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Working Party on Brakes and Running Gear

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MEETING OF THE GRRF WORKING GROUP ON ELECTRONIC STABILITY CONTROL

Alignment of Regulations Nos. 13 and 13-H

Proposal for amendments to Regulation No. 13-H
(Braking)

Submitted by the expert from the European Commission (EC)

The text reproduced below was prepared by the expert from the EC in order to insert into the Regulation requirements for Electronic Stability Control (ESC) systems. These new requirements are based on the provisions contained within the proposed draft global technical regulation (gtr) on ESC (see ECE/TRANS/WP.29/GRRF/2007/14).

A. PROPOSAL

Insert new paragraphs 2.24. to 2.32., to read:

"2.24. "Ackerman steer angle" means the angle whose tangent is the wheelbase divided by the radius of the turn at a very low speed.

2.25. "Electronic Stability Control System" or "ESC System" means a system that has all of the following attributes:

2.25.1. The function shall have the ability to automatically control individually, the speed of the left and right wheels on each axle 1/ by selective braking based on the evaluation of actual vehicle behaviour in comparison with a determination of vehicle behaviour demanded by the driver, to induce a correcting yaw moment to the vehicle;

2.25.2. The function is under the control of a computer using a closed-loop algorithm to limit vehicle oversteer and vehicle understeer;

2.25.3. That has a means to determine the value of the vehicle's yaw rate and to estimate its side-slip or side-slip derivative with respect to time;

2.25.4. That has a means to monitor driver steering inputs;

2.25.5. That has an algorithm to determine the need, and a means to modify engine torque, as necessary, to assist the driver in maintaining control of the vehicle.

2.26. "Lateral acceleration" means the component of the acceleration vector of a point in the vehicle perpendicular to the vehicle x axis (longitudinal) and parallel to the road plane.

2.27. "Oversteer" means a condition in which the vehicle's yaw rate is greater than the yaw rate that would occur at the vehicle's speed as result of the Ackerman steer angle.

2.28. "Sideslip or side slip angle" means the arctangent of the ratio of the lateral velocity to the longitudinal velocity of the centre of gravity of the vehicle.

2.29. "Understeer" means a condition in which the vehicle's yaw rate is less than the yaw rate that would occur at the vehicle's speed as result of the Ackerman steer angle.

2.30. "Yaw rate" means the rate of change of the vehicle's heading angle measured in degrees/second of rotation about a vertical axis through the vehicle's centre of gravity.

2.31. "Peak braking coefficient (PBC)": means the measure of tyre to road surface friction based on the maximum deceleration of a rolling tyre.

1/ An axle group shall be treated as a single axle and dual wheels shall be treated as a single wheel.

2.32. "Common space" means an area on which more than one tell-tale, indicator, identification symbol, or other message may be displayed but not simultaneously."

Insert a new paragraph 5.2.25., to read:

"5.2.25. Subject to the requirements of paragraphs 12.2. to 12.4., any vehicle stability system fitted to a vehicle with a braking system approved under this Regulation shall meet the equipment, performance and test requirements contained in Annex 9 to this Regulation."

Insert new paragraphs 12.2. to 12.4., to read:

"12.2. As from the official date of entry into force of Supplement [x] to this Regulation, no Contracting Party applying this Regulation shall refuse to grant approval under this Regulation to a vehicle with respect to any electronic stability control system, provided this system meets the requirements of paragraph 5.2.25. to this Regulation.

12.3. As from [24] months after the date of entry into force of Supplement [x] to this Regulation, Contracting Parties applying this Regulation [may/shall] refuse to recognize new type approvals with respect to vehicles which are not equipped with a electronic stability system which meets the requirements of paragraph 5.2.25. to this Regulation.

12.4. As from [48] months after the date of entry into force of Supplement [x] to this Regulation, Contracting Parties applying this Regulation [may/shall] refuse to recognize existing type approvals with respect to vehicles which are not equipped with a electronic stability system which meets the requirements of paragraph 5.2.25. to this Regulation."

Annex 1

Insert a new item 21, to read:

"21 The vehicle is equipped with a vehicle stability function:..... Yes / No
If yes: The vehicle stability function has been tested according to and fulfils the requirements of Annex 9..... Yes / No"

Items 21 to 30 (former), renumber as items 22 to 31.

Insert a new Annex 9, to read (see next pages):

"Annex 9

ELECTRONIC STABILITY CONTROL SYSTEMS

1. GENERAL REQUIREMENTS

Vehicles equipped with an ESC system shall meet the functional requirements specified in paragraph 2. and the performance requirements in paragraph 3. under the test procedures specified in paragraph 4. and under the test conditions specified in paragraph 5. of this annex.

2. FUNCTIONAL REQUIREMENTS

Vehicles to which this annex applies shall be equipped with an electronic stability control system that:

2.1. Is capable of applying brake torques individually to all four wheels 1/ and has a control algorithm that utilizes this capability;

2.2. Is operational over the full speed range of the vehicle, during all phases of driving including acceleration, coasting, and deceleration (including braking), except:

2.2.1. when the driver has disabled ESC,

2.2.2. when the vehicle speed is below 15 km/h,

2.2.3. [while the initial start-up self test and plausibility checks are completed, and these are not to exceed 2 minutes when driven under the conditions of paragraph 5.10.2.,]

2.2.4. when the vehicle is being driven in reverse.

2.3. Remains capable of activation even if the antilock braking system or traction control system is also activated.

3. PERFORMANCE REQUIREMENTS

During each test performed under the test conditions of paragraph 4 and the test procedure of paragraph 5.9., the vehicle with the ESC system engaged shall satisfy the directional stability criteria of paragraphs 3.1. and 3.2., and it shall satisfy the responsiveness criterion of paragraph 3.3. during each of those tests conducted with a commanded steering wheel angle of 5A or greater but limited as per paragraph 5.9.4., where A is the steering wheel angle computed in paragraph 5.6.1.

1/ An axle group shall be treated as a single axle and dual wheels shall be treated as a single wheel.

3.1. The yaw rate measured 1 second after completion of the sine with dwell steering input (time $T_0 + 1$ in Figure 1) shall not exceed 35 percent of the first peak value of yaw rate recorded after the steering wheel angle changes sign (between first and second peaks) ($\dot{\psi}_{Peak}$ in Figure 1) during the same test run.

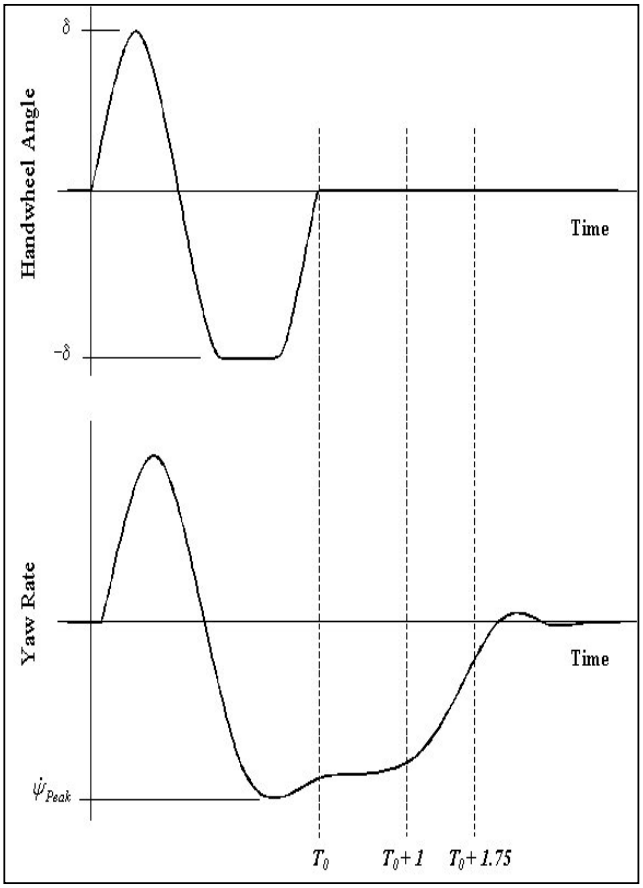

Figure 1 Steering wheel position and yaw velocity information used to assess lateral stability.

3.2. The yaw rate measured 1.75 seconds after completion of the Sine with Dwell steering input shall not exceed 20 percent of the first peak value of yaw rate recorded after the steering wheel angle changes sign (between first and second peaks) during the same test run.

3.3. The lateral displacement of the vehicle centre of gravity with respect to its initial straight path shall be at least 1.83 m for vehicles with a GVM of 3,500 kg or less, and 1.52 m for vehicles with a GVWR greater than 3,500 kg when computed 1.07 seconds after the Beginning of Steer (BOS). BOS is defined in paragraph 5.11.6.

3.3.1. The computation of lateral displacement is performed using double integration with respect to time of the measurement of lateral acceleration at the vehicle centre of gravity, as expressed by the formula:

$$\text{Lateral Displacement} = \iint a_{y_{C.G.}} dt$$

3.3.2 Time t = 0 for the integration operation is the instant of steering initiation, known as the Beginning of Steer (BOS). BOS is defined in paragraph 5.11.6.

3.4. ESC malfunction detection

The vehicle shall be equipped with a separate tell-tale that provides a warning to the driver of the occurrence of one or more malfunctions that affect the generation or transmission of control or response signals in the vehicle's electronic stability control system.

3.4.1. The ESC malfunction tell-tale:

3.4.1.1. Shall be displayed in direct and clear view of the driver while driving.

3.4.1.2. Shall be identified by the symbol shown for "ESC Malfunction Tell-tale" below or the text "**ESC**":

3.4.1.3. Except as provided in paragraph 3.4.1.4., the ESC malfunction tell-tale shall illuminate [only] when a malfunction(s) exists and remain continuously illuminated under the conditions specified in paragraph 3.4. for as long as the malfunction(s) exists, whenever the ignition locking system is in the "On" ("Run") position and;

3.4.1.4. Except as provided in paragraph 3.4.2., each ESC malfunction tell-tale shall be activated as a check of lamp function either when the ignition locking system is turned to the "On" ("Run") position when the engine is not running, or when the ignition locking system is in a position between "On" ("Run") and "Start" that is designated by the manufacturer as a check position;

3.4.1.5. Shall extinguish as soon as the system has detected that the malfunction no longer exists.

3.4.2. The ESC malfunction tell-tale need not be activated when a starter interlock is in operation.

3.4.3. The requirement of paragraph 3.4.1.4. does not apply to tell-tales shown in a common space.

3.4.4. The manufacturer may use the ESC malfunction tell-tale in a flashing mode to indicate that ESC is intervening.

3.5. ESC Off and other system controls

The manufacturer may include an "ESC Off" control, which shall be illuminated when the vehicle's headlamps are activated, whose only purpose is to place the ESC system in a mode in which it will no longer satisfy the performance requirements of paragraphs 3.1., 3.2. and 3.3. Manufacturers may also provide controls for other systems that have an ancillary effect upon ESC operation. Controls of either kind that place the ESC system in a mode in which it will no longer satisfy the performance requirements of paragraphs 3.1, 3.2. and 3.3. are permitted, provided that the system also meets the requirements of paragraphs 3.5.1., 3.5.2. and 3.5.3.

3.5.1. The vehicle's ESC system shall always return to a mode that satisfies the requirements of paragraphs 2. and 3. at the initiation of each new ignition cycle, regardless of what mode the driver had previously selected except that:

3.5.1.1. If that mode is specifically for enhanced traction during low-speed, off-road driving and is entered by the driver using a mechanical control that cannot be automatically reset electrically.

3.5.1.2. If the system has more than one mode that satisfies these requirements, the default mode shall be that one which satisfies the performance requirements of paragraph 3. by the greatest margin.

3.5.2. A control whose only purpose is to place the ESC system in a mode in which it will no longer satisfy the performance requirements of paragraphs 3.1., 3.2. and 3.3. shall be identified by the symbol shown for "ESC Off" below or the text "ESC Off".

3.5.3. A control for another system that has the ancillary effect of placing the ESC system in a mode in which it no longer satisfies the performance requirements of paragraphs 3.1., 3.2. and 3.3. need not be identified by the "ESC Off" symbol of paragraph 3.5.2., but the ESC status shall, in this case, be identified by the "ESC Off" tell-tale in accordance with paragraph 3.6.

3.6. ESC Off tell-tale

If the manufacturer elects to install a control to turn off or reduce the performance of the ESC system under paragraph 3.5., the tell-tale requirements of paragraphs 3.6.1. to 3.6.9. shall be met in order to alert the driver to the inhibited or reduced state of ESC system functionality.

3.6.1. The vehicle manufacturer shall provide a tell-tale indicating that the vehicle has been put into a mode that renders it unable to satisfy the requirements of paragraphs 3.1., 3.2. and 3.3., if such a mode is provided.

3.6.2. The "ESC Off" tell-tale shall be identified by the symbol shown for "ESC Off" in paragraph 3.5.2. or the text "ESC Off".

3.6.3. The "ESC Off" tell-tale shall be displayed in direct and clear view of the driver while driving.

3.6.4. The "ESC Off" tell-tale shall remain continuously illuminated for as long as the ESC is in a mode that renders it unable to satisfy the requirements of paragraphs 3.1., 3.2. and 3.3.

3.6.5. The vehicle manufacturer may use the "ESC Off" tell-tale to indicate an ESC level of function other than the fully functional operating mode even if the vehicle would still meet paragraphs 3.1., 3.2. and 3.3. at that level of ESC function.

3.6.6. Except as provided in paragraphs 3.6.7. and 3.6.8., each "ESC Off" tell-tale shall be activated as a check of lamp function either when the ignition locking system is turned to the "On" ("Run") position when the engine is not running, or when the ignition locking system is in a position between "On" ("Run") and "Start" that is designated by the manufacturer as a check position.

3.6.7. The "ESC Off" tell-tale needs not be activated when a starter interlock is in operation.

3.6.8. The requirement of paragraph 3.6.6. does not apply to tell-tales shown in a common space.

3.6.9. The"ESC Off" tell-tale shall extinguish after the ESC system has been returned to its fully functional default mode.

3.7. ESC system technical documentation

Further to the requirements defined in Annex 8 to this Regulation the documentation package shall, as confirmation that the vehicle is equipped with an ESC system that meets the definition of an "ESC System" as in paragraph 2.25. to this Regulation, include the vehicle manufacturer's documentation as specified in paragraphs 3.7.1. to 3.7.4. below.

3.7.1. System diagram identifying all ESC system hardware. The diagram shall identify those components that are used to generate brake torques at each wheel, determine

vehicle yaw rate, estimated side-slip or the side-slip derivative and driver steering inputs.

3.7.2. Written explanation describing the ESC system basic operational characteristics. This explanation shall include a description of the system's capability to apply braking torques at each wheel and how the system modifies engine torque during ESC system operation. The explanation shall also specify the vehicle speed range and the driving phases (acceleration, deceleration, coasting, during activation of the ABS or traction control) under which the ESC system can activate.

3.7.3. Logic diagram. This diagram supports the explanation provided under paragraph 3.7.2.

3.7.4. Understeer information. Specifically for mitigating vehicle understeer, the manufacturer shall provide a description of the pertinent inputs to the computer or calculations within the computer and how its algorithm uses that information and controls ESC system hardware to limit vehicle understeer.

4. TEST CONDITIONS

4.1. Ambient conditions

4.1.1. The ambient temperature is between 7 °C and 40 °C.

4.1.2. The maximum wind speed is no greater than 10 m/s for M_1 vehicles and 5 m/s for other vehicle categories.

4.2. Road test surface

4.2.1. The tests are conducted on a dry, uniform, solid-paved surface. Surfaces with irregularities and undulations, such as dips and large cracks, are unsuitable.

4.2.2. The road test surface shall produce a peak braking coefficient (PBC) of 0.9 when measured without water delivery using either:

4.2.2.1. the American Society for Testing and Materials (ASTM) E1136 standard reference test tyre, in accordance with ASTM Method E1337-90, at a speed of 40 mph without water delivery; or

4.2.2.2. the k-test method specified in Appendix 2 to Annex 6 of this Regulation.

4.2.3. The test surface has a consistent slope between level and 1 per cent.

4.3. Vehicle conditions

4.3.1. The ESC system is enabled for all testing.

4.3.2. Vehicle mass. The vehicle is loaded with the fuel tank filled to at least 75 percent of capacity, and total interior load of 168 kg comprised of the test driver, approximately 59 kg of test equipment (robot steering machine, data acquisition system and the power supply for the steering machine), and ballast as required to make up for any shortfall in the weight of test drivers and test equipment. Where required, ballast shall be placed on the floor behind the passenger front seat or if necessary in the front passenger foot well area. All ballast shall be secured in a way that prevents it from becoming dislodged during testing.

4.3.3. Tyres. The vehicle is tested with the tyres installed on the vehicle by the manufacturer and inflated to his recommended cold inflation pressure(s) specified on the vehicle's placard or the tyre inflation pressure label. Tubes may be installed to prevent tire de-beading.

4.3.4. Outriggers. Outriggers shall be used for testing high vehicles such as multipurpose passenger vehicles, and vans. Such vehicles with a baseline weight under 2,722 kg shall be equipped with "standard" outriggers and vehicles with a baseline weight equal to or greater than 2,722 kg shall be equipped with "heavy" outriggers. A vehicle's baseline weight is the weight of the vehicle as would be delivered from the dealer, fully fueled, with a 73 kg driver. Standard outriggers shall be designed with a maximum weight of 32 kg and a maximum roll moment of inertia of 35.9 $kg \cdot m^2$. Heavy outriggers shall be designed with a maximum weight of 39 kg and a maximum roll moment of inertia of 40.7 $kg \cdot m^2$.

4.3.5. Automated steering machine. A steering robot programmed to execute the required steering pattern shall be used in paragraphs 5.5.2., 5.5.3., 5.6. and 5.9. The steering machine shall be capable of supplying steering torques between 40 to 60 Nm. The steering machine shall be able to apply these torques when operating with steering wheel velocities up to 1200 degrees per second.

5. Test Procedure

5.1. Inflate the vehicles' tyres to the cold inflation pressure(s) provided on the vehicle's placard or the tyre inflation pressure label.

5.2. Tell-tale bulb check. With the vehicle stationary and the ignition locking system in the "Lock" or "Off" position, switch the ignition to the "On" ("Run") position or, where applicable, the appropriate position for the lamp check. The ESC malfunction tell-tale shall be illuminated as a check of lamp function, as specified in paragraph 3.4.1.4, and if equipped, the "ESC Off" tell-tale shall also be illuminated as a check of lamp function, as specified in paragraph 3.6.6. The tell-tale bulb check is not required for a tell-tale shown in a message centre as specified in paragraphs 3.4.2. and 3.6.8.

5.3. "ESC Off" control check. For vehicles equipped with an "ESC Off" control, with the vehicle stationary and the ignition locking system in the "Lock" or "Off" position, switch the ignition locking system to the "On" ("Run") position. Activate the "ESC

Off" control and verify that the "ESC Off" tell-tale is illuminated, as specified in paragraph 3.6.4. Turn the ignition locking system to the "Lock" or "Off" position. Again, switch the ignition locking system to the "On" ("Run") position and verify that the "ESC Off" tell-tale has extinguished indicating that the ESC system has been restored as specified in paragraph 3.5.1.

5.4. Brake conditioning

Condition the vehicle brakes in the manner described in paragraphs 5.4.1. to 5.4.4.

5.4.1. Ten stops are performed from a speed of 56 km/h, with an average deceleration of approximately 0.5g.

5.4.2. Immediately following the series of ten 56 km/h stops, three additional stops are performed from 72 km/h at higher deceleration.

5.4.3. When executing the stops in paragraph 5.4.2., sufficient force is applied to the brake pedal to bring the vehicle's antilock braking system (ABS) into operation for a majority of each braking event.

5.4.4. Following completion of the final stop in 5.4.2., the vehicle is driven at a speed of 72 km/h for five minutes to cool the brakes.

5.5. Tyre Conditioning

Condition the tyres using the procedure of paragraphs 5.5.1. to 5.5.3. to wear away mould sheen and achieve operating temperature immediately before beginning the test runs of paragraphs 5.6. and 5.9.

5.5.1. The test vehicle is driven around a circle 30 meters in diameter at a speed that produces a lateral acceleration of approximately 0.5 to 0.6g for three clockwise laps followed by three anticlockwise laps.

5.5.2. Using a sinusoidal steering pattern at a frequency of 1 Hz, a peak steering wheel angle amplitude corresponding to a peak lateral acceleration of 0.5 to 0.6g, and a vehicle speed of 56 km/h, the vehicle is driven through four passes performing 10 cycles of sinusoidal steering during each pass.

5.5.3. The steering wheel angle amplitude of the final cycle of the final pass shall be twice that of the other cycles. The maximum time permitted between each of the laps and passes is five minutes.

5.6. Slowly increasing steer procedure

The vehicle is subjected to two series of runs of the slowly increasing steer test using a constant vehicle speed of 80 $\pm$ 2 km/h and a steering pattern that increases by 13.5 degrees per second until a lateral acceleration of approximately 0.5g is

obtained. Three repetitions are performed for each test series. One series uses anticlockwise steering, and the other series uses clockwise steering. The maximum time permitted between each test run is five minutes.

5.6.1. From the slowly increasing steer tests, the quantity "A" is determined. "A" is the steering wheel angle in degrees that produces a steady state lateral acceleration (corrected using the methods specified in paragraph 5.11.3.) of 0.3g for the test vehicle. Utilizing linear regression, A is calculated, to the nearest 0.1 degrees, from each of the six slowly increasing steer tests. The absolute value of the six A values calculated, is averaged and rounded to the nearest 0.1 degrees to produce the final quantity, A, used below.

5.7. After the quantity A has been determined, without replacing the tyres, the tyre conditioning procedure described in paragraph 5.5. is performed again immediately prior to conducting the Sine with Dwell test of paragraph 5.9. Initiation of the first Sine with Dwell test series shall begin within two hours after completion of the slowly increasing steer tests of paragraph 5.6.

5.8. Check that the ESC system is enabled by ensuring that the ESC malfunction and "ESC Off" (if provided) tell-tales are not illuminated.

5.9. Sine with Dwell test of oversteer intervention and responsiveness

The vehicle is subjected to two series of test runs using a steering pattern of a sine wave at 0.7 Hz frequency with a 500 ms delay beginning at the second peak amplitude as shown in Figure 2 (the Sine with Dwell tests). One series uses anticlockwise steering for the first half cycle, and the other series uses clockwise steering for the first half cycle. The vehicle is allowed to cool-down between each test run for a period of 1.5 to 5 minutes, with the vehicle stationary.

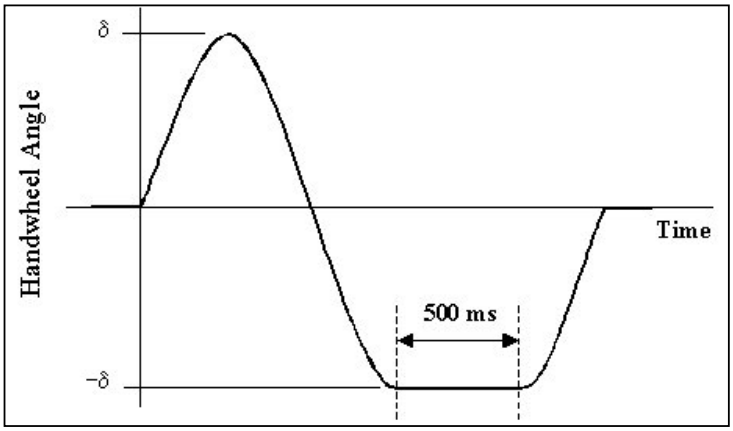

Figure 2 Sine with Dwell

5.9.1. The steering motion is initiated with the vehicle coasting in high gear at 80 ± 2 km/h.

5.9.2. The steering amplitude for the initial run of each series is 1.5 A, where A is the steering wheel angle determined in paragraph 5.6.1.

5.9.3. In each series of test runs, the steering amplitude is increased from run to run, by 0.5 A, provided that no such run will result in a steering amplitude greater than that of the final run specified in paragraph 5.9.4.

5.9.4. The steering amplitude of the final run in each series is the greater of 6.5 A or 270 degrees, provided the calculated magnitude of 6.5 A is less than or equal to 300 degrees. If any 0.5 A increment, up to 6.5 A, is greater than 300 degrees, the steering amplitude of the final run shall be 300 degrees.

5.9.5. Upon completion of the two series of test runs, post processing of yaw rate and lateral acceleration data is done as specified in paragraph 5.11.

5.10. ESC malfunction detection

5.10.1. Simulate one or more ESC malfunction(s) by disconnecting the power source to any ESC component, or disconnecting any electrical connection between ESC components (with the vehicle power off). When simulating an ESC malfunction, the electrical connections for the tell-tale lamp(s) are not to be disconnected.

5.10.2. With the vehicle initially stationary and the ignition locking system in the "Lock" or "Off" position, switch the ignition locking system to the "Start" position and start the engine. Place the vehicle in a forward gear and obtain a vehicle speed of 48 $\pm$ 8 km/h. Drive the vehicle for at least two minutes including at least one left and one right turning manoeuvre and one brake application. Verify that within two minutes of obtaining this vehicle speed, the ESC malfunction indicator illuminates in accordance with paragraph 3.4.

5.10.3. Stop the vehicle, switch the ignition locking system to the "Off" or "Lock" position. After a five-minute period, switch the vehicle's ignition locking system to the "Start" position and start the engine. Verify that the ESC malfunction indicator again illuminates to signal a malfunction and remains illuminated as long as the engine is running or until the fault is corrected.

5.10.4. Switch the ignition locking system to the "Off" or "Lock" position. Restore the ESC system to normal operation, switch the ignition system to the "Start" position and start the engine. [Place the vehicle in a forward gear and obtain a vehicle speed of 48 $\pm$ 8 km/h. Drive the vehicle for at least two minutes including at least one left and one right turning manoeuvre and one braking application. Verify that within two minutes of obtaining this vehicle speed, the ESC malfunction indicator has extinguished.]

5.11. Post data processing – calculations for performance metrics

Yaw rate and lateral displacement measurements and calculations shall be processed utilizing the techniques specified in paragraphs 5.11.1. to 5.11.8.

5.11.1. Raw steering wheel angle data is filtered with a 12-pole phaseless Butterworth filter and a cut-off frequency of 10 Hz. The filtered data is then zeroed to remove sensor offset utilizing static pre-test data.

5.11.2. Raw yaw rate data is filtered with a 12-pole phaseless Butterworth filter and a cut-off frequency of 6 Hz. The filtered data is then zeroed to remove sensor offset utilizing static pre-test data.

5.11.3. Raw lateral acceleration data is filtered with a 12-pole phaseless Butterworth filter and a cut-off frequency of 6 Hz. The filtered data is then zeroed to remove sensor offset utilizing static pre-test data. The lateral acceleration data at the vehicle centre of gravity is determined by removing the effects caused by vehicle body roll and by correcting for sensor placement via the use of coordinate transformation. For data collection, the lateral accelerometer shall be located as close as possible to the position of the vehicle's longitudinal and lateral centres of gravity.

5.11.4. Steering wheel velocity is determined by differentiating the filtered steering wheel angle data. The steering wheel velocity data is then filtered with a moving 0.1 second running average filter.

5.11.5. Lateral acceleration, yaw rate and steering wheel angle data channels are zeroed utilizing a defined "zeroing range." The methods used to establish the zeroing range are defined in paragraphs 5.11.5.1. and 5.11.5.2.

5.11.5.1. Using the steering wheel rate data calculated using the methods described in paragraph 5.11.4., the first instant that the steering wheel rate exceeds 75 deg/sec is identified. From this point, steering wheel rate shall remain greater than 75 deg/sec for at least 200 ms. If the second condition is not met, the next instant that the steering wheel rate exceeds 75 deg/sec is identified and the 200 ms validity check applied. This iterative process continues until both conditions are ultimately satisfied.

5.11.5.2. The "zeroing range" is defined as the 1.0 second time period prior to the instant the steering wheel rate exceeds 75 deg/sec (i.e., the instant the steering wheel velocity exceeds 75 deg/sec defines the end of the "zeroing range").

5.11.6. The Beginning of Steer (BOS) is defined as the first instance when the filtered and zeroed steering wheel angle data reaches -5 degrees (when the initial steering input is anticlockwise) or +5 degrees (when the initial steering input is clockwise) after a time defining the end of the "zeroing range." The value for time at the BOS is interpolated.

5.11.7. The Completion of Steer (COS) is defined as the time the steering wheel angle returns to zero at the completion of the Sine with Dwell steering manoeuvre. The value for time at the zero degree steering wheel angle is interpolated.

5.11.8. The second peak yaw rate is defined as the first local yaw rate peak produced by the reversal of the steering wheel. The yaw rates at 1.000 and 1.750 seconds after COS are determined by interpolation.

5.11.9. Determine lateral velocity by integrating corrected, filtered and zeroed lateral acceleration data. Zero lateral velocity at the BOS point. Determine lateral displacement by integrating zeroed lateral velocity. Zero lateral displacement at the BOS point. The lateral displacement measurement is made at 1.07 seconds after BOS point and is determined by interpolation."

B. JUSTIFICATION

The purpose of this document is to introduce requirements for electronic stability control (ESC) systems based on the technical requirements of the proposed global technical regulation on ESC.

The affected paragraphs (taking into account other pending amendments to this Regulation) are:

(a) Paragraphs 2.24. to 2.32. – New definitions.
(b) Paragraph 5.2.25. – General requirement.
(c) Paragraphs 12.2. to 12.4. – Transitional Provisions.
(d) Annex 1, item 21 – Type Approval documentation requirements.
(e) Annex 9 – New annex covering functional and test requirements.

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