

**OICA proposal for an informal document amending GRRF/2007/28
(Possibility of ESC simulation in ECE 13H)**

A. PROPOSAL

Paragraph 3 of annex 9, amend to read (addition of a new subparagraph at the end **marked in bold**):

"3. PERFORMANCE REQUIREMENTS

During each test performed under the test conditions of paragraph 4 and the test procedure of paragraph 5.9., the vehicle with the ESC system engaged shall satisfy the directional stability criteria of paragraphs 3.1. and 3.2., and it shall satisfy the responsiveness criterion of paragraph 3.3. during each of those tests conducted with a commanded steering wheel angle of 5A or greater but limited as per paragraph 5.9.4., where A is the steering wheel angle computed in paragraph 5.6.1.

The equivalent performance to a physically tested version of the same vehicle type may be demonstrated by a computer simulation, which respects the test conditions of paragraph 4. and the test procedure of paragraph 5.9. The use of the simulator is defined in Appendix 1 to this Annex."

Add appendices 1 to 3 to annex 9:

"Annex 9 - Appendix 1

USE OF THE DYNAMIC STABILITY SIMULATION

The effectiveness of the electronic stability control system may be determined by computer simulation.

1. USE OF THE SIMULATION

1.1 The vehicle stability function shall be demonstrated by the vehicle manufacturer to the Type Approval Authority or Technical Service by simulating the dynamic manoeuvres of paragraph 5.9. of Annex 9.

1.2. The simulation shall be a means whereby the vehicle stability performance shall be demonstrated with:

- the yaw rate, one second after completion of the sine with dwell steering input (time $T_0 + 1$)
- the yaw rate, 1.75 seconds after completion of the Sine with Dwell steering input
- the lateral displacement of the vehicle centre of gravity with respect to its initial straight path

1.3. The simulation shall be carried out with a validated modelling and simulation tool and using the dynamic manoeuvres of paragraph 5.9. of Annex 9 under the test conditions of paragraph 4. of Annex 9.

The method by which the simulation tool is validated is given in Appendix 2 to this annex.

Annex 9 - Appendix 2

DYNAMIC STABILITY SIMULATION TOOL AND ITS VALIDATION

1. SPECIFICATION OF THE SIMULATION TOOL

1.1. The simulation method shall take into account the main factors which influence the directional and roll motion of the vehicle. A typical model may include the following vehicle parameters in an explicit or implicit form:

- (a) Axle/wheel
- (b) Suspension
- (c) Tyre
- (d) Chassis/vehicle body
- (e) Power train/driveline, if applicable
- (f) Brake system
- (g) Pay load

1.2. The Vehicle Stability Function shall be added to the simulation model by means of:

- a) a subsystem (software model) of the simulation tool, or
- b) the electronic control box in a hardware-in-the-loop configuration.

2. VALIDATION OF THE SIMULATION TOOL

2.1. The validity of the applied modelling and simulation tool shall be verified by means of comparisons with practical vehicle tests. The tests utilised for the validation shall be the dynamic manoeuvres of paragraph 5.9. of Annex 9.

During the tests, the following motion variables, as appropriate, shall be recorded or calculated in accordance with ISO 15037 Part 1:2005: General conditions for passenger cars or Part 2:2002: General conditions for heavy vehicles and buses (depending on the vehicle category):

- a) steering-wheel angle (δ_H)
- b) longitudinal velocity (v_X)
- c) sideslip angle (β) or lateral velocity (v_Y);(optional)
- d) longitudinal acceleration (a_X); (optional)
- e) lateral acceleration (a_Y)
- f) yaw velocity ($d\psi/dt$)
- g) roll velocity ($d\phi/dt$)
- h) pitch velocity ($d\theta/dt$)
- i) roll angle (ϕ)
- j) pitch angle (θ)

2.2. The objective is to show that the simulated vehicle behaviour and operation of the vehicle stability function is comparable with that seen in practical vehicle tests.

2.3. The simulator shall be deemed to be validated when its output is comparable to the practical test results produced by a given vehicle type during the dynamic manoeuvres of paragraph 5.9. of Annex 9. The relationship of activation and sequence of the vehicle stability function in the simulation and in the practical vehicle test shall be the means of making the comparison.

- 2.4. The physical parameters that are different between the reference vehicle and simulated vehicle configurations shall be modified accordingly in the simulation.
- 2.5. A simulator test report shall be produced, a model of which is defined in Appendix 3 to this annex, and a copy attached to the vehicle approval report.

Annex 9 - Appendix 3

VEHICLE STABILITY FUNCTION SIMULATION TOOL TEST REPORT

Test Report Number:

- 1. Identification
 - 1.1. Name and address of the simulation tool manufacturer
 - 1.2. Simulation tool identification: name/model/number (hardware and software)
- 2. Scope of application
 - 2.1. Vehicle type:
 - 2.2. Vehicle configurations:
- 3. Verifying vehicle test
 - 3.1. Description of vehicle(s):
 - 3.1.1. Vehicle(s) identification: make/model/VIN
 - 3.1.2. Vehicle description, including suspension/wheels, engine and drive line, braking system(s), steering system, with name/model/number identification:
 - 3.1.3. Vehicle data used in the simulation (explicit):
 - 3.2. Description of location(s), road/test area surface conditions, temperature and date(s):
 - 3.3. Results with the vehicle stability function switched on and off, including the motion variables referred to in Annex 9, Appendix 2, paragraph 2.1. as appropriate:
- 4. Simulation results
 - 4.1. Vehicle parameters and the values used in the simulation that are not taken from the actual test vehicle (implicit):
 - 4.2. Yaw stability and lateral displacement according to paragraphs 3.1 to 3.3 of Annex 9
- 5. This test has been carried out and the results reported in accordance with Appendix 2 of Annex 9 to ECE Regulation No. 13H as last amended by the series of amendments.

Technical Service conducting the test 1/

Signed: Date:

Approval Authority 1/

Signed: Date:

1/ To be signed by different persons if the Technical Service and the Approval Authority is the same organisation."

B. JUSTIFICATION

As the individual stability performance of the different versions of one vehicle type depends on many different parameters, it will be difficult to identify a worst-case version for the type approval test. In consequence, this could lead to the mandatory physical testing of all versions of a given vehicle type which may lead to several hundreds of physical tests.

A simulation could be appropriate in order to compare the performance of different versions to the related physically tested version and to keep a reasonable number of physical tests.

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