorded.

The Each overriding test is passed if the requirements from paragraph 2.4.8.1., 2.4.8.2., 2.4.8.3., 2.4.8.4. above are fulfilled.

5.2. Lane keeping functionality tests

5.2.1. Lane keeping and stability test

The vehicle shall be driven in a lane at the constant speed selected by technical service including  $v_{max}$  with the automated lane keeping function activated and the vehicle driver having the hands and feet off the vehicle controls for an appropriate time agreed between technical service and manufacturer of not less than [5] minutes. ~~The lane shall have curved and straight sections with the aim to approach the maximum lateral acceleration of the automated lane keeping function.~~

The test is passed if the vehicle's lane position fulfils the requirements of paragraph 2.5.1. above, ~~especially if no parts of the vehicle, including its devices for indirect vision, pass the outside edge of the lane markings, and if no noticeable oscillation of the lateral position is present. [This can be determined e.g. by checking if a dedicated peak in the frequency range from [0.1] to [5] Hz for any given window of [10] seconds of the power spectral density diagram of the lateral position or lateral acceleration is observed.]~~

Another vehicle shall be driven beside the ego-vehicle at the constant speed same as the speed of the ego-vehicle and shall be approached to ego-vehicle within its lane.

The test is passed if the vehicle's speed and/or lane position fulfils the requirement of paragraph 2.5.2..

Kommentiert [児島亨18]: Currently, there is no requirement regarding noticeable oscillation, because ALKS shall have the capability of lane keeping without any confusion of other road users. If the requirement of oscillation is added, the appropriate test method and parameters should be discussed with appropriate justification.

~~5.2.2. Test for object avoidance in the lane~~

~~An object with a size small enough for the vehicle to pass without leaving the lane but large enough to assume damage to the vehicle shall be positioned in the lane, such as an object of a size of [118 x 78 x 80 cm].~~

~~The vehicle shall be driven in a lane at the constant speed  $v_{max}$  with the automated lane keeping function activated and the vehicle driver having the hands and feet off the vehicle controls, towards the object. There shall be no other vehicles in adjacent lanes.~~

~~The test is passed if the requirements from paragraph 2.5.1., 2.5.2. and 2.5.5.1. are fulfilled, especially if no collision between vehicle and object occurs.~~

~~The test shall be carried out on straight as well as curved sections of the track, with the curved sections chosen in a way to reach the maximum lateral acceleration as specified by the manufacturer.~~

5.2.3. ~~False reaction test~~

~~An object with a size too small to assume damage to the vehicle but with a size large enough to be detectable by the vehicle's sensors shall be positioned in the lane, such as an object of a size of [200 x 80 x 0.03 m].~~

~~The vehicle shall be driven in a lane at the constant speed  $v_{max}$  with the automated lane keeping function activated and the vehicle driver having the hands and feet off the vehicle controls, towards the object. There shall be no other vehicles in adjacent lanes.~~

~~The test is passed if no noticeable intervention of the automated lane keeping system occurs.~~

~~The test shall be carried out on straight as well as curved sections of the track, with the curved sections chosen in a way to reach the maximum lateral acceleration as specified by the manufacturer.~~

5.3. Interaction with a preceding vehicle

5.3.1. ~~Following distance test~~

~~The vehicle shall be driven in a curved lane or a straight lane with constant speed as below, with varying a curvatures as specified in the operational design domain, with the automated lane keeping function activated and the vehicle driver having the hands and feet off the vehicle controls, and with a preceding target, for an appropriate time at least [3] minutes per parameter combination.~~

~~The preceding target shall have the characteristics as defined below and shall be driven at the constant speeds and with offsets as defined below, as well as with any stationary speed sequence with a deceleration level below [2] m/s<sup>2</sup> for an appropriate time period longer than [3] minutes (for example the speed sequence "WLTC low" XXX reference).~~

~~At least [two] combination of the following characteristics shall be performed for each target:~~

- ~~• Constant speed: 5 km/h, 40 km/h,  $v_{max}$ , other speed in the table of paragraph 2.5.3.2. selected by technical service  $0.5 \times v_{max}$~~
- ~~• Target characteristics: Vehicle, Powered Two Wheeler,~~
- ~~• Offset: 50%, 25%, 75%~~

**Kommentiert [児島亨19]:** This test should be covered by Annex CEL.

**Kommentiert [N20]:** Such a requirement of false reaction is not defined in the requirements, so the necessity of such a requirement should be discussed first. In case of including such a requirement, test could be covered by Annex CEL due to the complexity of so many possible situations of false reaction.

**Kommentiert [児島亨21]:** Representative condition should be carried out as the conventional tests in Annex X.

**Kommentiert [N22]:** Need to be discussed whether offset is necessary or not.

The test is passed if the requirements of paragraph 2.5.3.2. above are fulfilled at all times.

5.3.2. ~~Following stability test~~

~~The vehicle shall be driven with  $v_{max}$  in a straight lane with the automated lane keeping function activated and the vehicle driver having the hands and feet off the vehicle controls, and with a preceding vehicle.~~

~~The preceding vehicle shall perform a swerving motion with an amplitude of [10°] heading angle and a peak yaw rate of [1°/s] for not less than [1] minute.~~

~~The test is passed if the vehicle's lane position fulfils the requirements of paragraph 2.5.1. above, especially if no parts of the vehicle, including its devices for indirect vision, pass the outside edge of the lane markings, and if no noticeable oscillation of the lateral position is present. [This can be determined e.g. by checking if a dedicated peak in the frequency range from [0.1] to [5] Hz for any given window of [10] seconds of the power spectral density diagram of the lateral position or lateral acceleration is observed.]~~

5.3.3. Preceding vehicle severe braking test

The vehicle shall be driven in a curved lane or a straight lane with constant speed in a lane with varying curvatures as specified in the operational design domain, with the automated lane keeping function activated and the vehicle driver having the hands and feet off the vehicle controls, and with a preceding target, for at least [1] minute, after which the preceding target will perform a deceleration manoeuvre with a mean fully developed deceleration of [6] m/s<sup>2</sup> until standstill. *(The purpose of this test is to confirm paragraph 2.10.3.2. of ACSF24-18)*

And then, the vehicle shall be driven in a curved lane or a straight lane with constant speed, with the automated lane keeping function activated and the vehicle driver having the hands and feet off the vehicle controls, and with a preceding target, for at least [1] minute, after which the preceding target will perform a deceleration manoeuvre with a mean fully developed deceleration of [6] m/s<sup>2</sup> in short time, and emergency manoeuvre initiates, after that, it will perform an acceleration manoeuvre. (The purpose of this test is to confirm paragraph the first part of 2.10.3. and 2.10.3.1.)

The vehicle shall be driven in a curved lane or a straight lane with constant speed, with the automated lane keeping function activated and the vehicle driver having the hands and feet off the vehicle controls, and with a preceding target, for at least [1] minute, after which the preceding target will perform a deceleration manoeuvre with a mean fully developed deceleration of [6] m/s<sup>2</sup> until standstill. During emergency manoeuvre, the driver deactivate the system (The purpose of this test is to confirm paragraph the second part of 2.10.3. of ACSF24-18)

- ~~At least [two] combination of the following characteristics shall be performed for each target: Constant Vehicle speed: 40 km/h,  $v_{max} \cdot 0.5$~~   
 ~~$\times v_{max}$~~
- Target characteristics: Vehicle, ~~Powered Two Wheeler,~~
- ~~Offset: 25%, 50%, 75%~~

**Kommentiert [児島亨23]:** Currently, there is no requirement regarding noticeable oscillation, because ALKS shall have the capability of lane keeping without any confusion of other road users. If the requirement of oscillation is added, the appropriate test method and parameters should be discussed with appropriate justification.

**Kommentiert [児島亨24]:** This test seems to be appropriate since this is stable (robust) and reproducible test in order to evaluate performance of emergency manoeuvre.

**Kommentiert [SP25]:** Current targets do not allow higher deceleration. However, using real vehicles in a driverless setup would allow TS' ses to check more severe conditions.  
This is allowed according to paragraph 5.

**Kommentiert [N26]:** Need to be discussed whether offset is necessary or not.



The test is passed if the requirements of paragraph 2.5.5.4. above are fulfilled at all times.

5.4. Interaction with road users and objects in the lane

5.4.1.1. Stationary road user or blocked lane test

A stationary target with the characteristics as specified below and with an offset specified below shall be positioned in a curved lane or a straight lane with constant speed in a lane with the curvature as specified below.

The vehicle shall be driven with  $v_{max}$  in the lane with the automated lane keeping function activated and the vehicle driver having the hands and feet off the vehicle controls, without any preceding vehicles or vehicles in the adjacent lanes, and with an initial time to collision with respect to the road user enough to collision avoidance without emergency manoeuvre of not less than [10] seconds.

- ~~At least two combination of the following target characteristics shall be performed, for each target: Curvature: 0-1/m, curvature to achieve the maximum lateral acceleration or maximum curvature, whichever is lower,~~
- Target characteristics: Vehicle, ~~Powered Two Wheeler, blocked lane~~
- ~~Offset: 25%, 50%, 75% (25% and 75% not for blocked lane)~~

The test is passed if the requirements of paragraph 2.5.4.4. above are fulfilled ~~(especially: collision avoidance without emergency manoeuvre).~~

5.4.1.2. Blocked lane test

A stationary target with the characteristics as specified below and with an offset specified below shall be positioned in a curved lane or a straight lane with constant speed as specified below.

The vehicle shall be driven with  $v_{max}$  in the lane with the automated lane keeping function activated and the vehicle driver having the hands and feet off the vehicle controls, without any preceding vehicles or vehicles in the adjacent lanes, and with an initial time to collision with respect to the road user enough to collision avoidance without emergency manoeuvre.

- Target characteristics: blocked lane

The test is passed if the requirements of paragraph 2.5.4., 2.7.2.2. and 2.7.3.1. above are fulfilled

5.4.1.3. Function of transition demand and minimum risk manoeuvre

The vehicle shall be driven in a curved lane or a straight lane with constant speed as specified below.

- Case 1 -

The vehicle shall be driven with  $v_{max}$  in the lane with the automated lane keeping function activated and the vehicle driver having the hands and feet off the vehicle controls with or without any preceding vehicles, and without vehicles in the adjacent lanes, and with an initial time to collision with respect to the road user enough to collision avoidance without emergency manoeuvre.

Kommentiert [N27]: Need to be discussed whether offset is necessary or not.

Kommentiert [児島亨28]: The purpose of this test is to evaluate capability of normal braking, and initiation of transition demand to a stationary target.

Kommentiert [児島亨29]: The purpose of this test is to evaluate the sequence from initiation of transition demand to MRM.

A condition which occurs transition demand declared by the manufacturer shall be set (ex. Lost of lane marking, disappear the preceding vehicle), and the vehicle shall continue to drive at the speed above 20]km/h.

The driver takes over the steering control during transition demand.(Confirmation of paragraph 2.7.4. in ACSF-24-18)

- Case 2 -

The vehicle shall be driven with  $v_{max}$  in the lane with the automated lane keeping function activated, and the vehicle driver having the hands and feet off the vehicle controls with or without any preceding vehicles, and without vehicles in the adjacent lanes, and with an initial time to collision with respect to the road user enough to collision avoidance without emergency manoeuvre.

A condition which occurs transition demand declared by the manufacturer shall be set (ex. Lost of lane marking, disappear the preceding vehicle), and the vehicle shall continue to drive at the constant speed.

The driver does not take over any control during transition phase in the speed of above 20km/h. (Confirmation of paragraph 2.7.3.2. and 2.7.4. in ACSF-24-18)

After minimum risk manoeuvre initiates, the driver does not take over any control during minimum risk manoeuvre, the vehicle brings to standstill.(Confirmation of paragraph 2.9.1., 2.9.2. and 2.9.5. in ACSF-24-18)

After the above, the driver turns off the ignition switch. And reactivates the system after the new ignition cycle.( Confirmation of paragraph 2.9.6. in ACSF-24-18)

- Case 3 -

The vehicle shall be driven with  $v_{max}$  in the lane with the automated lane keeping function activated, and the vehicle driver having the hands and feet off the vehicle controls with or without any preceding vehicles, and without vehicles in the adjacent lanes, and with an initial time to collision with respect to the road user enough to collision avoidance without emergency manoeuvre.

A condition which occurs transition demand declared by the manufacturer shall be set (ex. Lost of lane marking, disappear the preceding vehicle), and the vehicle shall continue to drive at the speed above 20]km/h.

The driver does not take over any control during transition phase in the speed of above 20km/h.

After minimum risk manoeuvre initiates, the driver does takes over the steering control.(Confirmation of paragraph 2.9.4. in ACSF-24-18)

The test is passed if the requirements of paragraph 2.7. and 2.9. above are fulfilled

5.4.2.

Large obstacle test

~~An obstacle with a size so as to assume severe damage to the vehicle, such as a vehicle parked orthogonal to the direction of traffic shall be positioned in a lane with the curvature as specified below.~~

Kommentiert [児島亨30]: This test should be covered by Annex CEL.

The vehicle shall be driven with  $v_{max}$  in the lane with the automated lane keeping function activated and the vehicle driver having the hands and feet off the vehicle controls, without any preceding vehicles or vehicles in the adjacent lanes, and with an initial time to collision with respect to the road user of not less than [10] seconds.

At least [two] combinations of the following characteristic shall be performed:

- Curvature: 0-1/m, curvature to achieve the maximum lateral acceleration or maximum curvature, whichever is lower.

The test is passed if the requirements of paragraph 2.5.5.1. above are fulfilled (especially: collision avoidance, emergency manoeuvre permitted).

[5.4.3.] Crossing pedestrian test

A pedestrian test in a straight and curved lane shall be carried out according to Regulation (UN) Nr. 152-01, paragraph 5.2.2.4., where the vehicle shall be driven with  $v_{max}$  in the lane with the automated lane keeping function activated and the vehicle driver having the hands and feet off the vehicle controls.

The test is passed if the requirements from paragraph 2.5.5.3. above are fulfilled.]

[5.4.4.] Pedestrian crossing in slow traffic

A pedestrian test in a straight and curved lane shall be carried out according to Regulation (UN) Nr. 152-01, paragraph 5.2.2.4., where the vehicle shall be driven in the lane preceding for another vehicle that come to a stop and then starts to move from 0 to 10kph with an acceleration not over  $2m/s^2$  with the automated lane keeping function activated and the vehicle driver having the hands and feet off the vehicle controls. At the moment that the preceding vehicle starts to move, the pedestrian start to cross the lane with the exception that the pedestrian shall be an adult pedestrian

The test is passed if the requirements from paragraph 2.5.5.3. above are fulfilled.]

5.5. Interaction with vehicles intruding into the lane

5.5.1. Cut-In Tests

The vehicle and a target vehicle shall be travelling parallel and in the same direction, both on individual marked lanes and with their individual longitudinal speeds as shown in the figure below, in stationary conditions for at least [10] seconds.

The offset between lane centre and longitudinal axis of the vehicle shall be chosen by the ALKS, the target shall be travelling initially with an offset to the vehicle's lane centre equal to the lane width as shown in the table below.

The vehicle shall be driven with the speed as shown in the following table, in the lane with the automated lane keeping function activated and the vehicle driver having the hands and feet off the vehicle controls.

When the longitudinal distance between the vehicles has reached a distance corresponding to the Time-To-Collision value as shown in the table below, the target shall perform a lane change, the desired trajectory for the target being composed of two segments of equal duration with the same constant lateral

**Kommentiert [SP31]:** There is no requirement yet. This needs to be discussed in the group.

**Kommentiert [N32]:** ALKS is capable of operating on the road which 'pedestrians and cyclists are prohibited and which, by design, are equipped with a physical separation that divides the traffic moving in opposite directions.' The necessity of this test should be discussed in ACSF IWG.

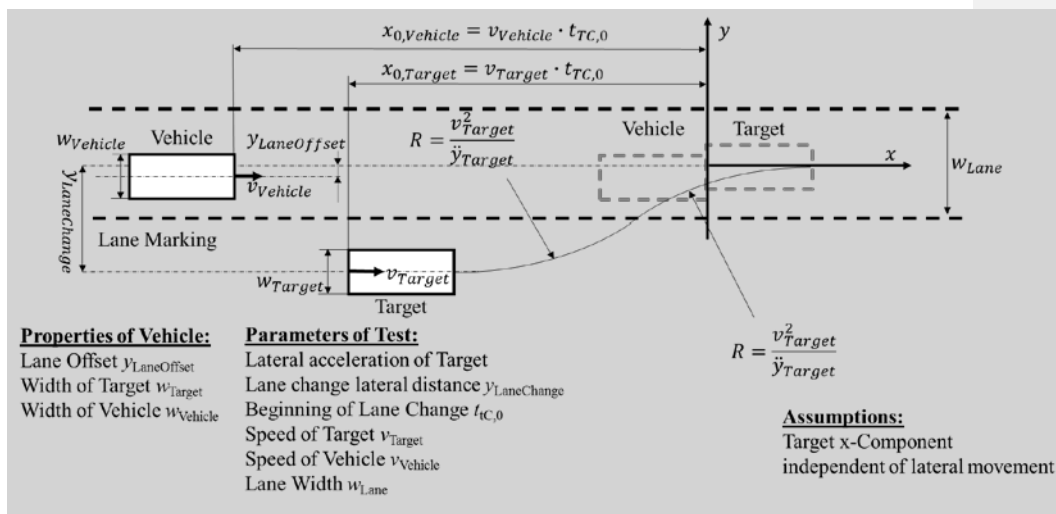
**Kommentiert [N33]:** ALKS is capable of operating on the road which 'pedestrians and cyclists are prohibited and which, by design, are equipped with a physical separation that divides the traffic moving in opposite directions.' The necessity of this test should be discussed in ACSF IWG.

**Kommentiert [児島亨34]:** It is considered that Cut-In test is one of the test method in order to evaluate the capability of emergency manoeuvre. However, the parameters for the test is much more complicated compared to the Preceding vehicle severe braking test. Therefore, appropriate test procedure and parameters should be discussed carefully and justified.

acceleration demand, but opposed signs. The total lane change distance shall be the initial offset between the target's longitudinal axis and the vehicle lane's centre plane.

Resulting from the defined manoeuvre, the target shall enter the vehicle's lane at the time  $t_{C, intrusion}$ .

During the test, all movement variables shall be recorded, and the value for  $t_{C, intrusion}$  shall be calculated.



Tests shall be performed according to the parameters as shown in the table below. Each test is passed when the requirements of paragraph 2.5.4.2. and 2.5.5.2. (avoidance as function of  $t_{C, intrusion}$ ) are fulfilled.

The tests shall all be performed with a vehicle target and a powered two-wheeler target. Additionally the tests may be performed on a curved track with any curvature as specified in the operational design domain.

Test Case	1	2	3	4	5
$v_{Vehicle}$ [km/h]	50	60	60	30	45
$v_{Target}$ [km/h]	10	50	10	15	40
Lateral acceleration of target [m/s <sup>2</sup> ]	0,5	1,5	3	3	1
Lane Width [m]	3,5	3,5	3,5	3,5	3,5

$t_{c,0}$ [s]	3	2,5	2,6	2,5	1,5
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5.5.2. Cut-Out Tests

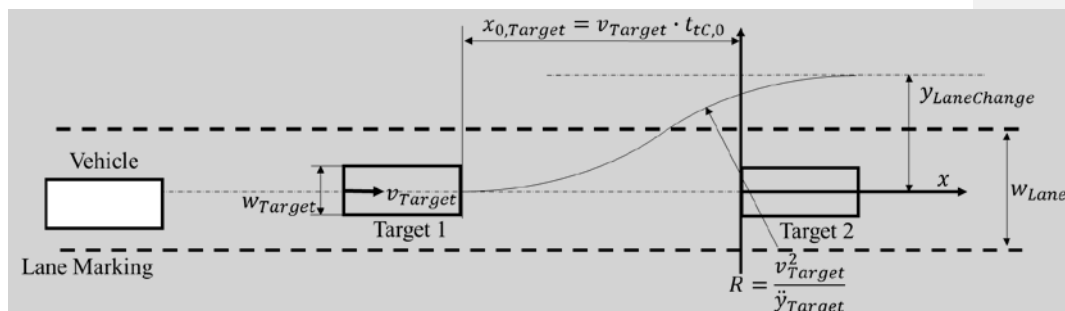
The vehicle and a preceding target vehicle shall be travelling in the same lane with the speed of the target vehicle  $v_{Target}$  with a maximum of  $v_{max}$  in stationary conditions for at least [10] seconds. The vehicle shall be driven with the automated lane keeping function activated and the vehicle driver having the hands and feet off the vehicle controls.

The offset between lane centre and longitudinal axis of the vehicle as well as the distance between vehicle and target shall be chosen by the ALKS.

A second target object as specified in the table below shall be positioned in the lane sufficiently ahead and being approached by the target vehicle.

When the longitudinal distance between the target vehicle and the second, stationary target has reached a distance corresponding to a time to collision value as specified below, the target shall perform a lane change, the desired trajectory for the target being composed of two segments of equal duration with the same constant lateral acceleration demand, but opposed signs, chosen in a way to fulfil the Time To Collision value and so as to have no collision between the target vehicle and the second, stationary target. The total lane change distance shall be the initial offset between the target's longitudinal axis and the vehicle lane's centre plane.

**Kommentiert [児島亨35]:** It is considered that Cut-Out test is one of the test method in order to evaluate the capability of emergency manoeuvre. However, the parameters for the test is much more complicated compared to the Preceding vehicle severe braking test. Therefore, appropriate test procedure and parameters should be discussed carefully and justified.



At least [two] combination of the following characteristics shall be performed for each target:

- Speeds: 10 km/h,  $0.5 \times v_{max}$ ,  $v_{max}$
- TTCs: 1.5 s, 2 s, 3 s,
- Peak lateral acceleration of 1, 2, 3 m/s<sup>2</sup>.

The test is passed if the requirements from paragraph 2.5.5.1. are fulfilled (especially there shall be no collision between vehicle and the second, stationary target).

5.6. Traffic insertion tests

~~XXX UTAC, please describe tests in a corresponding way, if possible.~~

**Kommentiert [児島亨36]:** It is considered that Traffic insertion test is one of the test method in order to evaluate the capability of emergency manoeuvre. However, the parameters for the test is much more complicated compared to the Preceding vehicle severe braking test. Therefore, appropriate test procedure and parameters should be discussed carefully and justified.

5.7. Traffic way out tests

~~XXX UTAC, please describe tests in a corresponding way, if possible.~~

**Kommentiert [児島亨37]:** It is considered that Traffic way out test is one of the test method in order to evaluate the capability of emergency manoeuvre. However, the parameters for the test is much more complicated compared to the Preceding vehicle severe braking test. Therefore, appropriate test procedure and parameters should be discussed carefully and justified.

5.8. Traffic insertion tests

~~XXX UTAC, please describe tests in a corresponding way, if possible.~~

**Kommentiert [児島亨38]:** The difference between 5.6. and 5.8. should be clarified.

5.9. Field of view tests

~~XXX UTAC, please describe tests in a corresponding way, if possible.~~

**Kommentiert [児島亨39]:** Sensing capability should be evaluated in this test.

5.10. Driver availability test

The vehicle shall be driven with  $v_{max}$  in the lane with the automated lane keeping function activated and the vehicle driver having the hands and feet off the vehicle controls, with or without any preceding vehicles, and without vehicles in the adjacent lanes.

**Kommentiert [HF40]:** Relevancy of these tests scenarios has to be confirmed.

According to paragraph 2.6.2., the driver carries out some activities which are declared by the manufacturer, and selected by the technical service.

The test is passed if the requirements of paragraph 2.6.2. above are fulfilled

**Kommentiert [児島亨41]:** The purpose of this test is to evaluate the capability of driver availability recognition system. Driver availability recognition system is one of the key functions for ALKS, therefore, it is considered that the standalone test is necessary.