Transmitted by the AMEVSC informal group

Informal document No. **GRRF-69-06-Rev.1**
(69th GRRF, 1-4 February 2011
agenda item 3(a))

Updating of document ECE/TRANS/WP.29/GRRF/2011/2(Regulation No. 13 (Heavy vehicle braking) - ESC)

The text reproduced below was prepared by the informal group on Alternative Method Electronic Vehicle Stability Control (AMEVSC) to introduce into Regulation No. 13 an alternative method to assess the Vehicle Stability Function of Heavy Duty motor vehicles. It is an update of the working document ECE/TRANS/WP.29/GRRF/2011/2 as a result of a subsequent informal working group meeting (GRRF-69-06), includes GRRF-69-22 and the modifications proposed during the 69th GRRF. Modifications to the current provisions of the regulation and to GRRF-69-06 are marked in bold characters for new and strikethrough for deleted text.

The modification proposed by GRRF-69-22:

- Annex 19 Appendix 12 Paragraph 6 Footnote
- Justification Paragraph 9 (r)

The modifications proposed during the 69th GRRF:

- Annex 19 Part 2 Paragraph 1.1.5.
- Annex 19 Appendix 12 Paragraphs 5.7., 5.7.1. and 5.7.2.
- Justification Paragraph 9 (r)

I. Proposal

Insert a new paragraph 2.38., to read:

"2.38. **"*Character of the vehicle*" means a descriptive term for a vehicle – tractor for semi-trailer, truck, bus, semi-trailer, full trailer, centre-axle trailer."**

Annex 19, amend to read (inserting also a new footnotes [1] and [2]):

"**Annex 19**

Performance testing of ~~trailer~~ braking system components

Part 1

Performance testing of trailer braking components

1. General

~~This annex~~ **Part 1** defines the test procedures applicable in defining the performance of the following:

…

6.6.1. A test report shall be produced, the content of which shall be at least that defined in Appendix 8 to this Annex.

Annex 19

Performance testing of ~~trailer~~ braking system components

Part 2

Performance testing of motor vehicle braking components

1. General

Part 2 defines the procedures applicable in defining the performance of the following:

1.1. A vehicle stability function.

1.1.1. General

1.1.1.1. This section defines the procedure of determining the dynamic characteristics of a vehicle equipped with a vehicle stability function as specified in paragraph 5.2.1.32. of this Regulation.

1.1.2. Information document

1.1..2.1. The system manufacturer shall supply the Technical Service with an information document on the vehicle stability control function(s) for which performance verification is required. This document shall contain at least the information defined in Appendix 11 to this annex and shall be attached as an appendix to the test report.

1.1..3. Definition of test vehicle(s)

1.1..3.1. Based on the stability control function(s) and their application(s) defined in the system manufacturer's information document, the Technical Service shall carry out a vehicle based performance verification. This shall include one or more dynamic manoeuvres as defined in paragraph 2.1.3. of Annex 21 to this Regulation on a motor vehicle(s) which is representative of the application(s) defined in paragraph 2.1. of the system manufacturers information document.

1.1.3.2. When selecting the motor vehicles(s) for evaluation, consideration shall also be given to the following:

(a) Braking system: the braking system of the test vehicle(s) to be evaluated shall comply with all of the relevant requirements of this Regulation;

(b) Vehicle category – M_2, M_3, N_2, N_3;

(c) Character of the vehicle;

(d) Vehicle configuration(s) (e.g. 4x2, 6x2, etc.): each configuration to be evaluated;

(e) Drive orientation (Left or right hand drive): not a limiting factor – evaluation not required;

(f) Single front axle steering: not a limiting factor – evaluation not required (see (g) and (h));

(g) Additional steering axles (e.g. forced steering, self-steering): to be evaluated;

(h) **Steering ratio: to be evaluated – end-of-line programming or self-learning systems not a limiting factor;**

(i) **Drive axles: to be taken into consideration with regard to the use (loss) of wheel speed sensing in the determination of vehicle speed;**

(j) **Lift axles: lift axle detection / control and lifted condition to be evaluated;**

(k) **Engine management: communication compatibility to be evaluated;**

(l) **Gearbox type (e.g. manual, automated manual, semi-automatic, automatic): to be evaluated;**

(m) **Drive train options (e.g. retarder): to be evaluated;**

(n) **Differential type (e.g. standard or self-locking): to be evaluated;**

(o) **Differential lock(s) (driver selected): to be evaluated;**

(p) **Brake system type (e.g. air over hydraulic, full air): to be evaluated;**

(q) **Brake type (disc, drum (single wedge, twin wedge, S-cam)): not a limiting factor, however, should other types become available, then comparative testing may be required;**

(r) **Anti-lock braking configurations: to be evaluated;**

(s) **Wheelbase: to be evaluated**

In the case where vehicles conforming to the minimum and maximum wheelbases as specified in the information document are not available at the time of testing, minimum and maximum wheelbase verification may be carried-out using system manufacturer test data for real vehicles with a wheelbase within 20 percent of the actual minimum and maximum wheelbase vehicles being tested by the Technical Service;

(t) **Wheel type (single or twin): to be covered in the system manufacturer's information document;**

(u) **Tyre type (e.g. structure, category of use, size): to be covered in the system manufacturer's information document;**

(v) **Track width: not a limiting factor – covered by variations in the centre of gravity evaluation;**

(w) **Suspension type (e.g. air, mechanical, rubber): to be evaluated;**

(x) **Centre of gravity height: to be evaluated**

In the case where vehicles conforming to the maximum centre of gravity height as specified in the information document are not available at the time of testing, maximum centre of gravity height verification may be carried-out utilising system manufacturer's test data for real vehicles with a centre of gravity height within +20 percent of the actual maximum centre of gravity height of the vehicles being tested by the Technical Service;

(y) **Lateral acceleration sensor position: installation envelop as specified by the system manufacturer to be evaluated;**

(z) **Yaw rate sensor position: installation envelop as specified by the system manufacturer to be evaluated.**

1.1.4. **Test schedule**

1.1.4.1. To evaluate the vehicle stability control function, the tests used shall be agreed upon between the system manufacturer and the Technical Service and shall include conditions, appropriate to the function being evaluated, that would without the intervention of the stability control function result in loss of directional control or roll-over control. The dynamic manoeuvres, test conditions and results shall be included in the test report.

The evaluation shall include the following, as appropriate:

1.1.4.1.1. Additional steering axles:

Evaluate the influence by a comparison of results with the axle in its normal steering mode and with the steering disabled so that it becomes a fixed axle, unless it is an end-of-line programming parameter.

1.1.4.1.2. Steering ratio:

Tests to be carried-out to determine the effectiveness of any end-of-line programming or self learning using a number of vehicles with different steering ratios, or the approval is restricted to the steering ratios actually tested.

1.1.4.1.3. Lift axle:

Tests to be carried-out with the lift axle in the raised and lowered conditions, with position detection and signal transfer being evaluated to establish that the change in wheelbase has been recognized.

1.1.4.1.4. Engine management:

Control of the engine, or any other source(s) of motive power, to be shown to be independent from driver demand.

1.1.4.1.5. Drive train options:

The effect of any options to be shown, e.g. retarder management to be independent of the driver in the case of a retarder.

1.1.4.1.6. Differential type/differential lock(s):

Effect of self-locking or driver selected locking to be shown, e.g. function maintained, reduced or switched-off.

1.1.4.1.7. Anti-lock braking configurations:

Each anti-lock braking configuration shall be tested on at least one vehicle.

If the vehicle stability function is hosted on different systems (e.g. ABS, EBS), tests shall be carried-out on vehicles having the different hosting systems.

1.1.4.1.8. Suspension type:

Vehicles shall be selected on the basis of the suspension type (e.g. air, mechanical, rubber) of each axle or axle group.

1.1.4.1.9. Centre of gravity height:

Tests shall be carried-out on vehicles where it is possible to adjust the centre of gravity height so as to demonstrate that the roll-over control is able to adapt to changes in the centre of gravity height.

1.1.4.1.10. Lateral acceleration sensor position:

The effect of the lateral acceleration sensor being installed in different positions on the same vehicle shall be evaluated to confirm the installation envelop specified by the system manufacturer.

1.1.4.1.11. Yaw rate sensor position:

The effect of the yaw rate sensor being installed in different positions on the same vehicle shall be evaluated to confirm the installation envelop specified by the system manufacturer.

1.1.4.1.12. Loading:

Vehicles shall be tested in both the laden and unladen/part laden conditions to demonstrate that the vehicle stability function is able to adapt to differing conditions of load.

In the case of a semi-trailer tractor, tests shall be carried-out as follows:

(a) With a coupled semi-trailer, in the laden and unladen/part laden conditions, in which the roll-over control, if fitted, has been disabled.

(b) In the solo condition (without a coupled semi-trailer or imposed load),

(c) With a load simulating the laden condition (without a coupled semi-trailer).

1.1.4.2. Evaluation of buses

As an alternative, in the case of buses, trucks having the same braking system type may be used in the evaluation. However, at least one bus shall be included in the testing and the subsequent report.

~~**1.1.5. Use of simulation**~~

~~**Simulation, using a simulation tool validated in accordance with Appendix 2 of Annex 21, may be used to evaluate the boundary conditions of the following:**~~

- ~~**Wheelbase**~~
- ~~**Centre of gravity**~~
- ~~**Lateral acceleration sensor position**~~
- ~~**Yaw rate sensor position**~~

1.1.~~6.~~5. Test report

1.1.~~6.~~5.1. A test report shall be produced, the content of which shall be at least that defined in Appendix 12 of this annex.

…

Annex 19

Appendix 7

Vehicle (trailer) stability function information document

…

Annex 19

Appendix 8

Vehicle (trailer) stability function test report

…

Annex 19

Appendix 11

Vehicle (motor vehicle) stability function information document

1. General:

1.1. Name of manufacturer

1.2. System

1.3. System variants

1.4. System options

1.4.1. Control function (directional/roll-over/both) including an explanation of the basic function and/or philosophy of the control

1.5. System configurations (where appropriate)

1.6. System identification including software level identifier

2. Applications:

2.1. List of motor vehicles by description and configuration that are covered by the information document

2.2. Schematic diagrams of the respective configurations installed on the motor vehicles defined in item 2.1. above with consideration given to the following:

(a) Lift axles

(b) Steering axles

(c) Anti-lock braking configurations

2.3. Scope of application with respect to suspension:

(a) Air

(b) Mechanical

(c) Rubber

(d) Mixed

(e) Anti-roll bar

2.4. Additional information (if applicable) to the application of the directional control and roll-over control functions, for example:

(a) Wheelbase, track, centre of gravity height

(b) Wheel type (single or twin) and tyre type (e.g. structure, category of use, size)

(c) Gearbox type (e.g. manual, automated manual, semi-automatic, automatic)

(d) Drive train options (e.g. retarder)

(e) Differential type/differential lock(s) (e.g. standard or self-locking, automatic or driver selected)

(f) Management of the engine or any other source(s) of motive power

(g) Brake type

3. Component Description:

3.1. Sensors external to the controller

(a) Function

(b) Limitations on the location of the sensors

(c) Identification (e.g. part numbers)

3.2. Controller(s)

(a) General description and function

(b) Functionality of internal sensors (if applicable)

(c) Hardware identification (e.g. part numbers)

(d) Software identification

(e) Limitations on the location of the controller(s)

(f) Additional features

3.3. Modulators

(a) General description and function

(b) Hardware identification (e.g. part numbers)

(c) Software identification (if applicable)

(d) Limitations

3.4. Electrical Equipment

(a) Circuit diagrams

(b) Powering methods

3.5. Pneumatic circuits

System schematics including anti-lock braking configurations associated with the motor vehicle types defined in item 2.1. of this appendix

3.6. Safety aspects of the electronic system in accordance with Annex 18 to this Regulation

3.7. Electro-magnetic compatibility

3.7.1. Documentation demonstrating compliance with Regulation No. 10 as required by paragraph 5.1.1.4. of this Regulation

Annex 19

Appendix 12

Vehicle (motor vehicle) stability function test report

Test Report No.: .....

1. Identification:

1.1. Manufacturer of the vehicle stability function (name and address)

1.2. Applicant (if different from the manufacturer)

1.3. Systems

1.3.1. System variants

1.3.2. System options

1.3.2.1. Control functions

2. System(s) and installations:

2.1. Anti-lock braking configurations

2.2. Vehicle applications

2.2.1. Vehicle category (e.g. N_2, N_3, etc.)

2.2.2. Character of the vehicle

2.2.3. Vehicle configuration(s) (e.g. 4x2, 6x2, etc.)

2.2.4. End of line programming

2.3. System identification

2.4. Functional description

2.4.1. Directional control

2.4.2. Roll-over control

2.4.3. Low speed operation

2.4.4. Off-road mode

2.4.5. Drive train options

2.5. Components

2.6. Trailer detection and functionality

2.7. Intervention warning

2.8. Failure warning

2.9. Stop lamp illumination

3.0. Assessed vehicle variables:

3.1. General

3.2 Brake system type

3.3. Brake type

3.4. Centre of gravity

3.5. Management of the engine or other source(s) of motive power

3.6. Gearbox type

3.7. Installation configurations

3.8. Lift axles

3.9. Effect of load variations

3.9.1. Roll-over control

3.9.2. Directional control

3.10. Steering ratio

3.11. Additional steering or steered axles

3.12. Suspension

3.13. Track width

3.14. Yaw rate and lateral acceleration sensor(s)

3.15. Wheelbase

3.16. Wheel type, tyre type, tyre size

4. Limits of Installation:

4.1. Suspension type

4.2. Brake type

4.3. Location of Components

4.3.1. Yaw rate and lateral acceleration sensor(s) position

4.4. Anti-lock braking configuration(s)

4.5. Additional steered axle

4.6. Additional recommendations and limitations

4.6.1. Brake system type

4.6.2. Management of the engine or other source(s) of motive power

4.6.3 Lift axles

5. Test data and results:

5.1. Test vehicle data (including the specification and functionality of any trailer(s) used during the test(s))

5.2. Test surface information

5.2.1. High adhesion surface

5.2.2. Low adhesion surface

5.3. Measurement and data acquisition

5.4. Test conditions and procedures

5.4.1. Vehicle tests

5.4.1.1. Directional control

5.4.1.2. Roll-over control

5.5. Additional Information

5.6. Test results

5.6.1. Vehicle tests

5.6.1.1. Directional control

5.6.1.2. Roll-over control

~~**5.7. Use of simulation**~~

~~5.7.1.~~ ~~Directional control~~

~~5.7.2.~~ ~~Roll-over control~~

5.~~8.~~7. Assessment in accordance with Annex 18 to this Regulation

5.~~9.~~8. Compliance with Regulation No. 10

6. Attachments [1]:

7. Date of test:

8. This test has been carried out and the results reported in accordance with Annex 19, Part 2 to Regulation No. 13 as last amended by the ..... series of amendments.

Technical Service [2] conducting the test

Signature: ..... Date: .....

9. Approval Authority [2]

Signature: ..... Date: ....."

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1 System supplier test data in support of the tolerance allowance as specified in paragraphs 1.1.3.2.(s) and 1.1.3.2.(x) of Part 2 to Annex 19 shall be attached.

2 **To be signed by different persons even when the Technical Service and Approval Authority are the same or alternatively, a separate Approval Authority Authorization is issued with the report.**

Annex 21, amend to read:

"**Annex 21**

Special requirements for vehicles equipped with a vehicle stability function

1. General

1.1. This annex defines … of this Regulation.

1.2. In meeting the requirements of this annex the "other vehicles" as mentioned in paragraphs 2.1.3. and 2.2.3. shall not differ in at least the following essential respects:

1.2.1. the character of the vehicle;

1.2.2. in the case of power-driven vehicles the axle configuration (e.g. 4x2, 6x2, 6x4);

1.2.3. in the case of trailers the number and arrangement of axles;

1.2.4. the front axle steering ratio in the case of power-driven vehicles when the vehicle stability function does not include it as a end-of-line programmable feature or as a self-learning feature;

1.2.5. additional steered axles in the case of power-driven, and steered axles in the case of trailers;

1.2.6. lift axles;

…

2.1.3. The vehicle stability function shall be demonstrated to the Technical Service by dynamic manoeuvres on one vehicle **which has the same vehicle stability function as the vehicle type to be approved**. This may be realized by a comparison of results obtained with the vehicle stability function enabled and disabled for a given load condition. As an alternative to carrying-out dynamic manoeuvres for other vehicles and other load conditions, fitted with the same vehicle stability system, the results from actual vehicle tests or computer simulations may be submitted.

As an alternative to the above, a test report conforming to Part 2 paragraph 1.1. of Annex 19 may be used.

The use of the …….. using the selected manoeuvre(s).

…

2.2.3. The vehicle stability function shall be demonstrated to the Technical Service by dynamic manoeuvres on one vehicle **which has the same vehicle stability function as the vehicle type to be approved**. This may be done by a comparison of results obtained with the vehicle stability function enabled and disabled for a given load condition. As an alternative to carrying-out dynamic manoeuvres for other vehicles and other load conditions, fitted with the same vehicle stability system, the results from actual vehicle tests or computer simulations may be submitted.

As an alternative to the above, a test report conforming to Part 1 paragraph 6 of Annex 19 may be used.

The use of the ……. using the selected manoeuvre(s).

…

Annex 21

Appendix 2

Dynamic stability simulation tool and it simulation

…

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

The simulator shall only be used with regard to features for which a comparison has been made between real vehicle tests and simulator 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.:

- **vehicle with shortest wheelbase and highest centre of gravity;**
- **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.

…

Annex 21

Appendix 3

Vehicle stability function simulation tool test report

…

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)**
~~2.~~ **3.**	Scope of application
~~2.1.~~ **3.1.**	**Character of** vehicle ~~type~~: (e.g. truck, tractor **for semi-trailer**, bus, semi-trailer, centre-axle trailer, full trailer)
~~2.2.~~ **3.2.**	……..
…	
~~5.~~ **6.**	…….

…"

II. Justification

1. In developing the requirements for a vehicle stability function (Annex 21), it was recognized that the testing of its component functions, directional control and roll-over control, at the time of type-approval would be very onerous on both the vehicle manufacturer and the system supplier in terms of timing (winter testing – low μ surface for directional control, summer testing – high μ surface for roll-over control) and safety equipment (roll-cage, outriggers, anti-jack-knifing device). Therefore, Annex 21 contains the requirement for a comparative "demonstration" (system on, system off) on "one vehicle", where the demonstration is a dynamic manoeuvre to show directional control and a dynamic manoeuvre to show roll-over control.

2. As an alternative for other vehicles and other load conditions may be submitted results from actual vehicle tests or computer simulations. In the case of a computer simulation, a Technical Service approved simulation tool must be used (Annex 21, Appendix 2).

3. As an alternative to the comparative demonstration and the computer simulation, it is proposed, via this amendment, to allow a Technical Service test report to be submitted.

4. For a number of years a Technical Service component test report (Annex 19) has been allowed to be used in the type approval of trailers (Annex 20) and this amendment proposal extends the use of Annex 19 to cover the vehicle stability function with regard to motor vehicles (the vehicle stability function for trailers is already included in Annex 19 and Annex 20). The existing content of Annex 19 becomes Part 1 (trailers) with the new content being in a Part 2 (motor vehicles, vehicle stability function).

5. In amending Annex 19 it is also appropriate to add a new definition to the Regulation and amend Annex 21 to make reference to the appropriate section of Annex 19 and to improve clarity with regard to the validation of the simulation tool.

Regulation:

6. The term “character of the vehicle” has been introduced as “vehicle type” and “vehicle category” are not appropriate in evaluating a vehicle stability function for use on different vehicles. The vehicle type includes differences (e.g. number and ratios of gears) which have no influence on the performance of a vehicle stability function, while, in the case of motor vehicles, the vehicle category does not differentiate between a semi-trailer tractor and a truck which does influence the performance of the vehicle stability function.

Annex 19:

7. The vehicle stability function, which is integrated into the motor vehicle, includes the same basic components and functionality irrespective of the vehicle type. Changes of parameters to suit specific vehicle characteristics such as wheelbase and centre of gravity height values may be necessary but the system itself remains unchanged. On this basis, vehicles can be selected and tested to cover worst case situations and the various vehicle characteristics that influence the performance of a vehicle stability function.

8. Therefore, the proposed Part 2 is structured as follows:

(a) An "Information Document" detailing the capability of the vehicle stability function for which the test report will be applicable is to be provided by the system manufacturer – paragraph 1.1.2. The content of the information document is defined (Appendix 11 to Annex 19) and it is required that the information document is attached to the test report.

(b) A list of the vehicle characteristics to be considered in selecting vehicles to be tested is given in "Definition of test vehicle(s)" – paragraph 1.1.3.

(c) A list of the vehicle characteristics affecting the performance of the vehicle stability function and how they are to be evaluated in the testing for the test report is given in "Test schedule" – paragraph 1.1.4. The content of the test report is defined in Appendix 12 to Annex 19.

9. In considering the content of paragraphs 1.1.3. and 1.1.4. the following was taken into account:

(a) Drive orientation (left or right hand drive)

No aspect of directional control or roll-over control is influenced by the side of the vehicle on which driver sits and, therefore, tests carried-out on a left hand drive vehicle are equally applicable to a right hand drive vehicle and visa versa.

(b) Single front axle steering

How the link between driver demand and the actual angular position of the road wheels is achieved has no influence on performance (the relationship is covered under "steering ratio"). As a result different steering arrangements are not evaluated.

(c) Additional steering axles

Whether a third axle is a fixed axle or a steering axle may have an influence on performance and, therefore, unless it is an end-of-line programming parameter (the control logic is adjusted to take its steering effect into account), it needs to be evaluated. Evaluation is by comparison of results with the steering axle in it normal operating mode and with it fixed in the straight ahead position.

(d) Steering ratio

The steering ratio — relationship between steering wheel rotation and resulting road wheel angle — is critical in determining any difference between the driver's directional demand and the actual directional movement of the vehicle, and any corrective action by the vehicle stability function (directional control). Therefore, unless the ratio is an end-of-line programming parameter or a self-learning feature in the control logic (which is required to be verified by testing for the test report), only vehicles having the same ratio(s) as that actually tested, can be type-approved.

(e) Lift axle

Lifting an axle will change the vehicle wheelbase and the change in wheelbase may affect performance. Therefore, it is required to determine if the system is able to recognize a change in axle position and provide a signal to adjust the control logic.

(f) Engine management

To optimize control of the vehicle in a pending loss of stability situation, it is not only necessary to apply the brakes of the appropriate wheels, but also to take control of the engine away from the driver. Therefore, this is to be evaluated not only in terms of signal generation but also communication compatibility.

(g) Drive train options

As with engine management, it is required to show that control (e.g. retarder control) is taken away from the driver.

(h) Differential type/differential locks

The effect of self-locking or driver selected locking may affect the performance and, therefore, the effect is to be shown.

(i) Anti-lock braking configurations

The ABS wheel speed sensors provide one of the system inputs and the ABS modulators control the output of the system and, therefore, the ABS configuration is significant in terms of system performance. As a result each ABS configuration is to be tested. As the vehicle stability function is built into a host system, e.g. ABS, EBS, each host system is also to be tested.

(j) Wheelbase

While wheelbase influences performance, it can be a major logistic problem to have extreme worst case vehicles available at the appropriate time. As a result, an allowance (tolerance) is permitted on the value actually tested by the Technical Service for the test report and test data provided by the system supplier which is used to set the wheelbase limits for which the test report can be used.

(k) Wheel type and tyre type

It is not possible to test all wheel and tyre type combinations, nor is it possible to control what is actually fitted to the vehicle when the vehicle is in service. As a result, the control logic has to be robust enough to cover such possibilities and, therefore, any limitations are as given in the information document.

(l) Track width

While track width will influence the roll-over potential of a vehicle, it is subservient to the centre of gravity height. Once the resultant force of the vehicle weight and its centrifugal force acting at the centre of gravity, acts outside the effective track (the outer limit of the tyre/road surface interface) the vehicle will roll-over. Therefore, track width is not evaluated as a separate characteristic.

(m) Suspension type

Similar to track width, the type of suspension is subservient to the centre of gravity height. Therefore, suspension is only evaluated on the basis of basic type, i.e. air, mechanical, rubber.

(n) Centre of gravity height

The centre of gravity height is a variable during the operation of a vehicle due the amount and type of load and, therefore, it is to be shown that the vehicle stability function can automatically adapt to changes in centre of gravity height.

While it is possible to adjust the centre of gravity height of a vehicle, it can be a major logistic problem to have an extreme worst case vehicle available at the appropriate time. As a result, an allowance (tolerance) is allowed on the maximum value actually tested by the Technical Service for the test report and test data provided by the system supplier which is used to set the maximum centre of gravity height for which the test report can be used.

(o) Lateral acceleration sensor position/yaw rate sensor position

The positioning of individual sensors or a combined sensor can influence performance and, therefore, the installation envelop specified by the system manufacturer in the information document is to be evaluated to demonstrate conformity.

(p) Loading

As vehicles are operated under differing conditions of load, testing is required in the laden and unladen/part laden conditions.

In the case of semi-trailer tractors, the semi-trailer is influential in the performance of the system and, therefore, laden and unladen/part laden test are carried-out with a semi-trailer attached. A specific semi-trailer is not specified as there is no control of the semi-trailers that will be used in service. The control logic has to be sufficiently robust to cope with all possibilities. The tractor alone (solo without any additional weight representing a semi-trailer) is also required to be evaluated as this is a possible operating condition. As it is also possible for a tractor to be used as a truck, an evaluation is carried-out on a solo tractor with a load simulating the tractor laden condition.

(q) Buses

As the control logic for directional control and for roll-over control is the same for a motor vehicle regardless of the character of the vehicle (e.g. semi-trailer tractor) or vehicle category (e.g. N_3), a semi-trailer tractor can be considered to be a short wheelbase truck, and a truck can be considered to be representative of a bus.

In the case of a bus, the fitment of outriggers requires a large amount of very significant structural work to be carried-out which means that the availability of such vehicles is limited.

Therefore, as an alternative in the case of buses, it is allowed to read-across the evaluation results of trucks having the same type of braking system to buses, provided that at least one bus is tested. The requirement to test at least one bus is to cover those cases where the intervention threshold is different between truck and bus.

~~(r) Simulation~~

~~As an alternative to using system manufacturer vehicle test data to bridge the gap between the wheelbase and centre of gravity values of the actual vehicles used in the test report testing and the values given in the information document, simulation may be used provided the simulation tool has been validated in accordance with Appendix 2 of Annex 21.~~

~~Similarly changes in the positioning of the lateral acceleration sensor and the yaw rate sensor, not evaluated by actual vehicle tests, may be evaluated using simulation provided the simulation tool has been validated in accordance with Appendix 2 of Annex 21 with regard to this feature.~~

(r) Footnote [1]

The footnote ensures that the system supplier provided test data is attached to the test report.

Annex 21:

10. A new paragraph 1.2. is introduced to clarify the “demonstration vehicle” and “other vehicles” referred to in paragraph 2.1.3. and 2.2.3.

11. In paragraphs 2.1.3. and 2.2.3. it is clarified that the vehicle stability function is the common factor.

12. Also in paragraphs 2.1.3. and 2.2.3. reference is made to Annex 19 to allow its possible use as an alternative to the demonstration and demonstration plus simulation. Originally, in the development of Annex 21, it was proposed to only use simulation. However, it was considered that there needed to be a more concrete relationship to actual vehicle test results than that provided by simulation. It is considered that a test report conforming to Annex 19 and its detailed listing of requirements now provides the necessary confidence that enables the demonstration to be dispensed with.

13. In paragraph 2.3. of Appendix 2 it is clarified that simulation tool can only be used with regard to vehicle features for which a same vehicle comparison has been made between real vehicle results and simulator results. It is also clarified that the comparison shall cover laden and unladen conditions and establishes the extreme parameters for which the tool can be used.

14. A new paragraph 2. is added to Appendix 3 to ensure that the simulation tool test report contains details applicable to the functionality of the tool.