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**Economic Commission for Europe****Inland Transport Committee****World Forum for Harmonization of Vehicle Regulations****Working Party on Brakes and Running Gear****Seventy-fourth session**

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Item 3(a) the provisional agenda

**Regulations Nos. 13 and 13-H (Braking) - Electronic Stability Control (ESC)****Proposal for Supplement 10 to the 11 series of amendments to Regulation No. 13 (Heavy vehicle braking)****Submitted by the informal group on Alternative Method to assess the Electronic Vehicle Stability Control system (AMEVSC)\***

The text reproduced below was prepared by the informal group on Alternative Method to assess the Electronic Vehicle Stability Control system (AMEVSC) clarifying the requirements in Annex 21 of UN Regulation No. 13 on the use of simulation, specifically in the Appendices 1, 2 and 3 of Annex 21. As a result of comments made at the seventy-second session of the Working Party on Brakes and Running Gear (GRRF) (ECE/TRANS/WP.29/GRRF/72, para. 14) and subsequent meetings of the AMEVSC informal working group, the document ECE/TRANS/WP.29/GRRF/2012/2 were revised. The amendments are as detailed in document AMEVSC-09-06e. Modifications to the current provisions of the Regulation are marked in bold characters for new and strikethrough for deleted characters. Note: the amendments proposed in ECE/TRANS/WP.29/2011/94 that were marked in the original document are no longer marked as they were agreed at the 156<sup>th</sup> (March 2012) session of the World Forum for Harmonization of Vehicle Regulations (WP.29/AC.1)

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\* In accordance with the programme of work of the Inland Transport Committee for 2010–2014 (ECE/TRANS/208, para. 106, ECE/TRANS/2010/8, programme activity 02.4), the World Forum will develop, harmonize and update Regulations in order to enhance the performance of vehicles. The present document is submitted in conformity with that mandate.

## I. Proposal

*Annex 21, Appendix 1, amend to read:*

### "Annex 21

#### Appendix 1

#### Use of the dynamic stability simulation

The effectiveness of the directional and/or roll-over stability control function of power driven vehicles and trailers of categories M, N and O, 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 with the same dynamic manoeuvre(s) as for the practical demonstration in paragraph 2.1.3. or 2.2.3. of Annex 21.
  - 1.2. The simulation shall be a means whereby the vehicle stability performance may be demonstrated with the vehicle stability function enabled or disabled, and in the laden and unladen conditions.
  - 1.3. The simulations shall be carried out with a validated modelling and simulation tool. **The simulation tool shall only be used when each relevant parameter of the vehicle to be type-approved, as listed in paragraph 1.1. of Appendix 2 of this Annex, is included in the simulation tool and when the value of each parameter falls within its respective validated range.** The verification shall be carried out using the same manoeuvre(s) as defined in paragraph 1.1. ~~above~~ of this Appendix.

The method by which the simulation tool is validated is given in Annex 21, Appendix 2.

- 1.3.1. **A vehicle manufacturer using a validated simulation tool that was not directly validated by themselves for a vehicle type-approval shall carry-out at least one confirmation test.**

**This confirmation test shall be conducted in conjunction with a Technical Service and shall be a comparison between an actual vehicle test and a simulation using one of the manoeuvres as defined in paragraph 1.1. of this Appendix.**

**The confirmation test shall be repeated in the event of any change to the simulation tool.<sup>1</sup>**

**The results of the confirmation test shall be attached to the type-approval documentation.**

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<sup>1</sup> The necessity of a confirmation test shall be subject to a discussion between the vehicle manufacturer, the Technical Service and the Approval Authority. "

- 1.4. The availability of the simulation tool software, to the software version used, shall be maintained for a period of not less than 10 years."

*Annex 21, Appendix 2, amend to read:*

## "Annex 21

### Appendix 2

#### Dynamic stability simulation tool and its validation

1. Specification of the simulation tool
  - 1.1. The simulation ~~method~~ **tool** shall take into account the main factors which influence the directional and roll motion of the vehicle.
    - 1.1.1. ~~A typical model may include~~ **The simulation tool shall take into account the following vehicle parameters in an explicit or implicit form as applicable:**<sup>1</sup>
      - ~~(a) Axle/wheel~~
      - ~~(b) Suspension~~
      - ~~(c) Tyre~~
      - ~~(d) Chassis/vehicle body~~
      - ~~(e) Power train/driveline, if applicable~~
      - ~~(f) Brake system~~
      - ~~(g) Pay load~~
      - (a) **Vehicle category;**
      - (b) **Character of the vehicle;**
      - (c) **Gearbox type (e.g. manual, automated manual, semi-automatic, automatic);**
      - (d) **Differential type (e.g. standard or self-locking);**
      - (e) **Differential lock(s) (driver selected);**
      - (f) **Brake system type (e.g. air over hydraulic, full air);**
      - (g) **Brake type (e.g. disc, drum (single wedge, twin wedge, S-cam));**
      - (h) **Tyre type (e.g. structure, category of use, size);**
      - (i) **Suspension type (e.g. air, mechanical, rubber).**
    - 1.1.2. **The simulation model shall include at least the following parameters as applicable:**<sup>1</sup>
      - (a) **Vehicle configuration(s) (e.g. 4x2, 6x2, etc., identifying axle functionality (e.g. free running, driven, lifted, steered) and position);**
      - (b) **Steering axles (working principle);**

- (c) **Steering ratio;**
- (d) **Drive axle(s) (effect on wheel speed sensing and vehicle speed);**
- (e) **Lift axle(s) (detection/control and wheelbase change effect when lifted);**
- (f) **Engine management (communication, control and response);**
- (g) **Gearbox characteristic(s);**
- (h) **Drive train option(s) (e.g. retarder, regenerative braking, auxiliary propulsion system);**
- (i) **Brake characteristic(s);**
- (j) **Anti-lock braking configuration;**
- (k) **Wheelbase;**
- (l) **Track width;**
- (m) **Centre of gravity height;**
- (n) **Lateral acceleration sensor position;**
- (o) **Yaw rate sensor position;**
- (p) **Loading.**

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<sup>1</sup> **Parameters not taken into account shall limit the use of the simulation tool.**

**1.1.3. The Technical Service conducting the validation shall be provided with an information document covering at least the points in paragraphs 1.1.1. and 1.1.2. above.**

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 **as software-in-the-loop**, or
- b) ~~The~~ **An actual** electronic control ~~box~~ **unit** in a hardware-in-the-loop configuration.

1.3. In the case of a trailer, the simulation shall be carried out with the trailer coupled to a representative towing vehicle.

1.4. Vehicle loading condition

1.4.1. ~~The simulator~~ **simulation tool** shall be able to take into account the laden and unladen conditions.

1.4.2. ~~The load shall be considered to be a fixed load with given properties (mass, mass distribution and maximum recommended height of the centre of gravity) specified by the manufacturer.~~

**The simulation tool shall, as a minimum, meet the following criteria:**

- **a fixed load,**

- a given mass,
- a given mass distribution, and
- a given height of the centre of gravity,

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 a practical vehicle test(s). The test(s) utilised for the validation shall be those which, without control action, would result in loss of directional control (under-steer and over-steer) **and/or** roll-over control as appropriate to the functionality of the stability control function installed on a ~~representative~~ vehicle.

During the test(s) the following motion variables, as appropriate, shall be recorded or calculated in accordance with ISO 15037 Part 1:2005 ~~2006: General conditions for passenger cars~~ or Part 2:2002: ~~General conditions for heavy vehicles and buses (depending on the vehicle category)~~ as relevant:

- (a) Yaw velocity;
- (b) Lateral acceleration;
- (c) Wheel load or wheel lift;
- (d) Forward velocity;
- (e) Driver input.

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.

**The ability of the simulation tool to be used with parameters that have not been validated by a practical vehicle test shall be shown by conducting simulations with varied parameter values. The results of these simulations shall be checked to be logical and similar in comparison to the results of known practical vehicle tests.**

2.3. The ~~simulator~~ **simulation tool** shall be deemed to be validated when its output is comparable to the practical test results produced by the same vehicle(s) during the manoeuvre(s) selected from those defined with paragraph 2.1.3. or 2.2.3. of Annex 21, as appropriate.

The ~~simulator~~ **simulation tool** shall only be used with regard to features for which a comparison has been made between real vehicle tests and ~~simulator~~ **simulation tool** results. The comparisons shall be carried-out in the laden and unladen condition to show the different conditions of load can be adapted to and to confirm the extreme parameters to be simulated, e.g.:

- (a) Vehicle with shortest wheelbase and highest centre of gravity;
- (b) Vehicle with longest wheelbase and highest centre of gravity.

In the case of the steady state circular test the under-steer gradient shall be the means of making the comparison.

In the case of a dynamic manoeuvre, 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~~ **simulation tool** test report shall be produced, a model of which is defined in Appendix 3 of this annex, and a copy attached to the vehicle approval report.
- 2.5.1. **A simulation tool validation carried-out in accordance with Annex 21 Appendix 2 and Appendix 3, prior to the entry into force of Supplement [10] to the 11 series of amendments to this Regulation, may continue to be used for a new vehicle stability function approval or extension of an existing vehicle stability function approval provided that the relevant technical requirements are fulfilled and the scope of application is complied with."**

*Annex 21, Appendix 3, amend to read:*

## "Annex 21

### 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. Simulation tool
  - 2.1. Simulation method (general description, taking into account the requirements of paragraph 1.1. of Appendix 2 to Annex 21)
  - 2.2. Hardware/software in the loop (see paragraph 1.2. of Appendix 2 to Annex 21)
  - 2.3. Vehicle loading conditions (see paragraph 1.4. of Appendix 2. to Annex 21)
  - 2.4. Validation (see paragraph 2. of Appendix 2 to Annex 21)
  - 2.5. Motion variables (see paragraph 2.1. of Appendix 2 to Annex 21)
- 3. Scope of application
  - 3.1. Vehicle category:**
    - ~~3.1.~~ **3.2.** Character of **the** vehicle (~~e.g. truck, tractor for semi-trailer, bus, semi-trailer, centre-axle trailer, full trailer~~)
    - ~~3.2.~~ **3.3.** Vehicle configuration: (~~e.g. 4x2, 4x4, 6x2, 6x4, 6x6~~)
  - 3.4. Steering axles:**
  - 3.5 Steering ratio:**
  - 3.6. Drive axles:**

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- 3.7. **Lift axles:**
  - 3.8. **Engine management:**
  - 3.9. **Gearbox type:**
  - 3.10. **Drive train options:**
  - 3.11. **Differential type:**
  - 3.12. **Differential lock(s):**
  - 3.13. **Brake system type:**
  - 3.14. **Brake type:**
  - 3.15. **Brake characteristics:**
  - 3.16. **Anti-lock braking configuration:**
  - 3.17. **Wheelbase:**
  - 3.18. **Tyre type:**
  - 3.19. **Track width:**
  - 3.20. **Suspension type:**
  - 3.21. **Centre of gravity height:**
  - 3.22. **Lateral acceleration sensor position:**
  - 3.23. **Yaw rate sensor position:**
  - 3.24. **Loading:**
  - ~~3.3.~~ 3.25. Limiting factors: ~~(e.g. mechanical suspension only)~~
  - ~~3.4.~~ 3.26. Manoeuvre(s) for which the ~~simulator~~ **simulation tool** has been validated:
    - 4. Verifying vehicle test(s)
      - 4.1. Description of vehicle(s) including the towing vehicle in case of trailer testing:
        - 4.1.1. Vehicle(s) identification: make/model/VIN
          - 4.1.1.1. Non-standard fitments:
        - 4.1.2. Vehicle description, including axle configuration/suspension/wheels, engine and drive line, braking system(s) and vehicle stability function content (directional control/rollover control), steering system, with name/model/number identification:
        - 4.1.3. Vehicle data used in the simulation (explicit)
      - 4.2. Description of test(s) including location(s), road/test area surface conditions, temperature and date(s):
      - 4.3. Results laden and unladen with the vehicle stability function switched on and off, including the motion variables referred to in Annex 21, Appendix 2, paragraph 2.1. as appropriate:
    - 5. Simulation results
      - 5.1. Vehicle parameters and the values used in the simulation that are not taken from the actual test vehicle (implicit):

5.2. Results laden and unladen with the vehicle stability function switched on and off for each test conducted under paragraph ~~3.2.~~ **4.2.** of this appendix, including the motion variables referred to in Annex 21, Appendix 2, paragraph 2.1. as appropriate:

**6. Concluding statement**

**The simulated vehicle behaviour and operation of the vehicle stability function is comparable with that of practical vehicle tests.**

**Yes/No**

**7. Limiting factors**

~~6.~~ **8.** This test has been carried out and the results reported in accordance with Appendix 2 of Annex 21 to ECE Regulation No. 13 as last amended by the ... series of Amendments.

Technical Service conducting the test <sup>1</sup> .....

Signed: ..... Date: .....

Approval Authority <sup>1</sup> ....."

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<sup>1</sup> To be signed by different persons if the Technical Service and the Approval Authority are the same organisation.

## II. Justification

The proposed amendments to Appendices 1, 2 and 3 of Annex 21 provide clarification on the use and validation of the simulation tool. A more uniformed application of the process can be ensured through a more detailed definition of the requirements. Consistent terminology is used and the continued use of existing simulation tool validation test reports is allowed provided that the relevant technical requirements are fulfilled and the scope of application is complied with.

### Appendix 1, paragraph 1.3.

The amendment ensures that the simulation tool can only be used in a braking system type-approval when the vehicle parameters of the vehicle to be type-approved are included in the simulation tool and when the value of each parameter is within the validated range of the simulation tool.

### Appendix 1, paragraph 1.3.1.

As the tool is basically only software, this new paragraph ensures that a vehicle manufacturer does not blindly use a tool from a third/fourth/fifth/... party. A vehicle manufacturer using an externally sourced simulation tool must carry-out at least one confirmation test in conjunction with a Technical Service. A footnote is added with regard to a change to the simulation tool so that a new conformation test is not automatically required, independent of the significance of the change.

### Appendix 1, paragraph 1.4.

This new paragraph ensures that it would be possible to re-evaluate the use of the tool for a period of at least 10 years, should it be necessary.



**Appendix 2, paragraph 1.1.**

The current use of the word "may" means that vehicle parameters that could affect the performance of a vehicle stability function do not have to be included in the tool. The "may" is changed to "shall", the list of vehicle parameters to be considered is expanded to be more comprehensive and a footnote ensures that parameters not covered shall be a limitation on the use of the tool.

All the listed parameters are divided into 2 types and placed in 2 new subparagraphs 1.1.1. and 1.1.2..

1.1.1. – Parameters that do not have a numerical value, but are important in understanding the capability of the simulation tool.

1.1.2. – Parameters that have a numerical value within the simulation model.

Wording "at least" is included in the introduction sentence of paragraph 1.1.2. so as to ensure that a simulation tool manufacturer can added additional parameters, to those listed, to the simulation tool.

For consistency of terminology and clarity, the word "simulator" is replaced by "simulation tool" (through-out the document).

**Appendix 2, paragraph 1.1.1.**

The new paragraph provides the Technical Service with information on the claimed performance of the tool.

**Appendix 2, paragraph 1.2.**

These small amendments provide a better understanding, without changing the requirements.

**Appendix 2, paragraph 1.4.2.**

Clarification that the load acts at a fixed point during the simulation, but that it is moveable as required by paragraph 1.4.1. of Appendix 2, and that the tool manufacturer can include other features with regard to load.

**Appendix 2, paragraph 2.1.**

Motor vehicles are required to have both direction control and roll-over control and, therefore, it is appropriate to add the word "and". The word "representative" is deleted as there is no definition of what it means, and as the verification is by comparison with actual vehicles test results, it is not necessary to define representative. The titles of the ISO standards bring no benefit and are, therefore, deleted. Part 1 of ISO 15037 was revised in 2006 and the date is, therefore, changed.

**Appendix 2, paragraph 2.2.**

The added paragraph clarifies the conditions under which parameters can be validated without a practical vehicle test result with which to compare the performance of the tool.

**Appendix 2, paragraph 2.5.1.**

As the proposed amendment does not justify the status of a "series" there will be no transitional provisions. However, it is considered that is should be possible to continue to use any simulation tool validation test reports that have been approved prior to this amendment, if the relevant technical requirements are fulfilled and the scope of application is complied with. This is the same approach as allowed under

Supplement 4 to the 10 Series of amendments (Annex 11, Appendix 2, paragraph 1.2.1.).

**Appendix 3, paragraph 3, new subparagraphs**

The list of vehicle parameters to be considered under paragraph 1.1. of Appendix 1 is included in the test report to ensure that each is covered.

**Appendix 3, paragraph 5.2.**

Correction of paragraph cross-referencing.

**Appendix 3, paragraph 6.**

A concluding statement with any limiting factors is added as a new paragraph so that there is an easily understood statement as to the capability/use of the tool.

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