

Transmitted by the expert from Russian Federation

EVSC05-38 (6th meeting document)

## 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 December 2005 in purple (items discussed and no longer applicable lined through)

Amendments proposed by the Expert from Russian Federation

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

...

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 vehicle behaviour from values of yaw rate, lateral acceleration and wheel speeds and from 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 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 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.

#### 2.1.2.1. Application of a vehicle stability function shall result increase of capability of safe movement of a vehicle on turns on roads of the certain categories at the certain operational speed for conditions of high and low adhesion coefficient.

[The maximum speed of driving of a vehicle on a circle of constant radius has to be set. The speed limit has to be set for conditions of high and low adhesion coefficient]

2.1.3. The operation of the vehicle stability control 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 demonstration on one vehicle configuration and submission of test results and a computer simulation 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 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.

- ~~• 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.**~~

The method by which this demonstration is carried out shall be agreed between the vehicle manufacturer and the Technical Service and 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.

The reliability of results of computer simulation shall be confirmed by the results of real tests of one vehicle sample. For the type approval purpose the results of simulation, at least, of the tests confirming compliance with the provisions of the paragraph 2.1.2.1. of this Annex, can be accepted.

2.1.3.1. It has to be assured that a vehicle stability function does not interfere with the driver in realization of control inputs (steering angle, steering angular velocity). Such conclusion shall concern all possible driving modes and road conditions.

For the type approval purpose the afore said conclusion can be based on comparing the condition, in which vehicle stability function is disabled, and the condition, in which the function is fully functioning, by using the the single lane change test maneuver. For the both cases the limiting speed of the test maneuver shall not differ [more than 10%]. The tests shall be performed on the roads with high and low adhesion coefficient.

[The test procedure has to be specified, if the proposal were adopted]

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 "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>17</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>17</sup>

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

- 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.

**2.2.2.1.** Application of a vehicle stability function shall result increase of capability of safe movement of a tractor-trailer combination on turns on roads of the certain categories at the certain operational speed for conditions of high and low adhesion coefficient.

[The maximum speed of driving of a tractor-trailer combination on a circle of constant radius has to be set. The speed limit has to be set for conditions of high and low adhesion coefficient]

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

A dynamic demonstration on one vehicle configuration and submission of test results and a computer simulation 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 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.

- ~~• 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.**~~

The method by which this demonstration is carried out shall be agreed between the trailer 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 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.

The reliability of results of computer simulation shall be confirmed by the results of real tests of one tractor-trailer combination sample. For the type approval purpose the results of simulation, at least, of the tests confirming compliance with the provisions of the paragraph 2.2.2.1. of this Annex, can be accepted.

2.2.3.1. It has to be assured that a vehicle stability function does not interfere with the driver in realization of control inputs (steering angle, steering angular velocity). Such conclusion shall concern all possible driving modes and road conditions.

For the type approval purpose the afore said conclusion can be based on comparing the condition, in which vehicle stability function is disabled, and the condition, in which the function is fully functioning, by using the the single lane change test maneuver. For the both cases the limiting speed of the test maneuver shall not differ [more than 10%]. The tests shall be performed on the roads with high and low adhesion coefficient.

[The test procedure has to be specified, if the proposal were adopted]

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 “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.

1/ 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:

## **Annex 21 - Appendix 1**

### **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 2, to read:

## Annex 21 - Appendix 2

### 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

- 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

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 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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