Proposal for amendments to

ECE/TRANS/WP.29/2020/81

The text reproduced below was prepared by the experts from the EC. The proposal is aimed at modifying the text of document ECE/TRANS/WP.29/2020/81 (Regulation 157 on ALKS). This document proposes a new annex (Annex 6) to amend Regulation 157, although it contains Section 5.4 in Annex 5 from the original text, which is given without highlighting. All modifications to ECE/TRANS/WP.29/2020/81 are given in **blue** text. Deletions are indicated by ~~red strikethrough~~ text.

I. Proposal

Annex 6, amend to read:

Specification for public road testing of ADSs

1.   Introduction

This annex defines ~~real world~~ **public road** tests ~~with the purpose to verify the technical requirements~~ on ~~ALKS~~ **ADS**. The ~~Technical Service shall conduct, or shall witness, an assessment of~~ the system is functional and ~~complies with the minimum performance requirements~~ **approval authority shall verify that the considered ADS is functional and complies with its own minimum performance requirements**, in a fault-free condition, ~~in the presence of traffic~~ **under real traffic conditions** (a '~~real world~~ **public road**' test). The purpose of this test is to ~~support the Technical Service in understanding~~ **assess essential aspects of** the functionality of the system in its operating environment and to complement the assessment of the documentation provided under Annex 4.
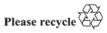
~~Until such time that specific test provisions have been agreed, the Technical Service shall ensure that the ALKS is subject to at least the tests outlined in Annex 5.~~ The ~~specific test parameters for~~ **parameters specific to** each test shall be selected by the ~~Technical Service~~ **approval authority** and shall be recorded in the test report in such a manner that allows traceability and repeatability of the test setup.

Together, the assessment of Annex 4 and the ~~real world~~ **public road** test shall enable the ~~Technical Service~~ **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 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).~~

The requirements are defined in such a way that the pass/fail criteria can be derived not only for a specific set of test parameters, but also for all safety-relevant combinations of parameters that may occur in the operating conditions covered by the type approval and the specified operating range (e.g. speed range, longitudinal and lateral acceleration range, radii of curvature, light conditions, number of lanes, etc.).

The test ~~specifications~~ **specified** in this document ~~are meant to be~~ **shall be intended as** a minimum set of tests~~,~~**.** ~~t~~**T**he ~~technical service~~ **approval**

authorities may perform ~~any other~~ **additional** test**s** within the system **ODD** ~~boundaries~~ and ~~may then~~ compare the measured results against the requirements.

~~It is recommended that~~ **T**he ~~real world~~ **public road** test ~~is~~ **shall be** undertaken once the system has passed ~~all of~~ the tests **under the provisions** outlined **in paragraphs 3 to 4.11 and paragraph 5 to** ~~this~~ **Annex 5** and upon completion of a risk assessment by the ~~Technical Service~~ **approval authority**.

2.	**Definitions**

for the purposes of this Annex

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.**
2.2.	*"Normal operation"* **means the operation within specified operational limits and conditions to perform the designed activity, including actions to ensure that the system stays within its operational limits.**
2.3.	*"Dense traffic conditions"* **means that ADS 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.**
2.4.	*"Free flow traffic conditions"* **means that ADS 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 to [90] km/h and lower than or equal to either the system maximum speed or the road maximum allowed, whichever lowest.**
2.5.	*"Congested traffic conditions"* **means that ADS operations are affected on a continuous basis by the behaviour of the surrounding vehicles. In this case the vehicle average speed shall be greater than [55] km/h to and lower than or equal to [90] km/h.**

3.	**General Principles**
3.1.	**The public road test shall primarily verify the ADS normal operation within (but including coming close to) the system boundaries. The manufacturer shall declare the system boundaries to the authority in accordance with Annex 4.**
3.2.	**For the public road test the authority shall assess the system in a fault-free condition of the vehicle and its ADS system. The systems carrying out the DDT shall not be modified for this test or set of tests; but additional system monitoring functions may be activated.**
4.	**Test conditions**
4.1.	The tests shall be performed under **starting** conditions (e.g. environmental, road geometry) that allow the activation of the ~~ALKS~~**ADS (excluding scenarios according to paragraph 5.7).**
4.2.	**The composition of the public road test shall allow the verification of the system on motorway free-flow condition and on motorway congested conditions.**
4.3.	The location and selection of the test route**s**, time-of-day and environmental conditions shall be determined by the ~~Technical Service~~ **approval authority. Such tests shall cover different time-of-day and light intensity. They shall include scenarios in which the ADS is expected to experience challenging scenarios (e.g. tight curvatures, speed changes caused by variable**

infrastructural or traffic conditions, merging situations) and to approach the limits of its declared ODD during ADS operation (changes in visibility or road conditions, planned or sudden end of ODD).

5.   **Test scenarios to assess the performance of the system under normal operation on public roads**

Public road testing shall include the following test scenarios to assess the performance of the system with regard to the DDT during a public road test under normal operating conditions.

Test scenarios shall be selected depending on the intended operating range (corresponding to an Operational Design Domain (ODD)).

5.1.   **Lane Keeping**

5.1.1. The public road test shall demonstrate that the ADS 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.

5.1.2. This test shall include at least:

   (a)   A passenger car, a PTW and a HDV as the lead vehicle;

   (b)   Another vehicle driving close beside in the adjacent lane.

5.2.   **Following a lead vehicle**

5.2.1. The public road test shall demonstrate that the ADS is able to maintain and restore the required safety distance to a vehicle in front.

5.2.2. This test shall be verified at least:

   (a)   Across the entire speed range of the ADS;

   (b)   With a passenger car, a PTW and a HDV as lead vehicle;

   (c)   For constant and varying lead vehicle velocities;

   (d)   For straight and curved sections of the road;

   (e)   For different lateral positions of lead vehicle in the lane.

5.3.   **Lane change of another vehicle into lane**

5.3.1. The public road test shall demonstrate that the ADS vehicle is capable of a proportional reaction to a vehicle cutting into the lane of the ADS vehicle.

5.3.3. This test shall satisfy at least the following conditions:

   (a)   For different TTC, distance and relative velocity values of the cut-in manoeuvre;

   (b)   For cutting-in vehicles travelling at constant longitudinal speed, accelerating and decelerating;

   (c)   For different lateral velocities, lateral accelerations of the cut-in vehicle;

5.4.   **Lane changing**

5.4.1. The public road test shall demonstrate that the ADS vehicle does not cause an unreasonable risk to safety of the vehicle occupants and other road users during a Lane Change Procedure (LCP), and that the system is able to correctly perform the assessment of the target lane in accordance with paragraph 5.2.6.6. of the present Regulation before starting the Lane Change Manoeuvre (LCM). The test is only required if the ADS vehicle is capable of performing lane changes during regular operation.

5.4.2.   This public road tests shall include:

(a) The ADS vehicle performing lane change in the adjacent (target) lane;

(b) Merging at motorway entry (if the ADS vehicle is capable of performing this maneuver);

(c) Merging at lane end (if the ADS vehicle is capable of performing this maneuver);

(d) Merging into an occupied lane.

5.4.3.   The public road tests shall include at least:

(a) Different vehicles, including a PTW approaching from the rear;

(b) A scenario where a lane changing manoeuvre in regular operation is possible to be executed;

(c) A scenario where a lane changing manoeuvre in regular operation is not possible due to a vehicle approaching from the rear;

(d) An equally fast vehicle following behind in the adjacent lane, preventing a lane change;

(e) A vehicle driving beside in the adjacent lane preventing a lane change;

(f) A scenario where a LCM during a minimal risk manoeuvre is possible and executed.

(g) A scenario where the ADS vehicle should abort the LCM maneuver due to changing scenario conditions such as an upcoming accelerating vehicle

5.5   Response to traffic rules and road furniture

5.5.1.   These public road tests shall ensure that the ADS respects traffic rules, detects and adapts to a variation of permanent and temporary road furniture.

5.5.2.   These tests shall include at least the list of scenarios below, but based on the ODD of the given system:

(a) Different speed limit signs, so that the ADS vehicle has to change its speed according to the indicated values;

(b) Driving through a tunnel: at least [X] m long section of the road with no sunlight and availability of the positioning system.

(c) Toll station: a section of the motorway with toll station-, speed limit signs and buildings (ticket machines, barriers, etc.).

(d) Temporary modifications: e.g., road maintenance operations indicated by traffic signs, cones and other modifications.

5.5.3.   Each test shall be verified at least:

(a) Without a lead vehicle;

(b) With a passenger car, a PTW and a HDV as the lead vehicle .

5.6.   Prevention of activation when the ADS system is outside the declared ODD of its technical boundaries/requirements for ALKS.

5.6.1.   This test shall ensure that the ADS system cannot be activated outside the declared ODD (i.e. geographical position, weather, road or light conditions, etc.).

5.7.   System override by the driver

5.7.1.   These public road tests shall ensure that the ADS stops performing the DDT in case of driver intervention.

5.7.2.   The tests shall include at least:

     a)   Intervention made by the steering wheel;

     b)   Intervention made by the acceleration pedal and

     c)   Intervention made by the brake pedal.

6.   **Test duration**

The duration of the test, or combination of tests, shall be such that allows recording at least [60] hours of ADS operation. The test shall include:

     a)   [4-10] hours of free-flow condition and

     b)   at least [5] hours of dense conditions.

The remaining test operation shall be predominantly under congested traffic conditions.

The test shall include situations where the ADS:

     a)   is involved in merging situations in congested traffic where the number of highway lanes is reduced (at least [10] situations starting from an ending lane and [10] situations from a continuous lane);

     b)   is approaching a standing end of a traffic jam (at least [10] situations);

     c)   is exposed to variable road signs (showing at least [3] different signs).

7.   **Data collection**

7.1.   **Minimum data channels**

To verify the performance of the system with regard to the dynamic driving task of the ADS during normal operation on the test scenarios prescribed in paragraph 5, the minimum data to be recorded during the public road test, or series of tests, shall include:

     (a)   ADS Vehicle longitudinal acceleration;

     (b)   ADS Vehicle lateral acceleration;

     (c)   ADS Vehicle longitudinal velocity;

     (d)   ADS Vehicle lateral velocity;

     (e)   ADS Vehicle position;

     (f)   ADS Vehicle distance to leading vehicle;

     (g)   Leading vehicle relative speed;

     (h)   Relative position of the ADS vehicle from lane markings;

     (i)   Traffic signs recognition along with their geo-localization;

     (j)   Follower vehicle's position to ADS vehicle;

     (k)   Follower vehicle's velocity to ADS vehicle;

     (l)   Position of the vehicle/s in the adjacent (target) lane;

     (m)   Velocity of the vehicle/s in the adjacent (target) lane.

     (n)   Quantitative safety metrics generated by the ADS to derive safety relevant behaviour changes.

Data from the test, or combination of tests, shall be recorded and the test vehicle instrumented with non-perturbing equipment.

Data from the test, or combination of tests, shall not be modified or be removed from the assessed test.

7.2.   **Further data channels**

The parameters listed in paragraph 7.1 are meant to be a minimum set of parameters. ~~The Technical Service may log, or request logs of~~ Any data channels used or generated by the system as deemed necessary for post-test evaluation **by the authority shall be logged. The quantitative safety metric which is used by the ADS in order to derive safety relevant behaviour changes may include several components. Relevant warning signals received (via communication/life HD map) or identified otherwise by the ADS (acoustical or optical emergency vehicle recognition) shall be logged.**

7.3.   **Data accuracy and acquisition frequency**

The accuracy of the logged data shall be at least within the statistical error of the best performing sensor used in the system to measure the same parameter. The data acquisition frequency shall be at least 10 Hz.

7.4.   **Data evaluation**

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

7.4.2.   If a collision or emergency manoeuvre cannot be avoided during the public road testing, the collected data will not be part of the verification under normal operation. The data collected under emergency operating conditions will be evaluated as part of the critical traffic scenarios assessment (see Annex 5).

7.4.3.   A qualified expert (or in case use new tools appear for automatic evaluation, they can be used as well) shall evaluate that the ADS:

a)   Respects the traffic rules;

b)   Adapts its operations to environmental conditions;

c)   Does not show an unpredictable behaviour creating a danger to surrounding traffic;

d)   Shows reasonable cooperative behaviour in relevant situations (i.e. merging in dense traffic).

7.4.4.   Time gap to leading vehicle, time gap left to the upcoming 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.

7.5.   **Data exchange and test report**

The data shall be exchanged between the measurement systems and the data evaluation software by a standardised data exchange file.

Any pre-processing of data shall be done with the control software of the measurement systems and shall be completed before the data exchange file is generated.

All data of a public road test shall be recorded according to a data reporting file.

A test report shall be prepared in accordance with a Data Reporting File and shall be made available to the Contracting Parties.