



# Economic and Social Council

Distr.: General  
11 April 2013

Original: English

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## Economic Commission for Europe

### Inland Transport Committee

### World Forum for Harmonization of Vehicle Regulations

#### 160<sup>th</sup> session

Geneva, 25-28 June 2013

Item 4.9.1. of the provisional agenda

**1958 Agreement – Consideration of draft amendments  
to existing Regulations submitted by GRRF**

### **Proposal for Supplement 10 to the 11 series of amendments to Regulation No. 13 (Heavy vehicle braking)**

#### **Submitted by the Working Party on Brakes and Running Gear\***

The text reproduced below was adopted by the Working Party on Brakes and Running Gear (GRRF) at its seventy-fourth session (ECE/TRANS/WP.29/GRRF/74, paras. 5, 10, 15 and 13). It is based on ECE/TRANS/WP.29/GRRF/2013/10 as amended by para. 5 of the report, ECE/TRANS/WP.29/GRRF/2012/21, ECE/TRANS/WP.29/GRRF/2012/16 as amended by Annex VIII of the report, and para. 15 of the report. It is submitted to the World Forum for Harmonization of Vehicle Regulations (WP.29) and to the Administrative Committee AC.1 for consideration.

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\* In accordance with the programme of work of the Inland Transport Committee for 2010–2014 (ECE/TRANS/208, para. 106 and 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.

*Annex 4, paragraph 1.4.1.2.2., amend to read:*

"1.4.1.2.2. Every test shall be repeated ...

In the case of a vehicle equipped with an electric regenerative braking system ...

This requirement is deemed to be satisfied if the batteries are at one of the following state of charge conditions where state of charge 3/ is determined by the method set out in Appendix 1 to this annex:

- (a) At the maximum charge level as recommended by the manufacturer in the vehicle specification; or
- (b) At a level not less than 95 per cent of the full charge level, where the manufacturer has made no specific recommendation; or
- (c) At the maximum level which results from automatic charge control on the vehicle, or
- (d) When the tests are conducted without a regenerative braking component regardless of the state of charge of the batteries."

*Annex 4, paragraph 1.5.3.1.3., amend to read:*

"1.5.3.1.3. In the case of vehicles ...

... against the criteria of paragraphs 1.5.3.1.1. and 1.5.3.2. of this Annex.

The tests may be conducted without a regenerative braking component. In this case, the requirement on the state of charge of the batteries is not applicable."

*Annex 4, Appendix, introductory paragraph, second sentence, amend to read:*

"The procedure requires the use of a bi-directional DC Watt-hour meter or a bi-directional DC Ampere-hour meter."

*Annex 10, paragraph 4.1.2., amend to read:*

"4.1.2. The provision of paragraph 4.1.1. does not have to be fulfilled, if a semi-trailer with a  $K_c$  factor less than 0.95 meets at least the braking performance specified in paragraph 3.1.2.1. or in paragraph 3.1.3.1., as appropriate, of Annex 4 to this Regulation."

*Annex 12, Appendix 4, item 9 to be deleted, including footnote 3.*

*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 to this Regulation.
  - 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 to Annex 21 to this Regulation, 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. of this appendix to Annex 21 to this Regulation.

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

    - 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.
    - 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 following the date of the approval of the vehicle.

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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 Type Approval Authority. "

*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 tool shall take into account the main factors which influence the directional and roll motion of the vehicle.
    - 1.1.1. The simulation tool shall take into account the following vehicle parameters as applicable<sup>1</sup>:
      - (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;

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<sup>1</sup> Parameters not included shall limit the use of the simulation tool.

- (m) Centre of gravity height;
  - (n) Lateral acceleration sensor position;
  - (o) Yaw rate sensor position;
  - (p) Loading.
- 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) 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 simulation tool shall be able to take into account the laden and unladen conditions.
- 1.4.2. The simulation tool shall, as a minimum, meet the following criteria:
- (a) A fixed load;
  - (b) A given mass;
  - (c) A given mass distribution; and
  - (d) 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 vehicle.
- During the test(s) the following motion variables, as appropriate, shall be recorded or calculated in accordance with ISO 15037 Part 1:2006 or Part 2:2002 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 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 to this Regulation, as appropriate.

The simulation tool shall only be used with regard to features for which a comparison has been made between real vehicle tests and 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 simulation tool 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.
- 2.5.1. A simulation tool validation carried-out in accordance with Appendix 2 and Appendix 3 to Annex 21 to this Regulation, 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 to this Regulation)
  - 2.2. Hardware/software in the loop (see paragraph 1.2. of Appendix 2 to Annex 21 to this Regulation)
  - 2.3. Vehicle loading conditions (see paragraph 1.4. of Appendix 2. to Annex 21 to this Regulation)
  - 2.4. Validation (see paragraph 2. of Appendix 2 to Annex 21 to this Regulation)
  - 2.5. Motion variables (see paragraph 2.1. of Appendix 2 to Annex 21 to this Regulation)
3. Scope of application:
  - 3.1. Vehicle category:
  - 3.2. Character of the vehicle:
  - 3.3. Vehicle configuration:
    - 3.4. Steering axles:
    - 3.5. Steering ratio:
    - 3.6. Drive axles:
    - 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:
- 3.25. Limiting factors:
- 3.26. Manoeuvre(s) for which the 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 paragraph 2.1. of Appendix 2 to Annex 21 to this Regulation, 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 4.2. of this appendix, including the motion variables referred to in paragraph 2.1. of Appendix 2 to Annex 21 to this Regulation, 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
  - 8. This test has been carried out and the results reported in accordance with Appendix 2 to Annex 21 to 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. "