

## Proposed amendments to ECE Regulation No. 13

EVSC05-38-1 amendments highlighted in RED

EVSC05-38-2 amendments highlighted in BLUE

EVSC05-38-3 amendments highlighted in GREEN

Changes made during the 12<sup>th</sup> December 2005 in purple (items discussed and no longer applicable lined through)

Japanese comments in ORANGE

### A. PROPOSAL (Provisions for vehicle stability control systems)

Add new paragraphs 2.32. to 2.32.2.2., to read:

- 2.32.** “Vehicle Stability Function (EVSC)” means an electronic control function for a vehicle which improves the dynamic stability of the vehicle.
- 2.32.1.** A vehicle stability function may include one or both of the following:
- directional control
  - roll-over control
- 2.32.2.** Control functions within a vehicle stability function:
- 2.32.2.1.** “Directional control” means a function within a vehicle stability function that assists the driver in maintaining the vehicle in the direction intended by the driver in the case of a power-driven vehicle, and assists in maintaining the direction of the trailer with that of the towing vehicle in the case of a trailer.
- 2.32.2.2.** “Roll-over control” means a function within a vehicle stability function that reacts to the potential of roll-over to stabilise the power-driven vehicle or towing vehicle and trailer combination or the trailer during dynamic manoeuvres.

### Annex 2

Add a new paragraph 14.14., to read:

**Comm. NL: paragraph 14.14 exists already; renumber as 14.15.?**

**14.14.** The vehicle is / is not <sup>2)</sup> equipped with a vehicle stability function

In the case where the vehicle is equipped with a vehicle stability function:

Vehicle stability function has been approved according to Annex 21: Yes / No <sup>2)</sup>

Vehicle stability function is optional equipment: Yes / No <sup>2)</sup>

Vehicle stability function includes directional control: Yes / No <sup>2)</sup>  
Vehicle stability function includes roll-over control: Yes / No <sup>2)</sup>  
~~Vehicle stability function has been approved according to Annex 21: Yes / No <sup>2)</sup>~~

**14.14.1. Where an Annex 19 test report has been utilised, the test report number shall be stated:**

**Annex 19**

Add a new paragraph 1.1.5., to read:

1.1.5. Vehicle stability function (refer to paragraph 6.).

**Add new a paragraph 6., to read:**

Add new paragraphs 6. to 6.5., to read:

**6. Vehicle Stability Function**

**6.1. General**

6.1.1. This section defines a test procedure to determine the performance of a vehicle stability function consisting of at least one of the following functions:

- directional control
- roll-over control.

**6.2. Information Document**

6.2.1. The system/vehicle ~~(Comm. NL: confusing; who is responsible for the correct installation?)~~ manufacturer ~~of the vehicle stability function~~ shall supply to the Technical Service an Information Document of the control function(s) for which performance verification is required. This document shall contain at least the information defined in Appendix 7 to this Annex.

**6.3. Definition of test vehicles(s)**

6.3.1. Based on the information supplied in the Information Document, in particular the trailer applications defined in paragraph 2.1. of Appendix 7, the Technical Service ~~shall~~ carries out demonstrative tests as defined in paragraph 2.2.3. of Annex 21 to this Regulation on a representative trailer(s) having up to three axles and equipped with the respective braking system configurations.

6.3.1.1. When selecting a representative trailer(s) for evaluation, consideration shall also be given to the following:

Suspension type: for each suspension group i.e. balanced pneumatic a representative trailer shall be evaluated.

Wheelbase: wheel base shall not be a limiting factor.

Brake type: approval shall be limited to S-cam or disc brakes but should other types become available, then comparative testing may be required.

Braking system: the braking system of the trailer(s) to be evaluated shall comply with all of the relevant requirements of this Regulation.

6.4. Test Schedule:

6.4.1. The demonstrative tests to be carried out ~~are specified in paragraph 2.2.3. of Annex 21 to this Regulation. shall be agreed between the system/vehicle manufacturer and the Technical Service and shall include the critical conditions of roll-over, under-steer and over-steer as appropriate to the vehicle stability function installed on the trailer with T~~the method of demonstrati~~on~~~~ive tests~~ and results ~~shall being~~ included in the test report.

6.5. Towing vehicle: the towing vehicle used for evaluating the performance of the vehicle (trailer) stability function shall have the necessary pneumatic and electrical connections and if the towing vehicle is equipped with a vehicle stability function as defined in paragraph 2.32. of this Regulation that function shall be disabled.

6.6 Test report

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.

Add a new Appendix 7 to Annex 19, to read:

## **Annex 19 – Appendix 7**

### **Vehicle Stability Function Information Document**

1. General

1.1. Name of manufacturer

1.2. System name

1.3. System variations

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

1.45. System configurations (where appropriate)

1.56. **System identification**

2. Applications

2.1. List of trailer types and configurations for which approval is required

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

- Lift axles
  - Steering axles
  - Anti-lock braking configurations
- 2.3. **Scope of application with respect to suspension type:**  
**Air suspension: Any type of balanced “trailing arm” air suspension**  
**Other suspensions: to be defined by manufacturer, model and type (balanced/unbalanced).**
- 2.4. Additional information (if applicable) to the application of the directional control and/or the roll-over control function(s)
3. Component Description
- 3.1. Sensors external to the controller
- Function
  - **Limitations on the location of the sensors.**
  - Identification e.g. part numbers
- 3.2. Controller(s)
- General description and function
  - Identification e.g. part numbers
  - **Limitations on the location of the controller(s).**
  - ~~Safety aspects of the controller(s) in accordance with Annex 18~~
  - Additional features
- 3.3. Modulators
- General description and function
  - Identification
  - Limitations
- 3.4. Electrical Equipment
- Circuit diagrams
  - Powering methods
- 3.5. Pneumatic circuits
- System schematics including anti-lock braking associated with the trailer types defined in paragraph 6.2.1 of this Annex
- 3.6 Safety aspects of the electronic system in accordance with Annex 18**
- 3.7. Electro Magnetic Compatibility
- 3.7.1. Documentation demonstrating compliance with Regulation No. 10 including the 02 Series of amendments.

Add a new Appendix 8 to Annex 19, to read:

## Annex 19 – Appendix 8

# Vehicle Stability Function Test Report

Test Report No: .....

**Comm. NL: If the test results will be used for the Dynamic Stability Simulation Tool the list shall also contain the data needed for the validation of the simulation tool.**

1. Identification:
  - 1.1. Manufacturer of the Vehicle Stability Function (name and address)
  - 1.2. System name / model
2. System(s) and Installations approved:
  - 2.1. Anti-lock braking configurations (where appropriate)
  - 2.2. Range of application (trailer type(s) and number of axles)
  - 2.3. System Identification
  - 2.4. Additional features
3. Test Data and Results:
  - 3.1. Test vehicle data **(including the specification and functionality of the towing vehicle)**
  - 3.2. Test surface information
  - 3.3. Demonstrative tests/**simulations** used for the purpose of evaluating the directional control and the roll-over control as appropriate.
  - 3.4. Test results
  - 3.5. Assessment in accordance with Annex 18 to this Regulation
4. Limits of installation:
  - 4.1. Suspension type
  - 4.2. Brake type
  - 4.3. **Trailer installation Location of components on the trailer.**
  - 4.4. Anti-lock braking configurations
  - 4.5. Other recommendations/limitations (e.g. lifting axles, steering axles, etc.)

**5.0. Attachments**

6. Date of Test:

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

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

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

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

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

<sup>1/</sup> To be signed by different persons even when the Technical Service and Approval Authority are the same or alternatively, a separate Approval Authority Authorisation issued with the report.

Appendix 7 (former), renumbered as Appendix 9

**Annex 20**

Paragraph 2.1.3., amend to read:

2.1.3. A documentation package that contains the relevant verification information including the relevant calculations, where appropriate, for the following:

<b>Performance Requirements</b>	<b>Annex 20 Reference</b>
Cold service braking performance	3.
Parking brake performance	4.
Automatic (emergency) brake performance	5.
Failure of brake distribution system	6.
Anti-lock braking	7.
Vehicle stability function	8.
Functional checks	9.

**~~Comm. NL: The current Paragraph 8. contains the functional and installation checks~~**

Add a new Paragraph 8.0., to read:

8.0. Alternative procedure for demonstrating the **performance of a trailer equipped with a vehicle stability function. performance**

8.1. **Evaluation** of a trailer in accordance with **paragraph 2 of** Annex 21 to this Regulation may be waived at the time of trailer type approval provided that the **vehicle stability control** function complies with the relevant requirements of Annex 19 to this Regulation.

8.2. Verification

8.2.1. Verification of components and installation

The specification of the braking system, in which the stability control function is integrated, installed on the trailer to be Type Approved shall be verified by satisfying each of the following criteria:

	Condition	Criteria
8.2.1.1.	(a) Sensor(s)	No change allowed
	(b) Controller(s)	No change allowed
	(c) Modulator(s)	No change allowed
8.2.1.2.	Trailer types as defined in the test report	No change allowed
8.2.1.2.	Installation configurations as defined in the test report	No change allowed
8.2.1.3.	For other limitations refer to paragraph 4 of the test report as described in Appendix 8 of Annex 19 to this Regulation.	No change allowed

**Paragraph 8.1.8. (former), renumber as paragraph 9.1.9.**

Add a new paragraph 9.1.8., to read:

9.1.8. Vehicle stability function

9.1.8.1. For practical reasons verification of the vehicle stability ~~control~~-function ~~shall~~ **may** be limited to an installation check and observation of the correct warning signal sequence to ensure no faults are present as defined in paragraph 8.2. above.

**Paragraph 9.1.8. (former), renumber as paragraph 9.1.9.**

Add new Annex 21, to read:

**Annex 21**

**SPECIAL REQUIREMENTS FOR VEHICLES EQUIPPED WITH A  
VEHICLE STABILITY FUNCTION, WHEN MANDATED**

**~~Comm NL: “when mandated “depends on the final operator/user.  
The manufacturer asks for the type approval for such systems if such provisions might be installed as option. Suggestion: “if installed and approved according the requirements of this annex”~~**

## 1. General

This annex defines the special requirements for vehicles equipped with a vehicle stability function where the installation of such equipment is mandatory, as specified in paragraphs 5.2.1.31. ~~and 5.2.2.23.~~ of this Regulation **and paragraph 2.4. of Annex 5 to this Regulation.**

## 2. Requirements

### 2.1. Power-driven vehicles

#### 2.1.1. Where a vehicle is equipped with a vehicle stability function as defined in paragraph 2.32. of this Regulation, the following shall apply:

In the case of directional control the function shall have the ability to automatically control individual wheel speeds by selective braking based on the evaluation of actual vehicle behaviour in comparison with a determination of vehicle behaviour demanded by the driver.<sup>1/</sup>

In the case of roll-over control the function shall have the ability to automatically control individual or multiple wheel speeds by selective braking or automatically commanded braking based on the evaluation of actual vehicle behaviour that may lead to vehicle roll-over.<sup>1/</sup>

#### 2.1.2. To realise the functionality defined above a vehicle stability function shall include, in addition to selective braking and/or automatically commanded braking, at least the following:

- The ability to regulate engine power output.
- In the case of directional control: The determination of **actual** vehicle behaviour from values of yaw rate, lateral acceleration and wheel speeds and **of vehicle behaviour demanded by the driver** from **value of** the driver's control input to the braking system, to the steering system, and to the engine. If these values are not directly measured, the evidence of the appropriate correlation with directly measured values under all driving conditions (e.g. including driving in a tunnel) shall be shown to the technical service at the time of type approval. Only on-board generated information shall be used.
- In the case of roll-over control: The determination of **actual** vehicle behaviour from values of the vertical force on the tyre(s) (or at least lateral acceleration and wheel speeds) ~~and from the driver's control input to the braking system, and to the engine.~~ If these values are not directly measured, the evidence of the appropriate correlation with directly measured values under all driving conditions (e.g. including driving in a tunnel) shall be shown to the technical service at the time of type approval. Only on-board generated information shall be used.
- In the case of a towing vehicle equipped **with [...(name of the device)]** according to paragraph 5.1.3.1. of this Regulation: The ability to apply the service brakes of the trailer via the respective control line(s) independently of the driver.

#### 2.1.3. The operation of the vehicle stability ~~control~~ **function** shall be demonstrated by ~~means of one of the following:~~

- ~~a dynamic demonstration on one vehicle configuration and submission of test results for other vehicle configurations under the condition that these vehicles are equipped~~



~~with the same vehicle stability function as the one fitted on the vehicle which has been used for the dynamic demonstration~~

~~A dynamic demonstrative tests on at least one vehicle configuration. For other vehicle configurations, and submitted test results and a computer simulation may be used for this purpose for other vehicle configurations under the condition that these vehicles are equipped with the same vehicle stability function as the one fitted on the vehicle which has been used for the dynamic demonstrative tests together with data which verifies the simulation model against a practical vehicle test. The specification and functionality of the simulator is defined in Appendix 2 to this Annex.~~

- ~~• a computer simulation, together with data which verifies the simulation model against a practical vehicle test. The specification and functionality of the simulator is defined in Appendix 1 to this Annex. **In addition, a dynamic operational check shall be carried out on a vehicle fitted with a vehicle stability function, identical to that used in the computer simulation, and the results included in the test report.**~~

[For directional control, evaluation is carried out by following tests.

1.J-turn test on low adhesion surface as defined in Appendix 1 to this Annex ]

For roll-over control, evaluation is carried out ~~agreed between the vehicle manufacturer and the Technical Service~~ and by following test(s).

1.accelerating circular test on high adhesion surface as defined in Appendix 1 to this Annex and

[2. one period sine steer input test on high adhesion surface as defined in Appendix 1 to this Annex.]

These demonstrations shall include the critical conditions of under-steer, over-steer and roll-over as appropriate to the vehicle stability function installed on the vehicle with the method of demonstration and results being appended to the type approval report. This may be carried-out other than at the time of type approval.

If it is impossible to carry out the tests for directional control evaluation on low adhesion surface due to limitation of the test facility, submitted of test results and a computer simulation may be used as alternative if agreed by the Technical Service.

- 2.1.4.** Interventions of the vehicle stability function shall be indicated to the driver by a specific optical warning signal. The indication shall be present as long as the vehicle stability function is in an intervention mode. The warning signals specified in paragraph 5.2.1.29. of this Regulation shall not be used for this purpose.

Interventions of the vehicle stability function used in any learning process to determine the vehicle operational characteristics shall not generate the above signal.

The signal shall be visible to the driver, even in daylight, such that the driver can easily verify the satisfactory condition of the signal without leaving the driver's seat.

- 2.1.5.** A vehicle stability function failure or defect shall be detected and indicated to the driver by the specific optical warning signal referred to in paragraph 5.2.1.29. of this Regulation.

The warning signal shall be constant and remain displayed as long as the failure or defect persists and the ignition (start) switch is in the “on” (run) position.

**2.1.6.** In the case of a power-driven vehicle equipped with an electric control line and electrically connected to a trailer with an electric control line the driver shall be warned by a specific optical warning signal whenever the trailer provides the information “EVSC ~~VDC~~ Active” via the data communications part of the electric control line. The optical signal defined in paragraph 2.1.4. above may be used for this purpose.

**2.2.** Trailers

**2.2.1.** Where a trailer is equipped with a vehicle stability function as defined in paragraph 2.32. of this Regulation, the following shall apply:

In the case of directional control the function shall have the ability to automatically control individual wheel speeds by selective braking based on the evaluation of actual trailer behaviour in comparison with a determination of the relative behaviour of the towing vehicle.<sup>1/</sup>

In the case of roll-over control the function shall have the ability to automatically control individual or multiple wheel speeds by selective braking or automatically commanded braking based on the evaluation of actual trailer behaviour that may lead to roll-over.<sup>1/</sup>

**2.2.2.** To realise the functionality defined above a vehicle stability function shall include, in addition to selective braking and/or automatically commanded braking ~~and where appropriate selective braking~~, at least the following:

- In the case of directional control: *[description needed.]*
- In the case of roll-over control: The determination of trailer behaviour from values of the vertical force on the tyre(s), or at least lateral acceleration and wheel speeds. If these values are not directly measured, the evidence of the appropriate correlation with directly measured values under all driving conditions (e.g. including driving in a tunnel) shall be shown to the technical service at the time of type approval. Only on-board generated information shall be used.

**2.2.3.** The operation of a vehicle stability function shall be demonstrated by ~~means of one of the following~~:

~~A dynamic demonstrative tests on at least one vehicle configuration. For other vehicle configurations, and submitted test results and a computer simulation may be used for this purpose for other vehicle configurations~~ under the condition that these vehicles are equipped with the same vehicle stability function as the one fitted on the vehicle which has been used for the dynamic demonstrative tests together with data which verifies the simulation model against a practical vehicle test. The specification and functionality of the simulator is defined in Appendix ~~4~~2 to this Annex.

- ~~a dynamic demonstration on one vehicle configuration and submission of test results for other vehicle configurations under the condition that these vehicles are equipped with the same vehicle stability function as the one fitted on the vehicle which has been used for the dynamic demonstration~~
- ~~a computer simulation together with data which verifies the simulation model against a practical vehicle test. The specification and functionality of the simulator is defined in Appendix 1 to this Regulation. **In addition, a dynamic operational check shall be carried out on a vehicle fitted with a vehicle stability function, identical to that used in the computer simulation, and the results included in the test report.**~~

[For directional control,<sup>1/</sup> evaluation is carried out by following tests.

1.J-turn test on low adhesion surface as defined in Appendix 1 to this Annex ]

For roll-over control,<sup>2/</sup> evaluation is carried out ~~agreed between the vehicle manufacturer and the Technical Service~~ and by following test(s).

1.accelerating circular test on high adhesion surface as defined in Appendix 1 to this Annex and

[2. one period sine steer input test on high adhesion surface as defined in Appendix 1 to this Annex.]

These demonstrations shall include the critical conditions of under-steer, over-steer and roll-over as appropriate to the vehicle stability function installed on the vehicle with the method of demonstration and results being appended to the type approval report. This may be carried-out other than at the time of type approval.

If it is impossible to carry out the tests for directional control evaluation on low adhesion surface due to limitation of the test facility, submitted of test results and a computer simulation may be used as alternative if agreed by the Technical Service.

- 2.2.4.** Trailers equipped with an electric control line, when electrically connected to a towing vehicle with an electric control line, shall provide the information “~~EVSC VDC~~ active” via the data communications part of the electric control line when the vehicle stability function is in an intervention mode. Interventions of the vehicle stability function used in any learning process to determine the trailer operational characteristics shall not generate the above information.

<sup>1/</sup> Additional interaction with other vehicle systems or components is allowed. Where these systems or components are subject to special Regulations, such interaction shall comply with the requirements of those Regulations, e.g. interaction with the steering system shall comply with the requirements set out in Regulation 79 for corrective steering.

Add new Appendix 1, to read:  
Annex21 – Appendix 1

## DYNAMIC DEMONSTRATIVE TESTS

The efficiency of the roll-over stability function of power-driven vehicles and trailers of categories M,N and O equipped with a Vehicle Stability Function shall be demonstrated by following method.

1. Dynamic demonstrative tests applicable to roll-over control evaluation.

1.1 Accelerating circular test on high adhesion surface

1.1.1. Variables and reference system

The variables to be determined may be selected for test purposes from those given in ISO 15037-2 and shall be monitored using appropriate transducers. The variables relate to the intermediate axis system(X,Y,Z) as specified in ISO 8855.

During the test, following variables are measured.

- vehicle speed (km/h)
- lateral acceleration ( $m/s^2$ )
- roll angle (degree)

1.1.2. Measuring equipment

The measuring and recording equipment shall be in accordance with ISO 15037-2.

1.1.3. Test conditions

The limits and specifications for ambient and vehicle test conditions shall be in accordance with ISO 15537-2

A coefficient of adhesion on road surface shall be greater than 0.5.

The use of anti-rollover outriggers shall be considered for any testing approaching the rollover limit.

1.1.4. Test vehicle

General specifications of the vehicle shall be in accordance with ISO 15037-2

1.1.5. Test procedures

1.1.5.1 Warm-up and Initial driving condition

Warm-up and Initial driving condition shall be in accordance with ISO 15037-2

1.1.5.2 Constant radius test

A standard radius of [50m] is used .

If it is impossible to have specified radius due to limitations of test facility, path with other radius may be selected. Whatever the radius chosen, the vehicle shall be steered such that the reference point of the first unit remains within 0.5m of the intended circular path except critical condition.

- (a) stop the vehicle along the line of test radius.
- (b) accelerate the vehicle gradually to the speed that is just before roll-over condition.
- (c) measure the three variables from the initial condition to the critical condition.
- (d) compare the conditions in which vehicle stability function is disabled and fully functioning.
- (e) repeat (a) to (d) in reverse direction.

#### 1.1.6. Presentation of results

Maximum value of following parameters at each demonstrative test shall be presented in the test report in accordance with Appendix2 to this Annex.

- vehicle speed (km/h)
- lateral acceleration ( $m/s^2$ )
- roll angle (degree)
- other variables

Following data shall be plotted on Figure A.3 in accordance with Annex A to ISO 14792.

- vehicle roll angle versus lateral acceleration.

The test results shall show a visible improvement in dynamic vehicle stability with the vehicle stability function being fully functional as compared to the function being disabled.

## Annex21 – Appendix2

### Test report – Presentation of results

#### 1. Record of test results

Test number	1	2	3	...	...
Test type					
Increasing speed on a constant radius					
The condition of vehicle stability function					
On, off					
Maximum vehicle speed, km/h					
Maximum centripetal acceleration, m/s <sup>2</sup>					
Maximum roll angle, degrees					
Other selected variables [variable 1],[units] [variable 1],[units] [variable 1],[units]					

Add new Appendix 13, to read:

## Annex 21 - Appendix 13

### DYNAMIC STABILITY SIMULATION

The efficiency of the directional and/or rollover stability of power-driven vehicles and trailers of categories M, N and O equipped with a Vehicle Stability Function, may be determined by computer simulation. In the case of any trailer, a representative towing vehicle shall be defined for the purpose of computer simulation in agreement with the Technical Service.

#### 1. GENERAL CONDITIONS

##### 1.1. Modelling and simulation tool

The simulations shall be carried out with a validated modelling and simulation tool which is either used by ~~or has been agreed with~~ a type approval authority or Technical Service (see paragraph 4 below) on basis of data which verifies the simulation model against a practical vehicle test.

##### 1.1.1. The simulation method shall take into account the main factors which influence the directional and roll motion of the vehicle. The model shall include at least the following vehicle parameters in an explicit or implicit form:

###### Axle/wheel parameters

- axle/wheel geometry;
- wheel loads;
- track width;
- centre of gravity positions of unsprung masses;
- inertia (mass,  $J_x$ ,  $J_y$  &  $J_z$ ) of unsprung masses;
- in the case of steered wheels:
  - principal of steering;
  - steering ratio or self steering characteristics.

###### Suspension parameters

- principal of suspension;
- height of roll centre;
- suspension stiffness (vertical and roll; lateral and for/aft if significant);
- suspension damping characteristics;
- suspension kinematics(if significant);
- roll stabiliser characteristic.

###### Tyre parameters

- pure cornering characteristics;
- pure braking characteristics;
- combined cornering and braking characteristics;
- relaxation length (dynamic behaviour);
- radial/vertical stiffness;
- lateral stiffness;

- dynamic tyre/road friction coefficient ranging from low (ice) to high (dry asphalt) on an individual wheel basis.

#### Chassis/vehicle body parameters

- centre of gravity position of sprung masses;
- inertia (mass,  $J_x$ ,  $J_y$  &  $J_z$ ) of sprung masses;
- chassis/vehicle body (torsional) stiffness if significant.

#### Power train/driveline parameters if applicable

- power source characteristics (engine traction/braking torque/torque converter);
- transmission characteristics (gear ratios);
- differential gearing (gear reduction, locking characteristics).

#### Brake system parameters

- dynamic characteristics of the brakes.

#### Pay load parameters

- centre of gravity positions;
- Inertia (mass,  $J_x$ ,  $J_y$  &  $J_z$ ).

#### Other parameters/properties

- driver model with path following properties for the subjective type of simulation tests;
- steering stiffness;
- load sharing distribution between the axles of a bogie;
- in the case of a height levelling system the properties/characteristics of the height levelling system.

The vehicle parameter values represent the loaded condition and are expressed in SI-units. The values of relevant parameters (e.g. suspension, tyres, etc.) have to be non-linear to predict correctly the directional and roll-over stability of the vehicle.

- 1.1.2. 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. TRAILERS

In the case of a trailer, it shall be simulated using the characteristics of a representative power-driven vehicle to be agreed by the type approval authority or Technical Service in consultation with the manufacturer of the trailer.

## 3. VEHICLE LOADING CONDITION

- 3.1. The standard test condition shall be the maximum technical permissible mass of the vehicle distributed among the axles as declared by the manufacturer such that the load on each axle is proportional to the maximum permissible load for each axle.

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



In the case of a tank type vehicle the normally intended load shall be considered as an equivalent fixed load.

3.2. Every test shall be carried out with the stability function engaged and disengaged. All tests shall be repeated in the unladen condition.

#### 4. VALIDATION OF THE SIMULATION TOOL

4.1.1. 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 result in loss of directional control (under-steer and over-steer) or roll-over control as appropriate to the functionality of the stability control function installed on a representative vehicle. Such a test(s) may include one or more of the following:

- steady state circular test;
- step steer input test;
- $\mu$ -split single lane change;
- double lane change;
- reversed steering test or “fish hook” test;
- asymmetrical one period sine steer or pulse steer input test;
- other recognised tests(s).

During the test(s) the following motion variables, as appropriate, shall be recorded or calculated:

- yaw velocity;
- lateral acceleration;
- roll angle;
- forward velocity;
- driver input;

4.2. The modelling and simulation tool can be regarded as valid when the simulation data is within [5%] for a steady state test and within [10%] for a dynamic test of the practical test data. A simulator **approval** report shall be produced, a model of which is defined in Appendix 2 of this annex, and a copy attached to the vehicle approval report.

~~Comm NL: Suggestion for the calculation of the difference between the simulation and test data: maximum deviation divided by the range of the motion variable during the test.~~

**Calculation of the difference between the simulation and test data: maximum deviation divided by the range of the motion variable during the test.**

Add new Appendix 24, to read:

## Annex 21 - Appendix 24

### 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. ~~Approved use~~ Applicable to

- 2.1. Vehicle type: (e.g. truck, tractor, bus, semi-trailer, centre-axle trailer, full trailer)
- 2.2. Vehicle configuration: (e.g. 4x2, 4x4, 6x2, 6x4, 6x6)
- 2.3. Limiting factors: (e.g. mechanical suspension only)

#### 3. Verifying vehicle test(s)

- 3.1. Description of vehicle(s) including the towing vehicle in case of trailer testing:
  - 3.1.1. Vehicle(s) identification: make/model/VIN
    - 3.1.1.1 Non-standard fitments:
  - 3.1.2. Vehicle description, including axle configuration/suspension/wheels, engine and drive line, braking system(s) and vehicle stability function content (directional control/roll-over control), steering system, with name/model/number identification:
  - 3.1.3. Vehicle data used in the simulation (explicit):
- 3.2. Description of test(s) including location(s), road/test area surface conditions, temperature and date(s):
- 3.3. Results laden and unladen with the vehicle stability function switched on and off:

#### 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. Results laden and unladen with the vehicle stability function switched on and off for each test conducted under paragraph 3.2. of this appendix:

#### ~~Comm NL: add new paragraph 5.~~

#### 5. Comparison between the simulation and test results for the following motion variables, as appropriate, recorded during the tests:

- yaw velocity;
- lateral acceleration;
- roll angle;
- forward velocity;
- ⊖ driver input;

#### 5.1. Maximum deviation of the steady state tests:..... %

5.2. Maximum deviation of the dynamic tests: ..... %

~~Comm NL: renumber former paragraph 5. as 6.~~

56. ~~Approval~~ Verification

56.1. Technical Service conducting the test <sup>(1)</sup>: .....

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

56.2. Approval Authority <sup>(1)</sup>: .....

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

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

~~An Information document and test reports based on the requirements and procedures as defined in this Annex 21 are missing with the exception of the “Vehicle Stability Function Simulation Tool Test report”.~~

~~We believe that this part should also contain separate Appendices with an Information document to be presented by the vehicle manufacturer and a test report of the vehicle involved~~

## B. JUSTIFICATION

To support the mandatory introduction of a vehicle stability function it is necessary to have a definition of what a vehicle stability function is and how it is to be approved by a Technical Service.

A system definition method of specifying the vehicle stability function, together with a performance demonstration – either an actual vehicle or a computer simulation (where the computer simulation tool has been ~~approved~~ verified against actual vehicle tests) – has been chosen in preference to a purely functional test so that:

- a) a vehicle stability function is not designed to meet a single critical situation (a single test), to the detriment of other critical situations,
- b) the homologation of each vehicle requires such a large number of different tests, to cover all critical situations, that the cost is prohibitive,
- c) system supplier/vehicle manufacturer winter test facilities can be utilised rather than low temperature test facilities having to be developed by the Technical Services,
- d) development - in a new field - is not restricted through a minimum level test requirement that provides no incentive for future development of higher performance functions.

The term “Vehicle Stability Function” has been chosen as it is believed to be unconnected with a specific organization. Organization specific terminology includes – Vehicle Dynamics Control (VDC), Vehicle Stability Control (VSC), Electronic Stability Control (ESC), Electronic Stability Program

(ESP), Electronic Stabilisation Programme (ESP), Porsche Stability Management (PSM), Dynamic Stability Control (DSC), Dynamic Stability Program (DSP), Roll Stability Program (RSP), Trailer Roll Stability Program (TRSP), Roll Over Protection (ROP), Roll Stability Control (RSC), and Roll Stability Support (RSS).

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