

Proposal for amendments regarding GRVA-12-52

Modifications to the existing text of UN-Regulation No. 157 are in **bold** for new or ~~strikethrough~~ for deleted characters.

Modifications to GRVA-12-52 are in **green bold** for new or ~~green strikethrough~~ for deleted characters.

Amendments **highlighted yellow** are still to be confirmed.

I. Proposal

Annex 5

Annex 5, Paragraph 1., amended to read:

1. Introduction

This annex defines **track** tests with the purpose to verify the technical requirements on ALKS. All the tests in this annex shall be performed or witnessed by the Technical Service during the approval process as specified below.

Until such time that specific test provisions have been agreed, **the type-approval authority or the Technical Service acting on its behalf (hereafter referred as type-approval authority) shall ensure that the ALKS is subject to at least the tests outlined in Annexes 5 and 6. The** specific test parameters for each test shall be selected by the ~~Technical Service~~ **type-approval authority** and shall be recorded in the test report in such a manner that allows traceability and repeatability of the test setup.

Pass- and Fail-Criteria for tests are derived solely from the technical requirements in paragraphs 5 to 7 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 ~~system boundaries~~ **ODD description**).

The test ~~specifications~~ **specified** in this document ~~are meant to be~~ **shall be intended as** a minimum set of tests, ~~the technical service~~ **Type-approval authorities** may perform ~~any other~~ **additional** tests within the system ~~ODD boundaries~~ and ~~may then~~ compare the measured results against the requirements (concrete: expected test outcome).

Annex 5, Paragraphs 2.7. and 2.8., amended to read:

2.7. A “passable object” is such an object, that may be **rolled driven over without causing an unreasonable risk to the vehicle occupants or other road users.**

2.8. **"Operational Design Domain (ODD)" of the automated lane keeping system defines the specific operating conditions (e.g. environmental, geographic, time-of-day, traffic, infrastructure, speed range, weather and other conditions)**

within the boundaries fixed by this regulation under which the automated lane keeping system is designed to operate without any intervention by the driver.

Annex 5, Paragraph 3.3., amended to read:

3.3. Test parameter variation

The manufacturer shall declare the system ~~boundaries~~**ODD** to the ~~Technical Service type-approval authority~~. The ~~Technical Service type-approval authority~~ shall define different combinations of test parameters (e.g. present speed of the ALKS vehicle, type and offset of target, curvature of lane) in order to cover scenarios in **accordance with paragraph 3.3.1 of this annex** ~~which a collision shall be avoided by the system as well as those in which a collision is not expected to be avoided, where applicable.~~

If this is deemed justified, ~~the Technical Service may test additionally~~ any other combination of parameters **may be additionally tested**.

~~If a collision cannot be avoided for some test parameters, the manufacturer shall demonstrate either by documentation or, if possible, by verification/testing that the system doesn't unreasonably switch its control strategy.~~

Annex 5, Paragraphs 4. and 4.1.1., amended to read:

4. Test scenarios to assess the performance of the system with regard to the dynamic driving task

At the time of type approval, the Technical Service shall conduct or shall witness at least the following tests to assess the behaviour of the ALKS:

Test scenarios shall be selected depending on the ~~Operational Design Domain (ODD)~~.

4.1. Lane Keeping

4.1.1. The test shall demonstrate that the ALKS does not leave its lane and maintains a stable ~~position~~ **motion** inside its ego lane across the speed range and different curvatures within its ~~system~~ **boundaries****ODD**.

Annex 5, Paragraph 4.6.1., amended to read (removal of square brackets):

4.6.1. The test shall demonstrate that the ALKS is capable of detecting another road user within the forward detection area up to the declared forward detection range and a vehicle beside within the lateral detection area up to at least the full width of the adjacent lane. **¶If the ALKS is capable of performing lane changes, it shall additionally demonstrate that the ALKS is capable of detecting another vehicle within the front, side and rearward detection range as declared in paragraphs 7.1., 7.1.1.1., 7.1.2.1. and 7.1.3., and, if applicable, the direction indicator status of another vehicle within the direction indicator status area as declared in paragraph 7.1.4.¶**

Annex 5, Paragraph 4.6.2.2., amended to read (removal of square brackets):

¶4.6.2.2. The requirements of this paragraph apply to the system, if the ALKS is capable to perform a LCP.

The test for the forward detection range shall be executed at least when approaching a PTW target positioned 9m to the side(s) to which the ALKS performs a LCP, measured from the centreline of the ALKS vehicle.¶

Annex 5, Paragraph 4.6.3.2.- 4.6.5.1., amended to read (removal of square brackets):

4.6.3.2 The requirements of this paragraph apply to the system, if the ALKS is capable to perform a LCP.

The test for the lateral detection range shall be executed at least with:

- (a) a PTW target approaching the ALKS vehicle 9m to the left side of the ALKS, measured from the centreline of the ALKS vehicle;
- (b) a PTW target approaching the ALKS vehicle 9m to the right side of the ALKS, measured from the centreline of the ALKS vehicle.

4.6.4. ~~Rearward~~Rearward detection range

4.6.4.1. The requirements of this paragraph apply to the system, if the ALKS is capable to perform a LCP.

The test for the rear detection range shall be executed at least with:

- (a) a PTW approaching the ALKS from the rear within an area 9m to the left of the ALKS vehicle, measured from the centreline of the ALKS vehicle;
- (b) a PTW approaching the ALKS from the rear within an area 9m to the right of the ALKS vehicle, measured from the centreline of the ALKS vehicle.

4.6.5. Direction indicator status detection ~~range~~area

4.6.5.1. The provisions of this paragraph apply to the ALKS that has a capability of detecting the direction indicator status of another vehicle.

The test for the detection area of direction indicator shall be executed at least with:

- (a) an activation of direction indicator of a vehicle positioned at random within the area declared in paragraph 7.1.4. of this Regulation;
- (b) different types of vehicles, including passenger car and PTW.]

Annex 5, Appendix 1, to be inserted here (moved from Annex 6) and amended to read:

Appendix 1

Guidance to determine the difficulty of the test

Following data sheets are pictorial examples of simulations, which determines conditions under which ALKS shall avoid a collision, taking into account the combination of every parameter in accordance to the Performance models of Annex 34-Appendix 3, at and below the maximum permitted ALKS vehicle speed.

1. In case of performance model 1 in Annex 34

Where collision is deemed to be avoidable, three subsets are defined, to differentiate between the parameter sets based on their difficulty in accordance to the Performance model 1 laid down in paragraph 3.3 of Annex 34-Appendix 3:

- “Avoidable” conditions are highlighted by green colour,
- “Difficult” conditions are highlighted by blue colour, while

“Unavoidable” is highlighted by red colour.

Annex 5, Appendix 1, paragraph 2. amended to read:

2. In case of performance model 2 of Annex 34

Following data sheets are pictorial examples of simulations which determine conditions under which ALKS shall avoid a collision, taking into account the combination of every parameter, *at and below* the maximum permitted ALKS vehicle speed.

Where collision is deemed to be avoidable, three subsets are defined, to differentiate between the parameter sets based on their difficulty in accordance to the performance model 2 laid down in paragraph 3.4 of Annex ~~34~~ [Appendix 3](#):

- “Easy” conditions are highlighted by green colour,
- “Medium” conditions are highlighted by yellow colour,
- “Difficult” conditions are highlighted by red colour, while
- “Unavoidable collision” is highlighted by red colour with black “X”.

Annex 5, Appendix 1, paragraphs 2.1., 2.2. and 2.3. amended to read:

2.1. Cut in

Classification of difficulty of the scenarios based on the initial parameters is done the following way in accordance to the performance model laid down in paragraph 3.4 of Annex ~~34~~ [Appendix 3](#):

- Easy: $PFS \leq 0.85$;
- Medium: $PFS > 0.85$ and $CFS < 0.9$;
- Difficult: $CFS \geq 0.9$.

Based on these equations the classification may be done for any parameter set; to show some examples, a number of figures are presented below with different ego vehicle speeds.

2.2. Cut out

Classification of difficulty of the scenarios based on the initial parameters is done the following way in accordance to the performance model 2 laid down in paragraph 3.4 of Annex ~~34~~ [Appendix 3](#):

- Easy: $PFS = 0$;
- Medium: $PFS > 0$ and $CFS < 0.5$;
- Difficult: $CFS \geq 0.5$.

Based on these equations the classification may be done for any parameter set; to show some examples, a number of figures are presented below with different ego vehicle speeds.

2.3. Deceleration

Classification of difficulty of the scenarios based on the initial parameters is done the following way in accordance to the performance model laid down in paragraph 3.4 of Annex ~~34~~ [Appendix 3](#):

- Easy: $PFS = 0$;
- Medium: $PFS > 0$ and $CFS < 0.5$;
- Difficult: $CFS \geq 0.5$.

Based on these equations the classification may be done for any parameter set. The classification matrix for the different cases is presented below in Fig. 22.

Annex 6

Annex 5, Paragraph 1., amended to read:

1. Introduction

This annex defines public road tests on ALKS. The purpose of this test is to assess the behaviour of the system, in a fault-free condition, in its operating environment and to complement the assessment of the documentation provided under Annex 4 and the assessment of Annex 5. The test parameters covered in the test shall be recorded in the test report in such a manner that allows traceability.

Together, the assessment of Annex 4, Annex 5 and the public road test shall enable the type-approval authority or the technical service acting on its behalf (hereafter referred as type-approval authority) to identify areas of system performance that may require further assessment, either through testing or further review of Annex 4.

Pass- and Fail-Criteria for tests are derived solely from the technical requirements in paragraphs 5 to 7 of the Regulation. These requirements are worded in a way that they allow the derivation of pass-fail-criteria 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 ~~system boundaries~~ ODD description).

The scenarios specified in this document shall be intended as a minimum. The type-approval authority may perform additional tests within the system ODD and compare the measured results against the requirements.

The public road test shall be undertaken once the system has passed the tests under the provisions outlined in paragraphs 3 to 4.8. of this annex and paragraph 5 of Annex 5 and upon completion of a risk assessment by the type-approval authority.

Annex 6, Paragraph 2.1., to be deleted:

~~2.1. "Emergency operation" means the operation outside the operational limits specified by the manufacturer, when safety systems come into action in order to prevent or mitigate possible damage.~~

Annex 6, Paragraph 2.1., inserted to read:

2.1. "Operational Design Domain (ODD)" of the automated lane keeping system defines the specific operating conditions (e.g. environmental, geographic, time-of-day, traffic, infrastructure, speed range, weather and other conditions) within the boundaries fixed by this regulation under which the automated lane keeping system is designed to operate without any intervention by the driver.

Annex 6, Paragraph 2.3., to be deleted:

~~2.3. "Dense traffic conditions" means that ALKS operations have the main objective to maintain a safe distance from the surrounding vehicles. In this case the average speed shall be greater than or equal to 15 km/h and lower than or equal to [55] km/h.~~

Annex 6, Paragraphs 2.3. and 2.4., amended to read:

- 2.3. “Free flow traffic conditions” means that ALKS operations are not heavily affected on a continuous basis by the behaviour of the surrounding vehicles. ~~In this case the average speed shall be greater than [90] km/h and lower than or equal to either the system maximum speed or the road maximum allowed, whichever lowest.~~
- 2.4. “Lightly ~~C~~ongested traffic conditions” means that ALKS operations are affected on a continuous basis by the behaviour of the surrounding vehicles (i.e. continuous vehicle following operation). In this case the vehicle average speed shall be greater than [55] km/h ~~and lower than or equal to [90] km/h.~~

Annex 6, Paragraph 2.5., inserted to read:

- 2.5. “Heavily congested traffic conditions” means that ALKS operations are affected on a continuous basis by the behaviour of the surrounding vehicles and the ALKS is requested to perform frequent decelerations and accelerations, to cope with the perturbations in the surrounding traffic flow. In this case the average speed shall be greater than or equal to 15 km/h and lower than or equal to [55] km/h.

Annex 6, Paragraph 4.1., amended to read:

- 3.1. The public road test shall primarily verify the ALKS normal operation within (but including coming close to) the system ODD boundaries. The manufacturer shall declare the system ~~boundaries~~ODD to the type-approval authority in accordance with Annex 4.

Annex 6, Paragraphs 4.1. and 4.2., amended to read:

- 4.1. The tests shall be performed under starting conditions (e.g. environmental, road geometry) that allow the activation of the ALKS (excluding category “Prevention of activation when the system is outside of its technical boundaries“ of the table A6/1 ~~scenarios according to paragraph 5.7).~~
- 4.2. If applicable to the system’s ODD, the composition of the public road test shall allow the verification of the system ~~on~~ ~~motorway~~ in free-flow, lightly congested ~~condition~~ and ~~on~~ ~~motorway~~ heavily congested traffic conditions.

Annex 6, Paragraph 5., amended to read:

Category	Type of scenario	Mandatory / Recommended	Main reference requirements (non-exhaustive list)
Prevention of activation when the system is outside of its technical boundaries	On a section of highway that is not suitable	Mandatory	6.2.3.
	In an urban environment	Mandatory	
	On a normally suitable road when other conditions (e.g. weather/time of day) are not met	Recommended	
System override by the driver	Intervention made by the steering wheel	Mandatory	6.3.1.
	Intervention made by the acceleration pedal	Mandatory	6.3.3. and 6.3.4.

	Intervention made by the brake pedal	Mandatory	6.3.2. and 6.3.4.	
No violation of traffic rules	Adheres to speed limits	Mandatory	5.1.2	
	Repeated changes in speedlimit above 60 km/h	Mandatory	5.1.2 and 5.2.3	
	Exposure to different road signs which require system reaction (at least [3] different times)	Mandatory		
	Sufficient distance to vehicle in front	Mandatory	5.2.3.3	
	Does not cross solid lane markings where lane change is prohibited	Recommended	5.1.2 and 5.2.1	
Response to road events	Tunnel	Recommended	5.4.2.1	
	End of motorway	Recommended		
	Work zone	Recommended	§ 5.4.2.1 or 5.4.2.2	
	Toll station	Recommended	5.4.2.1	
	Reacts to closed lane	Recommended	5.4.2.1 or 5.4.2.2	
	Emergency vehicle approaching	Recommended	5.4.2.2	
	Change in environmental conditions	Recommended		
Response to other road users within the frontal and lateral detection range	Response to the acceleration and deceleration of a lead vehicle	Mandatory	5.2.5	
	PTW as lead vehicle	Recommended		
	HDV as lead vehicle	Mandatory		
	Another vehicle merging at an entry lane	Mandatory		
	Another vehicle merging at an ending lane	Free flow and lightly congested dense traffic conditions	Mandatory	
		Heavily congested traffic conditions (repetition of at least [10] times)	Recommended	
	Another vehicle merging with little longitudinal distance between the vehicles	Recommended		
	Cut-out of another vehicle (e.g. at highway exit)	Mandatory	5.2.5 and 5.2.3.3	
The ALKS approaching stop and go traffic situations with different initial speeds (at least [10] situations)	Mandatory			
Lane Keeping	Lane keeping on roads with different lane curvature	Mandatory	5.2.1	
	Another vehicle driving close beside in the adjacent lane	Recommended	5.2.2	
Lane changing performed by the system	The ALKS performing lane change in the adjacent (target) lane with and without surrounding traffic	Mandatory	5.2.6	
	Merging at motorway entry	Mandatory		

	Merging at lane end	Free flow and lightly congested lightly congested dense traffic conditions	Mandatory	
		Heavily congested traffic conditions (repetition of at least [10] times)	Mandatory	

Annex 6, Paragraph 6.1., amended to read:

6.1. The test, or combination of tests, shall be such that allows recording the ALKS operation including:

- (a) at least [5] operating hours in ~~heavily congested~~ **lightly congested** dense traffic conditions; and, if applicable to the system's ODD,
- (b) at least [10] operating hours in free-flow traffic conditions.

Annex 6, Paragraph 7.3.1., amended to read:

7.3.1. The data recorded from ~~the~~ **the** activated system shall be assessed for the sections falling within the declared ODD ~~including as well as~~ those sections when the system has left the ODD inadvertently without correctly ending its operation.

Annex 6, Paragraph 7.3.4., amended to read:

7.3.4. Time gap to leading vehicle, time gap left to the ~~upcoming~~ **approaching** vehicle in the target lane in case of lane-change and lateral position deviation shall be quantitatively evaluated according to the technical requirements in paragraph 5 in this Regulation.

Annex 6, Appendix 1, to be deleted from here (moved to Annex 5):

~~Appendix 1~~

~~Guidance to determine the difficulty of the test~~

~~Following data sheets are pictorial examples of simulations, which determines conditions under which...~~

II. Justification

1. .
2. .
