

E/ECE/324
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7 August 2008

AGREEMENT

CONCERNING THE ADOPTION OF UNIFORM TECHNICAL PRESCRIPTIONS FOR WHEELED VEHICLES, EQUIPMENT AND PARTS WHICH CAN BE FITTED AND/OR BE USED ON WHEELED VEHICLES AND THE CONDITIONS FOR RECIPROCAL RECOGNITION OF APPROVALS GRANTED ON THE BASIS OF THESE PRESCRIPTIONS */

(Revision 2, including the amendments that entered into force on 16 October 1995)

Addendum 12: Regulation No. 13

Revision 6 - Amendment 1

11 series of amendments - Date of entry into force: 11 July 2008

UNIFORM PROVISIONS CONCERNING THE APPROVAL OF VEHICLES OF CATEGORIES M, N AND O WITH REGARD TO BRAKING



UNITED NATIONS

*/ Former title of the Agreement:

Agreement Concerning the Adoption of Uniform Conditions of Approval and Reciprocal Recognition of Approval for Motor Vehicle Equipment and Parts, done at Geneva on 20 March 1958.

GE.08-

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

- "2.32. "Vehicle Stability Function" means an electronic control function for a vehicle which improves the dynamic stability of the vehicle.
- 2.32.1. A vehicle stability function includes one or both of the following:
(a) directional control
(b) 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 the event of under steer and over steer conditions, within the physical limits of the vehicle in maintaining 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 an impending roll-over in order to stabilise the power-driven vehicle or towing vehicle and trailer combination or the trailer during dynamic manoeuvres within the physical limits of the vehicle."

Add new paragraph 5.2.1.32., to read (including the insertion of a reference to a new footnote 1/ and a new footnote 1/):

- "5.2.1.32. Subject to the provisions of paragraph 12.4. to this Regulation, all vehicles of categories M₂, M₃, N₂ and N₃ 1/ having no more than 3 axles shall be equipped with a vehicle stability function. This shall include roll-over control and directional control and meet the technical requirements of Annex 21 to this Regulation."

Add new paragraph 5.2.2.23., to read (including the insertion of a reference to a new footnote 2/ and a new footnote 2/):

- "5.2.2.23. Subject to the provisions of paragraph 12.4. to this Regulation, all vehicles of categories O₃ and O₄ 2/ having no more than 3 axles and equipped with air suspension shall be equipped with a vehicle stability function. This shall include

1/ Off-road vehicles, special purpose vehicles (e.g. mobile plant using non standard vehicle chassis – e.g. cranes - , hydro-static driven vehicles in which the hydraulic drive system is also used for braking and auxiliary functions), Class I and Class A buses of categories M₂ and M₃, articulated buses and coaches, N₂ tractors for semi-trailer with a gross vehicle mass (GVM) between 3.5 and 7.5 tonnes, shall be excluded from this requirement.

2/ Trailers for exceptional load transport and trailers with areas for standing passengers shall be excluded from this requirement.

at least roll-over control and meet the technical requirements of Annex 21 to this Regulation."

Add a new paragraph 12.1.7., to read (including the footnote */):

"12.1.7. As from the official date of entry into force of the 11 series of amendments, no Contracting Party applying this Regulation shall refuse to grant type-approval under this Regulation as amended by the 11 series of amendments. */

*/ This paragraph shall not prevent Denmark from continuing to mandate a vehicle stability function meeting the requirements of this Regulation."

Add a new paragraph 12.4., to read (including the footnote **/)

"12.4. Mandatory provisions for vehicles equipped with a vehicle stability function

12.4.1. Requirements for the equipment of vehicles with vehicle stability functions as specified in paragraphs 5.2.1.32. and 5.2.2.23. of this Regulation, as amended by the 11 series of amendments, shall be applied as follows:

Vehicle category	Application date (as from the date after entry into force of the 11 series of amendments)	
	Contracting Parties may grant approvals only if the vehicle type to be approved meets the requirements of this Regulation as amended by the 11 series of amendments	Contracting Parties applying this Regulation shall refuse first national or regional registration of a vehicle which does not meet the requirements of the 11 series of amendments to this Regulation
M ₂	60 months	84 months
M ₃ (Class III) */	12 months	36 months
M ₃ <16 tonnes (pneumatic transmission)	24 months	48 months
M ₃ (Class II and B (hydraulic transmission)	60 months	84 months
M ₃ (Class III) (hydraulic transmission)	60 months	84 months
M ₃ (Class III) (pneumatic control transmission and hydraulic energy transmission)	72 months	96 months
M ₃ (Class II) (pneumatic control transmission and hydraulic energy transmission)	72 months	96 months
M ₃ (other than above)	24 months	48 months
N ₂ (hydraulic transmission)	60 months	84 months
N ₂ (pneumatic control transmission and hydraulic energy transmission)	72 months	96 months
N ₂ (other than above)	48 months	72 months
N ₃ (2 axle tractors for semi-trailers)	12 months	36 months
N ₃ (2 axle tractors for semi-trailers with pneumatic control transmission (ABS))	36 months	60 months
N ₃ (3 axles with electric control transmission (EBS))	36 months	60 months
N ₃ (2 and 3 axles with pneumatic control transmission (ABS))	48 months	72 months
N ₃ (other than above)	24 months	48 months
O ₃ (combined axle load between 3.5 - 7.5 tonnes)	48 months	72 months
O ₃ (other than above)	36 months	60 months
O ₄	24 months	36 months

**/ Class III as defined in Regulation No. 107."

Paragraphs 12.4. and 12.4.1. (former), renumber as paragraphs 12.5. and 12.5.1.

Annex 2, add new items 14.14. and 14.14.1., to read:

- "14.14. The vehicle is equipped with a vehicle stability function: Yes/No 2/
If yes:
The vehicle stability function has been tested according to
and fulfils the requirements of Annex 21: Yes/No 2/
Vehicle stability function is optional equipment: Yes/No 2/
Vehicle stability function includes directional control: Yes/No 2/
Vehicle stability function includes roll-over control: Yes/No 2/
- 14.14.1. Where an Annex 19 test report has been utilised, the test
report number shall be stated:"

Annex 10, paragraph 1.3.1., footnote **/, amend to read:

"**/ In the case of multiple axles, where the axle spread between one axle and its adjacent axle is greater than 2.0 m, each individual axle shall be considered as an independent axle group."

Annex 19,

Add a new paragraph 1.1.5., to read:

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

Add new paragraphs 6. to 6.6.1., to read:

- "6. Vehicle stability function
- 6.1. General
- 6.1.1. This section defines a test procedure to determine the dynamic characteristics of a vehicle equipped with a vehicle stability function consisting of at least one of the following functions:
(a) directional control
(b) roll-over control
- 6.2. Information document
- 6.2.1. The system/vehicle manufacturer 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 vehicle(s)

6.3.1. Based on the stability control function(s) and their application(s) defined in the manufacturer's information document the Technical Service shall carry out a performance verification. This may include one or more dynamic manoeuvres as defined in paragraph 2.2.3. of Annex 21 to this Regulation on a trailer(s) having up to three axles which is representative of the application(s) defined in paragraph 2.1. of the manufacturers information document.

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

- (a) Suspension type: for each suspension group, e.g. balanced pneumatic, a trailer of that specification shall be evaluated.
- (b) Wheel base: wheel base shall not be a limiting factor.
- (c) Brake type: approval shall be limited to trailers with S-cam or disc brakes but should other types become available, then comparative testing may be required.
- (d) 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. To evaluate the vehicle stability control function the tests used shall be agreed between the system/vehicle 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. The dynamic manoeuvres, test conditions and results shall be included in the test report.

6.5. Towing vehicle

6.5.1. 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
 - 1.5. System configurations (where appropriate)
 - 1.6. 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 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 type:
 - (a) Air suspension: any type of balanced "trailing arm" air suspension
 - (b) Other suspensions: individually identified 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
 - (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) Identification e.g. part numbers
 - (c) Limitations on the location of the controller(s).

- (d) Additional features
- 3.3. Modulators
 - (a) General description and function
 - (b) Identification
 - (c) 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 trailer types defined in paragraph 6.2.1. of this Annex.
- 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 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:

- 1. Identification:
 - 1.1. Manufacturer of the vehicle stability function (name and address)
 - 1.2. System name / model
 - 1.3. Control function
- 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. Additional Information
 - 3.4. Demonstrative tests/simulations used for the purpose of evaluating the directional control and the roll-over control as appropriate.
 - 3.5. Test results
 - 3.6. Assessment in accordance with Annex 18 to this Regulation
4. Limits of installation
 - 4.1. Suspension type
 - 4.2. Brake type
 - 4.3. 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. 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 1/ conducting the test

Signed: Date:

8. Approval Authority 1/

Signed: Date:

1/ 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), renumber 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:

Performance Requirements	Annex 20 Reference
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.

Add new paragraphs 8. to 8.2.1.4., to read:

"8. Alternative procedure for demonstrating the performance of a trailer equipped with a vehicle stability function.

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 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 and 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
8.2.1.3.	Installation configurations as defined in the test report	No change allowed
8.2.1.4.	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 9.1.8. (former), renumber as paragraph 9.1.9.

Add new paragraphs 9.1.8. and 9.1.8.1., to read:

"9.1.8. Vehicle stability function

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

Add a new Annex 21, to read (including its Appendices 1 to 3):

"Annex 21

SPECIAL REQUIREMENTS FOR VEHICLES EQUIPPED WITH A
VEHICLE STABILITY FUNCTION

1. GENERAL

This annex defines the special requirements for vehicles equipped with a vehicle stability function, pursuant to paragraphs 5.2.1.32. and 5.2.2.23. of 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 individually the speed of the left and right wheels on each axle or an axle of each axle group 1/ by selective braking based on the evaluation of actual vehicle behaviour in comparison with a determination of vehicle behaviour demanded by the driver. 2/

1/ In the case of multiple axles, where the spread between one axle and its adjacent axle is greater than 2m, each individual axle shall be considered as an independent axle group.

2/ 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 No. 79 for corrective steering.

In the case of roll-over control the function shall have the ability to automatically control the wheel speeds on at least two wheels of each axle or axle group 1/ by selective braking or automatically commanded braking based on the evaluation of actual vehicle behaviour that may lead to vehicle roll-over. 2/

In both cases, the function is not required when the vehicle is in reverse mode or when the vehicle speed is below 10 km/h.

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:

- (a) The ability to control engine power output.
- (b) In the case of directional control: The determination of actual vehicle behaviour from values of yaw rate, lateral acceleration, wheel speeds, and from the driver's control inputs to the braking and steering systems and to the engine. Only on-board generated information shall be used. 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.
- (c) 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 inputs to the braking system and to the engine. Only on-board generated information shall be used. 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.
- (d) 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.

2.1.3. The vehicle stability function shall be demonstrated to the Technical Service by dynamic manoeuvres on one vehicle. 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.

The use of the simulator is defined in Appendix 1 to this annex.

The specification and validation of the simulator is defined in Appendix 2 to this annex.

Until unified test procedures are agreed, 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 directional control and roll-over control 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.

As a means of demonstrating the vehicle stability function any of the following dynamic manoeuvres shall be used 3/:

Directional Control	Roll-Over Control
Reducing radius test	Steady state circular test
Step steer input test	J-turn
Sine with dwell	
J-turn	
<u>μ-split single lane change</u>	
Double lane change	
Reversed steering test or "fish hook" test	
Asymmetrical one period sine steer or pulse steer input test	

To demonstrate repeatability the vehicle will be subject to a second demonstration using the selected manoeuvre(s).

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.

3/ Should the use of any of the above defined manoeuvres not result in loss of directional control or roll-over as appropriate an alternative manoeuvre may be used in agreement with the Technical Service.

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 individually the speed of the left and right wheels on each axle or an axle of each axle group 4/ by selective braking based on the evaluation of actual trailer behaviour in comparison with a determination of the relative behaviour of the towing vehicle. 5/

In the case of roll-over control the function shall have the ability to automatically control the wheel speeds on at least two wheels of each axle or axle group 4/ by selective braking or automatically commanded braking based on the evaluation of actual trailer behaviour that may lead to roll-over. 5/

4/ In the case of multiple axles, where the spread between one axle and its adjacent axle is greater than 2 m, each individual axle shall be considered as an independent axle group.

5/ 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 No. 79 for corrective steering.

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:

- (a) The determination of actual trailer behaviour from values of the vertical force on the tyre(s), or at least lateral acceleration and wheel speeds. Only on-board generated information shall be used. 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.

2.2.3. The vehicle stability function shall be demonstrated to the Technical Service by dynamic manoeuvres on one vehicle. 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.

The use of the simulator is defined in Appendix 1 to this Annex.

The specification and validation of the simulator is defined in Appendix 2 to this annex.

Until unified test procedures are agreed, 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 control and directional control 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.

As a means of demonstrating the vehicle stability function any of the following dynamic manoeuvres shall be used 6:/

6/ Should the use of any of the above defined manoeuvres not result in loss of directional control or roll-over as appropriate an alternative manoeuvre may be used in agreement with the technical service.

Directional Control	Roll-Over Control
Reducing radius test	Steady state circular test
Step steer input test	J-turn
Sine with dwell	
J-turn	
μ -split single lane change	
Double lane change	
Reversed steering test or "fish hook" test	
Asymmetrical one period sine steer or pulse steer input test	

To demonstrate repeatability the vehicle will be subject to a second demonstration using the selected manoeuvre(s).

- 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.
- 2.2.5. To maximise the performance of trailers that utilise "select-low" such trailers are permitted to change control mode to "select-high" during an intervention of the "Vehicle Stability Function".

Annex 21 - Appendix 1

USE OF THE DYNAMIC STABILITY SIMULATION

The effectiveness of the directional and/or roll-over stability control function of power-driven vehicles and trailers of categories M, N and O, may be determined by computer simulation.

1. USE OF THE SIMULATION
 - 1.1 The vehicle stability function shall be demonstrated by the vehicle manufacturer to the Type Approval Authority or Technical Service with the same dynamic manoeuvre(s) as for the practical demonstration in paragraph 2.1.3. or 2.2.3. of Annex 21.
 - 1.2. The simulation shall be a means whereby the vehicle stability performance may be demonstrated with the vehicle stability function enabled or disabled, and in the laden and unladen conditions.

- 1.3. The simulations shall be carried out with a validated modelling and simulation tool. The verification shall be carried out using the same manoeuvre(s) as defined in paragraph 1.1. above.

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

Annex 21 - Appendix 2

DYNAMIC STABILITY SIMULATION TOOL AND ITS VALIDATION

1. SPECIFICATION OF THE SIMULATION TOOL

- 1.1. The simulation method shall take into account the main factors which influence the directional and roll motion of the vehicle. A typical model may include the following vehicle parameters in an explicit or implicit form:

- (a) Axle/wheel
- (b) Suspension
- (c) Tyre
- (d) Chassis/vehicle body
- (e) Power train/driveline, if applicable
- (f) Brake system
- (g) Pay load

- 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.

- 1.3. In the case of a trailer, the simulation shall be carried out with the trailer coupled to a representative towing vehicle.

1.4 Vehicle loading condition

- 1.4.1. The simulator shall be able to take into account the laden and unladen conditions.

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

2. VALIDATION OF THE SIMULATION TOOL

- 2.1. The validity of the applied modelling and simulation tool shall be verified by means of comparisons with a practical vehicle test(s). The test(s) utilised for the validation shall be those which, without control action, would result in loss of

directional control (under-steer and over-steer) or roll-over control as appropriate to the functionality of the stability control function installed on a representative vehicle.

During the test(s) the following motion variables, as appropriate, shall be recorded or calculated in accordance with ISO 15037 Part 1:2005: General conditions for passenger cars or Part 2:2002: General conditions for heavy vehicles and buses (depending on the vehicle category):

- (a) yaw velocity;
- (b) lateral acceleration;
- (c) wheel load or wheel lift;
- (d) forward velocity;
- (e) driver input.

- 2.2. The objective is to show that the simulated vehicle behaviour and operation of the vehicle stability function is comparable with that seen in practical vehicle tests.
- 2.3. The simulator shall be deemed to be validated when its output is comparable to the practical test results produced by a given vehicle type during the selected manoeuvre(s) from those defined with paragraph 2.1.3. or 2.2.3. of Annex 21, as appropriate.

In the case of the steady state circular test the under-steer gradient shall be the means of making the comparison.

In the case of a dynamic manoeuvre, the relationship of activation and sequence of the vehicle stability function in the simulation and in the practical vehicle test shall be the means of making the comparison.

- 2.4. The physical parameters that are different between the reference vehicle and simulated vehicle configurations shall be modified accordingly in the simulation.
- 2.5. A simulator test report shall be produced, a model of which is defined in Appendix 3 of this annex, and a copy attached to the vehicle approval report.

Annex 21 - Appendix 3

VEHICLE STABILITY FUNCTION SIMULATION TOOL TEST REPORT

Test Report Number:

- 1. Identification
 - 1.1. Name and address of the simulation tool manufacturer
 - 1.2. Simulation tool identification: name/model/number (hardware and software)

2. Scope of application
 - 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)
 - 2.4. Manoeuvre(s) for which the simulator has been validated:

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, including the motion variables referred to in Annex 21, Appendix 2, paragraph 2.1. as appropriate:

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, including the motion variables referred to in Annex 21, Appendix 2, paragraph 2.1. as appropriate:

5. This test has been carried out and the results reported in accordance with Appendix 2 of Annex 21 to ECE Regulation No. 13 as last amended by the series of amendments.

Technical Service conducting the test 1/

Signed: Date:

Approval Authority 1/

Signed: Date:

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