

The following text is a clean version of the working document AMEVSC-09-05e in which all references to 'simulator' has been changed to 'simulation tool' and the justification text, as prepare by the AMEVSC secretariat, has been added.

It is the basis for the revision 1 amendment of GRRF/2012/2 to be submitted for consideration at the 73rd Session of GRRF (September 2012).

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 ~~the each~~ **relevant** parameters of the vehicle to be type-approved ~~fall within the validated range of parameters of the simulation tool.~~ , **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 **of this Annex.**

- 1.3.1. ~~In the case where a validated simulation tool is used by a vehicle manufacturer for whom the simulation tool was not validated, a single confirmation test shall be conducted by the vehicle manufacturer in conjunction with a Technical Service.~~

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.

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

The confirmation test shall be repeated in the event of a change to the ~~vehicle stability function or simulation tool.~~^{1/}

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."

^{1/} **The necessity of a confirmation test shall be subject to a discussion between the vehicle manufacturer, the Technical Service and the Approval Authority.**

Annex 21, Appendix 2, amend to read:

"Annex 21

Appendix 2

Dynamic stability simulation tool and it 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. The simulation ~~model~~ **tool** shall ~~include~~ **take into account** the following **vehicle** parameters as applicable^{1/}:
 - (a) Vehicle category;
 - (b) Character of the vehicle;

- ~~(c)~~ Vehicle configuration(s) (e.g. 4x2, 6x2, etc., identifying axle functionality (e.g. free running, driven, lifted, steered) and position);
- ~~(d)~~ Additional steering axles (e.g. forced steering, self-steering);
- ~~(e)~~ Steering ratio;
- ~~(f)~~ Drive axles (effect on wheel speed sensing and vehicle speed);
- ~~(g)~~ Lift axles (detection/control and wheelbase change effect when lifted);
- ~~(h)~~ Engine management (communication, control and response);
- ~~(i)~~(c) Gearbox type (e.g. manual, automated manual, semi-automatic, automatic);
- ~~(j)~~ Drive train options (e.g. retarder);
- ~~(k)~~(d) Differential type (e.g. standard or self-locking);
- ~~(l)~~(e) Differential lock(s) (driver selected);
- ~~(m)~~(f) Brake system type (e.g. air over hydraulic, full air);
- ~~(n)~~(g) Brake type (e.g. disc, drum (single wedge, twin wedge, S-cam));
- ~~(o)~~ Anti lock braking configuration;
- ~~(p)~~ Wheelbase;
- ~~(q)~~(h) Tyre type (e.g. structure, category of use, size);
- ~~(r)~~ Track width;
- ~~(s)~~(i) Suspension type (e.g. air, mechanical, rubber);
- ~~(t)~~ Centre of gravity height;
- ~~(u)~~ Lateral acceleration sensor position;
- ~~(v)~~ Yaw rate sensor position;
- ~~(w)~~ Loading.

1.1.2. The simulation model shall include at least the following parameters as applicable ¹:

- (a) Vehicle configuration(s) (e.g. 4x2, 6x2, etc., identifying axle functionality (e.g. free running, driven, lifted, steered) and position);
- (b) **Additional Steering axles (e.g. forced steering, self-steering) (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.

¹ Parameters not covered ~~shall be a limitation on~~ **taken into account** shall ~~be a limitation on~~ **limit** the use of the ~~simulator~~ **simulation tool**.

- ~~1.1.1.~~ **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 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 height of the centre of gravity).~~
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 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: ~~(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 ~~simulator~~ **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:
 - 3.2. Character of the vehicle:
 - 3.3. Vehicle configuration:
 - 3.4. ~~Additional~~ 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 characteristic(s):**
- ~~3.15.~~ **3.16.** Anti-lock braking configuration:
- ~~3.16.~~ **3.17.** Wheelbase:
- ~~3.17.~~ **3.18.** Tyre type:
- ~~3.18.~~ **3.19.** Track width:
- ~~3.19.~~ **3.20.** Suspension type:
- ~~3.20.~~ **3.21.** Centre of gravity height:
- ~~3.21.~~ **3.22.** Lateral acceleration sensor position:
- ~~3.22.~~ **3.23.** Yaw rate sensor position:
- ~~3.23.~~ **3.24.** Loading:
- ~~3.24.~~ **3.25.** Limiting factors:
- ~~3.25.~~ **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 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 ¹

Signed: Date:

Approval Authority ¹"

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

II. Justification

The proposed amendments are to provide clarification, consistency of terminology and allow the continued use of existing simulation tool validation test reports provided that the relevant technical requirements are fulfilled and the scope of application is complied with.

1. Appendix 1, paragraph 1.3.

Structure of paragraph changed to provide clarification 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.

2. Appendix 1, paragraph 1.3.1.

Structure of paragraph changed to provide clarification that 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 confirmation test is not automatically required, independent of the significance of the change. Also, with regard to the need to repeat the confirmation test, the requirement regarding a change to the vehicle stability function has been deleted as this is covered by the parameters of the simulation tool.

3. Appendix 2, paragraph 1.1.

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

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

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

Changes within the parameters:

- Additional steering axles – The word “additional” and the examples have been deleted. This removes any confusion with regard to the word “additional” as the item now clearly applies to all steered axles. The added wording “working principle” in brackets indicates

that the influence of the steering on the vehicle stability function has to be considered in the simulation tool.

- Gearbox – In addition to gearbox type with examples in paragraph 1.1.1., gearbox characteristics are added to paragraph 1.1.2.. This allows the suitability of the simulation tool to be established with regard to different gearbox types, and the way in which they are taken into account within the simulation tool to be identified.
- Drive train options – Examples added for clarification.
- Brake – In addition to brake type in paragraph 1.1.1., brake characteristics are added to paragraph 1.1.2.. This allows both the suitability of the simulation tool to be established with regard to different brake types, and the way in which they are taken into account within the simulation tool to be identified.

Wording “at least” is included in the introducing sentence of paragraph 1.1.2. so as to ensure that a simulation tool manufacturer can add additional parameters, to those listed, to the simulation tool.

Footnote restructured to clarify that it is not necessary for the simulation tool to include all the listed parameters, but that any parameters that are not specifically accounted for shall be a limitation on the use of the simulation tool. For consistency of terminology and clarity, the word “simulator” is replaced by “simulation tool” (through-out the document).

4. Appendix 2, paragraph 1.4.2.

Paragraph structure revised to clarify that the requirement is a minimum specification for the simulation tool.

5. Appendix 2, paragraph 2.5.

New paragraph 2.5.1. added. As the proposed amendment does not justify the status of a “series” there will be no transitional provisions. However, it is considered that it 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 (Annex 11 Appendix 2 paragraph 1.2.1.).

6. Appendix 3.

Brought inline with the changes made to Appendix 2.
