

## Assessment of ALKS against the Monitoring & Control Tests

January 2021

### Monitoring Test

*'An individual does not need to monitor the vehicle when the Automated Driving System (ADS) is engaged if the vehicle can safely achieve the following without human monitoring when the ADS is engaged, operating within its Operational Design Domain (ODD), and can identify the boundaries of that domain:'*

Test criterion	Relevant ALKS requirement(s) (Paragraph numbers relate to the paragraph in the ALKS adopted text)	Evidence and assessment methods	Government assessment/reasoning
Comply with road traffic rules that relate to the dynamic driving task	<p>5.1.2. The activated system shall comply with <u>traffic rules relating to the DDT</u> in the country of operation.</p> <p>Appendix:</p> <p>3.5. Safety management system (Process Audit)</p> <p>3.5.1. In respect of software and hardware employed in "The System", the manufacturer shall demonstrate to the type approval authority in terms of a safety management system that effective processes, methodologies and tools are in place, up to date and being followed within the organization to manage the safety and continued compliance throughout the product lifecycle (design, development, production, operation including respect of <b>traffic rules</b>, and decommissioning).</p> <p>4.1.1. Verification of the function of "The System" The Type approval authority shall verify "The System" under non-failure conditions by testing on a track a number of selected functions from those described by the manufacturer in paragraph 3.2. above, <b>and by checking the overall behaviour of the system in real driving conditions including the compliance with traffic rules.</b></p>	<ol style="list-style-type: none"> <li>1. Audit of safety documentation (Annex 4).</li> <li>2. Manufacturer's declaration (Appendix to the Type Approval communication form).</li> <li>3. Real-world demonstration drive in the country in which the Technical Service and manufacturer conducts the real-world test (Annex 5).</li> </ol>	<p>A vehicle that has received systems approval for compliance with GB road rules meets this criterion.</p> <p>A non-exhaustive list of noteworthy road traffic rules includes:</p> <ol style="list-style-type: none"> <li>1. Responding to an enforcement vehicle,</li> <li>2. Stopping after a minor collision,</li> <li>3. Identifying GB-specific road signage.</li> </ol>
Avoid collisions which a competent and careful driver could avoid	<p>5.1.1. The activated system shall not cause any collisions that are reasonably foreseeable and preventable. If a collision can be safely avoided without causing another one, it shall be avoided.</p> <p>When the vehicle is involved in a detectable collision, the vehicle shall be brought to a standstill.</p>	<ol style="list-style-type: none"> <li>1. Audit of safety documentation (Annex 4).</li> <li>2. Physical testing (Annex 5) for 5.2.4.</li> <li>3. Real-world demonstration drive (Annex 5) insofar as situations may</li> </ol>	<p>ALKS vehicles will either brake in the event of an impending collision ahead or attempt to avoid a collision by manoeuvring in lane.</p>

Test criterion	Relevant ALKS requirement(s) (Paragraph numbers relate to the paragraph in the ALKS adopted text)	Evidence and assessment methods	Government assessment/reasoning
	<p>5.2.4. The activated system shall be able to bring the vehicle to a complete stop behind a stationary vehicle, a stationary road user or a blocked lane of travel to avoid a collision. This shall be ensured up to the maximum operational speed of the system.</p> <p>5.2.5. The activated system shall detect the risk of collision in particular with another road user ahead or beside the vehicle, due to a decelerating lead vehicle, a cutting in vehicle or a suddenly appearing obstacle and shall automatically perform appropriate manoeuvres to minimize risks to safety of the vehicle occupants and other road users.</p> <p>For conditions not specified in paragraphs 5.2.4., 5.2.5. or its subparagraphs, this shall be ensured at least to the level at which a <u>competent and careful</u> human driver could minimize the risks. This shall be demonstrated in the assessment carried out under Annex 4 and by taking guidance from Appendix 3 to Annex 4.</p> <p>Annex 4 uses the following definition for “unreasonable risk” from which the system must be free: 2.16. “Unreasonable risk” means the overall level of risk for the driver, vehicle occupants and other road users which is increased compared to a competently and carefully driven manual vehicle.</p>	<p>arise which require the system to avoid a collision.</p>	
<p>Treat other road users with reasonable consideration</p>	<p>5.1.2. The activated system shall comply with traffic rules relating to the DDT in the country of operation.</p> <p>5.2.2. The activated system shall detect a vehicle driving beside as defined in paragraph 7.1.2. and, if necessary, adjust the speed and/or the lateral position of the vehicle within its lane as appropriate.</p> <p>5.2.3.3. The activated system shall detect the distance to the next vehicle in front as defined in paragraph 7.1.1. and shall adapt the vehicle speed in order to avoid collision.</p>	<ol style="list-style-type: none"> <li>1. Audit of safety documentation (Annex 4).</li> <li>2. Physical testing to check the lateral and forward detection ranges (Annex 5).</li> <li>3. Real-world demonstration drive (Annex 5) insofar as situations may arise which require the system to adjust to the presence of other road users.</li> </ol>	<p>ALKS is designed to drive cautiously, ensuring that it gives way when appropriate and responds safely to other vehicles cutting in.</p>

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	<p>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.</p> <p>In case the minimum time gap cannot be respected temporarily because of other road users (e.g. vehicle is cutting in, decelerating lead vehicle, etc.), the vehicle shall readjust the minimum following distance at the next available opportunity without any harsh braking unless an emergency manoeuvre would become necessary.</p> <table border="1" data-bbox="331 608 1064 959"> <thead> <tr> <th><i>Present speed of the ALKS vehicle</i></th> <th></th> <th><i>Minimum time gap</i></th> <th><i>Minimum following distance</i></th> </tr> <tr> <th>(km/h)</th> <th>(m/s)</th> <th>(s)</th> <th>(m)</th> </tr> </thead> <tbody> <tr> <td>7.2</td> <td>2.0</td> <td>1.0</td> <td>2.0</td> </tr> <tr> <td>10</td> <td>2.78</td> <td>1.1</td> <td>3.1</td> </tr> <tr> <td>20</td> <td>5.56</td> <td>1.2</td> <td>6.7</td> </tr> <tr> <td>30</td> <td>8.33</td> <td>1.3</td> <td>10.8</td> </tr> <tr> <td>40</td> <td>11.11</td> <td>1.4</td> <td>15.6</td> </tr> <tr> <td>50</td> <td>13.89</td> <td>1.5</td> <td>20.8</td> </tr> <tr> <td>60</td> <td>16.67</td> <td>1.6</td> <td>26.7</td> </tr> </tbody> </table>	<i>Present speed of the ALKS vehicle</i>		<i>Minimum time gap</i>	<i>Minimum following distance</i>	(km/h)	(m/s)	(s)	(m)	7.2	2.0	1.0	2.0	10	2.78	1.1	3.1	20	5.56	1.2	6.7	30	8.33	1.3	10.8	40	11.11	1.4	15.6	50	13.89	1.5	20.8	60	16.67	1.6	26.7		
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<p>Avoid putting itself in a position where it would be the cause of a collision</p>	<p>5.1.1. The activated system shall not cause any collisions that are reasonably foreseeable and preventable. If a collision can be safely avoided without causing another one, it shall be avoided. When the vehicle is involved in a detectable collision, the vehicle shall be brought to a standstill.</p> <p>5.4.1. The activated system shall recognise all situations in which it needs to transition the control back to the driver. Types of situations in which the vehicle will generate a transition demand to the driver shall be declared by the vehicle manufacturer and included in the documentation package required in Annex 4.</p>	<ol style="list-style-type: none"> <li>1. Audit of safety documentation (Annex 4).</li> <li>2. Physical check of the HMI requirements (e.g. to validate 5.4.4.1.).</li> <li>3. Real-world demonstration drive (Annex 5).</li> </ol>	<p>A vehicle stopping in lane is a risk to vehicles approaching from behind. An ALKS vehicle performing a Minimum Risk Manoeuvre is the final option if the driver does not respond to a transition demand.</p> <p>Government proposes requiring the driver to respond to a transition demand (or risk being in breach of Regulations 7 &amp; 6 of the Motorway Traffic (England &amp; Wales) Regulations and the Scottish</p>																																				

Test criterion	Relevant ALKS requirement(s) (Paragraph numbers relate to the paragraph in the ALKS adopted text)	Evidence and assessment methods	Government assessment/reasoning
	<p>5.4.2. The initiation of the transition demand shall be such that sufficient time is provided for a safe transition to manual driving.</p> <p>5.4.4.1. In case the driver is not responding to a transition demand by deactivating the system (either as described in paragraph 6.2.4. or 6.2.5.), a minimum risk manoeuvre shall be started, earliest 10 s after the start of the transition demand.</p> <p>5.4.4.1.1. Notwithstanding paragraph 5.4.4.1. a minimum risk manoeuvre may be initiated immediately in case of a severe ALKS or severe vehicle failure.</p> <p>In case of a severe ALKS or 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.</p> <p>5.4.4.1.2. The manufacturer shall declare the types of severe vehicle failures and severe ALKS failures that will lead the ALKS to initiate a MRM immediately.</p>		<p>Motorway Traffic Regulations respectively) to mitigate this risk. A driver needing to respond to a transition demand is compatible with the definition of AEVA and self-driving.</p>
<p>Recognise when it is operating outside of its operational design domain</p>	<p>5.4.1. The activated system shall recognise all situations in which it needs to transition the control back to the driver. Types of situations in which the vehicle will generate a transition demand to the driver shall be declared by the vehicle manufacturer and included in the documentation package required in Annex 4.</p> <p>5.1.9. When the system can no longer meet the requirements of this Regulation, it shall not be possible to activate the system. The manufacturer shall declare and implement a process to manage the safety and continued compliance of the ALKS system over lifetime.</p> <p>6.2.3. The system shall become active only upon a deliberate action by the driver and if all the following conditions are met:</p>	<ol style="list-style-type: none"> <li>1. Audit of safety documentation (Annex 4).</li> <li>2. Real-world demonstration drive (Annex 5).</li> </ol>	<p>The ALKS regulation requires that the vehicle detect when it has exited, or is outside of, its operational design domain.</p>

Test criterion	Relevant ALKS requirement(s) (Paragraph numbers relate to the paragraph in the ALKS adopted text)	Evidence and assessment methods	Government assessment/reasoning
	<ul style="list-style-type: none"> <li>- The driver is in the driver seat and the driver's safety belt is fastened according to paragraphs 6.1.1. and 6.1.2.;</li> <li>- The driver is available to take over control of the DDT according to paragraph 6.1.3.;</li> <li>- No failure affecting the safe operation or the functionality of the ALKS is present;</li> <li>- DSSAD is operational;</li> <li>- The environmental and infrastructural conditions allow the operation;</li> <li>- Positive confirmation of system self-check; and</li> <li>- <u>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.</u></li> </ul> <p>If any of the above conditions is no longer fulfilled, <u>the system shall immediately initiate a transition demand</u> unless specified differently in this Regulation.</p>		

## Control Test

*‘An individual does not need to control the vehicle when the Automated Driving System (ADS) is engaged if the vehicle can safely achieve the following without human control when the ADS is engaged, operating within its Operational Design Domain (ODD), and can identify the boundaries of that domain:’*

Test criterion	Relevant ALKS requirement(s)	Evidence and assessment methods	Government assessment/reasoning
<p>Dynamic Driving Task, incorporating:</p> <ol style="list-style-type: none"> <li>1. longitudinal dynamics (speed, acceleration, braking, gear selection)</li> <li>2. lateral dynamics (steering)</li> </ol>	<p>Introductory text: ALKS controls the lateral and longitudinal movement of the vehicle for extended periods without further driver command. ALKS is a system whereby the activated system is in primary control of the vehicle.</p> <p>2.1. “Automated Lane Keeping System (ALKS)” for low speed application is a system which is activated by the driver and which keeps the vehicle within its lane for travelling speed of 60 km/h or less by controlling the lateral and longitudinal movements of the vehicle for extended periods without the need for further driver input.</p> <p>5.1.1. The activated system shall perform the DDT shall manage all situations including failures, and shall be free of unreasonable risks for the vehicle occupants or any other road users.</p> <p>5.1.2. The activated system shall comply with traffic rules relating to the DDT in the country of operation.</p> <p>5.2. Dynamic Driving Task</p> <p>5.2.1. The activated system shall keep the vehicle inside its lane of travel and ensure that the vehicle does not cross any lane marking (outer edge of the front tyre to outer edge of the lane marking). The system shall aim to keep the vehicle in a stable lateral position inside the lane of travel to avoid confusing other road users.</p> <p>5.2.2. The activated system shall detect a vehicle driving beside as defined in paragraph 7.1.2. and, if necessary, adjust</p>	<p>Audit of safety documentation (Annex 4) Physical testing (Annex 5):</p> <ol style="list-style-type: none"> <li>1) Lane Keeping - the test shall demonstrate that the ALKS does not leave its lane and maintains a stable position inside its ego lane across the speed range and different curvatures within its system boundaries.</li> <li>2) Collision avoidance – avoid a collision with stationary road user blocking the lane</li> <li>3) Following a lead vehicle - The test shall demonstrate that the ALKS is able to maintain and restore the required safety distance to a vehicle in front and is able to avoid a collision with a lead vehicle which decelerates up to its maximum deceleration.</li> <li>4) Lane change of another vehicle into lane</li> <li>5) Stationary obstacle after a lane change of a lead vehicle – avoid a collision with an object that appears as a result of a lead vehicle moving out of lane.</li> </ol>	<p>ALKS is designed to keep a vehicle in lane and safely control speed, acceleration, braking, and gear selection.</p>

the speed and/or the lateral position of the vehicle within its lane as appropriate.

5.2.3. The activated system shall control the speed of the vehicle.

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5.2.3.3. The activated system shall detect the distance to the next vehicle in front as defined in paragraph 7.1.1. and shall adapt the vehicle speed in order to avoid collision.

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.

6.2.6. On deactivation of the system, there shall not be an automatic transition to any function, which provides continuous longitudinal and/or lateral movement of the vehicle (e.g. ACSF of Category B1 function).

After deactivation, Corrective Steering Function (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 imminent collision situations (e.g. Advanced Emergency Braking System (AEBS), Electronic Stability Control (ESC), Brake Assist System (BAS) or Emergency Steering Function (ESF)) shall not be deactivated in case of deactivation of ALKS.

6.3.1. A driver input to the steering control shall override the lateral control function of the system when the input exceeds a reasonable threshold designed to prevent unintentional override.

This threshold shall include a specified force and duration and shall vary depending on parameters that include criteria used for driver attentiveness to be checked during the drivers input as defined in paragraph 6.3.1.1.

	These thresholds and the rational for any variation shall be demonstrated to the Technical Service during the assessment according to Annex 4.		
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