

2 November 2018

Agreement

Concerning the Adoption of Harmonized Technical United Nations Regulations 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 United Nations Regulations*

(Revision 3, including the amendments which entered into force on 14 September 2017)

Addendum 78 – UN Regulation No. 79

Revision 3 –Amendment 2

03 series of amendments – Date of entry into force: 16 October 2018

Uniform provisions concerning the approval of vehicles with regard to steering equipment

This document is meant purely as documentation tool. The authentic and legal binding texts is: ECE/TRANS/WP.29/2018/35 (as amended by paragraph 92 of the report ECE/TRANS/WP.29/1137).



UNITED NATIONS

* Former titles 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 (original version); 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, done at Geneva on 5 October 1995 (Revision 2).

Paragraph 1.2.3., amend to read:

- "1.2.3. Steering systems exhibiting the functionality defined as ACSF of Category B2, D or E in paragraphs 2.3.4.1.3., 2.3.4.1.5., or 2.3.4.1.6., respectively, until specific provisions are introduced in this Regulation."

Insert a new paragraph 2.3.4.3., to read:

- "2.3.4.3. "Emergency Steering Function (ESF)" means a control function which can automatically detect a potential collision and automatically activate the vehicle steering system for a limited duration, to steer the vehicle with the purpose of avoiding or mitigating a collision, with:

- (a) Another vehicle driving* in an adjacent lane:
 - (i) Drifting towards the path of the subject vehicle and/or;
 - (ii) Into which path the subject vehicle is drifting and/or;
 - (iii) Into which lane the driver initiates a lane change manoeuvre.
- (b) An obstacle obstructing the path of the subject vehicle or when the obstruction of the subject vehicle's path is deemed imminent.

ESF shall cover one or more use cases from the list above.

* The vehicle may be driving in the same or the opposite direction as the subject vehicle."

Insert new paragraphs 2.4.16. and 2.4.17., to read:

- "2.4.16. A "Lane Change Procedure" in the case of ACSF of Category C starts when the direction indicator lamps are activated by a deliberate action of the driver and ends when the direction indicator lamps are deactivated. It comprises the following operations:

- (a) Activation of the direction indicator lamps by a deliberate action of the driver;
- (b) Lateral movement of the vehicle towards the lane boundary;
- (c) *Lane Change Manoeuvre*;
- (d) Resumption of the lane keeping function;
- (e) Deactivation of direction indicator lamps.

- 2.4.17. A "Lane Change Manoeuvre" is part of the *Lane Change Procedure* and,

- (a) Starts when the outside edge of the tyre tread of the vehicle's front wheel closest to the lane markings touches the inside edge of the lane marking to which the vehicle is being manoeuvred,
- (b) Ends when the rear wheels of the vehicle have fully crossed the lane marking."

Paragraph 5.1.6.1.1., amend to read:

- "5.1.6.1.1. Every CSF intervention shall immediately be indicated to the driver by an optical warning signal which is displayed for at least 1 s or as long as the intervention exists, whichever is longer.

In the case of a CSF intervention which is controlled by an Electronic Stability Control (ESC) or a Vehicle Stability Function as specified in the relevant UN Regulation (i.e. UN Regulations Nos. 13, 13-H or 140), the ESC flashing tell-tale indicating the interventions of ESC may be used, as long as the intervention exists, as an alternative to the optical warning signal specified above."

Insert a new paragraph 5.1.6.2., to read:

- "5.1.6.2. Vehicles equipped with an ESF shall fulfil the following requirements.
An ESF system shall be subject to the requirements of Annex 6.
- 5.1.6.2.1. Any ESF shall only start an intervention in the case where a risk of a collision is detected.
- 5.1.6.2.2. Any vehicle fitted with ESF shall be equipped with means to monitor the driving environment (e.g. lane markings, road edge, other road users) in line with the specified use case. These means shall monitor the driving environment at any time the ESF is active.
- 5.1.6.2.3. An automatic avoidance manoeuvre initiated by an ESF shall not lead the vehicle to leave the road.
- 5.1.6.2.3.1. In the case of an ESF intervention on a road or a lane delimited with lane markings on one or both side(s), an automatic avoidance manoeuvre initiated by an ESF shall not lead the vehicle to cross a lane marking. However, if the intervention starts during a lane change performed by the driver or during an unintentional drift into the adjacent lane, the system may steer the vehicle back into its original lane of travel.
- 5.1.6.2.3.2. In the absence of a lane marking on one or on both side(s) of the vehicle, a single ESF intervention is permitted, provided that it does not produce a lateral offset of the vehicle greater than 0.75 m in a direction where the lane marking is absent. The lateral offset during the automatic avoidance manoeuvre shall be determined using a fixed point on the front of the vehicle at the start and at the conclusion of the ESF intervention.
- 5.1.6.2.4. The ESF intervention shall not lead the vehicle to collide with another road user.*

* Until uniform test procedures have been agreed, the manufacturer shall provide the Technical Service with documentation and supporting evidence to demonstrate compliance with this provision. This information shall be subject to discussion and agreement between the Technical Service and the vehicle manufacturer.

- 5.1.6.2.5. The manufacturer shall demonstrate during type approval, to the satisfaction of the Technical Service, which means to monitor the driving environment are fitted to the vehicle to satisfy the provisions in the subparagraphs of paragraph 5.1.6.2. above.
- 5.1.6.2.6. Any intervention of an ESF shall be indicated to the driver with an optical and with an acoustic or haptic warning signal to be provided at the latest with the start of the ESF intervention.

For this purpose appropriate signals used by other warning systems (e.g. blind spot detection, lane departure warning, forward collision warning) are deemed

to be sufficient to fulfil the requirements for the respective optical, acoustic or haptic signals above.

- 5.1.6.2.7. A system failure shall be indicated to the driver with an optical warning signal. However, when the system is manually deactivated, the indication of failure mode may be suppressed.
- 5.1.6.2.8. The steering control effort necessary to override the directional control provided by the system shall not exceed 50 N.
- 5.1.6.2.9. The vehicle shall be tested in accordance with the relevant vehicle tests specified in Annex 8 of this Regulation.
- 5.1.6.2.10. System information data
- The following data shall be provided, together with the documentation package required in Annex 6 of this Regulation, to the Technical Service at the time of type approval:
- (a) Use case(s) where ESF is designed to operate (among the use cases a i, a ii, a iii and b. specified in the ESF definition in paragraph 2.3.4.3.),
 - (b) The conditions under which the system is active, e.g. the vehicle speed range V_{smax} , V_{smin} ,
 - (c) How ESF detects a risk of a collision,
 - (d) Description of the means to detect the driving environment,
 - (e) How to deactivate/reactivate the function,
 - (f) How it is ensured that the overriding force does not exceed the limit of 50 N."

Insert a new paragraph 5.6.3., to read:

"5.6.3. (Reserved for ACSF of Category B2)"

Insert a new paragraph 5.6.4., to read:

"5.6.4. Special Provisions for ACSF of Category C

Vehicles equipped with an ACSF system of Category C shall fulfil the following requirements.

5.6.4.1. General

5.6.4.1.1. A vehicle equipped with an ACSF of Category C shall also be equipped with an ACSF of Category B1 complying with the requirements of this Regulation.

5.6.4.1.2. When the ACSF of Category C is activated (standby) the ACSF of Category B1 shall aim to center the vehicle in the lane.

This shall be demonstrated to the Technical Service during type approval.

5.6.4.2. Activation/deactivation of the ACSF of Category C system

5.6.4.2.1. The default status of the system shall be off at the initiation of each new engine start/run cycle.

This requirement does not apply when a new engine start/run cycle is performed automatically, e.g. the operation of a stop/start system.

- 5.6.4.2.2. The vehicle shall be equipped with a means for the driver to activate (standby mode) and deactivate (off mode) the system. The same means as for an ACSF of Category B1 may be used.
- 5.6.4.2.3. The system shall only be activated (standby mode) after a deliberate action by the driver.
- Activation by the driver shall only be possible on roads where pedestrians and cyclists are prohibited and which, by design, are equipped with a physical separation that divides the traffic moving in opposite directions and which have at least two lanes in the direction the vehicles are driving. These conditions shall be ensured by the use of at least two independent means.
- In the case of a transition from a road type with a classification permitting an ACSF of Category C, to a type of road where an ACSF of Category C is not permitted, the system shall be deactivated automatically.
- 5.6.4.2.4. It shall be possible to deactivate the system (off mode) at any time by a single action of the driver. Following this action, the system shall only be able to be reactivated (standby mode) by a deliberate action of the driver.
- 5.6.4.2.5. Notwithstanding the requirements above it shall be possible to perform the corresponding tests in Annex 8 of this Regulation on a test track.
- 5.6.4.3. **Overriding**
- A steering input by the driver shall override the steering action of the system. The steering control effort necessary to override the directional control provided by the system shall not exceed 50 N.
- The system may remain activated (standby mode) provided that priority is given to the driver during the overriding period.
- 5.6.4.4. **Lateral acceleration**
- The lateral acceleration induced by the system during the lane change manoeuvre:
- (a) Shall not exceed 1 m/s^2 in addition to the lateral acceleration generated by the lane curvature, and
 - (b) Shall not cause the total vehicle lateral acceleration to exceed the maximum values indicated in tables of paragraph 5.6.2.1.3. above.
- The moving average over half a second of the lateral jerk generated by the system shall not exceed 5 m/s^3 .
- 5.6.4.5. **Human Machine Interface (HMI)**
- 5.6.4.5.1. Unless otherwise specified, the optical signals identified in paragraph 5.6.4.5. shall be easily distinguishable from each other (e.g. different symbol, colour, blinking, text).
- 5.6.4.5.2. When the system is in standby mode (i.e. ready to intervene), an optical signal shall be provided to the driver.
- 5.6.4.5.3. When the lane change procedure is ongoing an optical signal shall be provided to the driver.
- 5.6.4.5.4. When the lane change procedure is suppressed, in accordance with paragraph 5.6.4.6.8., the system shall clearly inform the driver about this system status

by an optical warning signal and additionally by an acoustic or haptic warning signal. In case the suppression is initiated by the driver, an optical warning is sufficient.

- 5.6.4.5.5. A system failure shall be signalled immediately to the driver by an optical warning signal. However, when the system is manually deactivated by the driver, the indication of failure mode may be suppressed.

If a system failure occurs during a lane change manoeuvre, the failure shall be signalled to the driver by an optical, and an acoustic or haptic warning.

- 5.6.4.5.6. The system shall provide a means of detecting that the driver is holding the steering control and shall warn the driver in accordance with the warning strategy below:

If, after a period of no longer than 3 seconds after the initiation of the lane change procedure, the driver is not holding the steering control, an optical warning signal shall be provided. This signal shall be the same as the signal specified in paragraph 5.6.2.2.5. above.

The warning signal shall be active until the driver is holding the steering control, or until the system is deactivated, either manually or automatically.

- 5.6.4.6. Lane Change Procedure

- 5.6.4.6.1. The initiation of a lane change procedure of an ACSF of Category C shall only be possible if an ACSF of Category B1 is already active.

- 5.6.4.6.2. The lane change procedure requires, and shall start immediately after, a manual activation by the driver of the direction indicator to the intended side for the lane change.

- 5.6.4.6.3. When the lane change procedure starts, the ACSF of Category B1 shall be suspended and the ACSF of Category C shall carry on the lane keeping function of ACSF of category B1, until the lane change manoeuvre starts.

- 5.6.4.6.4. The lateral movement of the vehicle towards the intended lane shall not start earlier than 1 second after the start of the lane change procedure. Additionally, the lateral movement to approach the lane marking and the lateral movement necessary to complete the lane change manoeuvre, shall be completed as one continuous movement.

The lane change manoeuvre shall not be initiated before a period of 3.0 seconds and not later than 5.0 seconds after the deliberate action of the driver described in paragraph 5.6.4.6.2. above.

- 5.6.4.6.5. The lane change manoeuvre shall be completed in less than:

- (a) 5 seconds for M₁, N₁ vehicle categories;
- (b) 10 seconds for M₂, M₃, N₂, N₃ vehicle categories.

- 5.6.4.6.6. Once the lane change manoeuvre has completed, ACSF of Category B1 lane keeping function shall resume automatically.

- 5.6.4.6.7. The direction indicator shall remain active throughout the whole period of the lane change manoeuvre and shall be deactivated by the system no later than 0.5 seconds after the resumption of ACSF of Category B1 lane keeping function as described in paragraph 5.6.4.6.6. above.

- 5.6.4.6.8. Suppression of the Lane Change Procedure

- 5.6.4.6.8.1. The lane change procedure shall be suppressed automatically by the system when at least one of the following situations occurs before the lane change manoeuvre has started:
- (a) The system detects a critical situation (as defined in paragraph 5.6.4.7.);
 - (b) The system is overridden or switched off by the driver;
 - (c) The system reaches its boundaries (e.g. lane markings are no longer detected);
 - (d) The system has detected that the driver is not holding the steering control at the start of the lane change manoeuvre;
 - (e) The direction indicator lamps are manually deactivated by the driver;
 - (f) The lane change manoeuvre has not commenced within 5.0 seconds following the deliberate action of the driver described in paragraph 5.6.4.6.2.;
 - (g) The lateral movement described in paragraph 5.6.4.6.4. is not continuous.
- 5.6.4.6.8.2. Manual deactivation of the lane change procedure, using the manual control of the direction indicator, shall be possible for the driver at any time.
- 5.6.4.7. Critical situation

A situation is deemed to be critical when, at the time a lane change manoeuvre starts, an approaching vehicle in the target lane would have to decelerate at a higher level than 3m/s^2 , 0.4 seconds after the lane change manoeuvre has started, to ensure the distance between the two vehicles is never less than that which the lane change vehicle travels in 1 second.

The resulting critical distance at the start of the lane change manoeuvre shall be calculated using the following formula:

$$S_{critical} = (v_{rear} - v_{ACSF}) * t_B + (v_{rear} - v_{ACSF})^2 / (2 * a) + v_{ACSF} * t_G$$

Where:

- v_{rear} is The actual speed of the approaching vehicle or 130 km/h whatever value is lower
- v_{ACSF} is The actual speed of the ACSF vehicle
- a = 3 m/s^2 (Deceleration of the approaching vehicle)
- t_B = 0.4 s (Time after the start of the lane change manoeuvre at which the deceleration of the approaching vehicle starts)
- t_G = 1 s (Remaining gap of the vehicles after the deceleration of the approaching vehicle).

- 5.6.4.8. Minimum distance and minimum operation speed
- 5.6.4.8.1. The ACSF of Category C shall be able to detect vehicles approaching from the rear in an adjacent lane up to a distance S_{rear} as specified below:
- The minimum distance S_{rear} shall be declared by the vehicle manufacturer. The declared value shall not be less than 55 m.

The declared distance shall be tested according to the relevant test in Annex 8 using a two-wheeled motor vehicle of Category L₃¹ as the approaching vehicle.

The minimum operation speed V_{smin} , down to which the ACSF of Category C is permitted to perform a lane change manoeuvre, shall be calculated with minimum distance S_{rear} using the following formula:

$$V_{Smin} = a * (t_B - t_G) + v_{app} - \sqrt{a^2 * (t_B - t_G)^2 - 2 * a * (v_{app} * t_G - S_{rear})}$$

Where:

S_{rear} is The minimum distance declared by the manufacturer in [m];

V_{app} = 36.1 m/s (The speed of the approaching vehicle is 130 km/h *i.e.* 36.1 m/s);

a = 3 m/s² (Deceleration of the approaching vehicle);

t_B = 0.4 s (Time after the start of the manoeuvre at which the deceleration of the approaching vehicle starts);

t_G = 1 s (Remaining gap of the vehicles after the deceleration of the approaching vehicle);

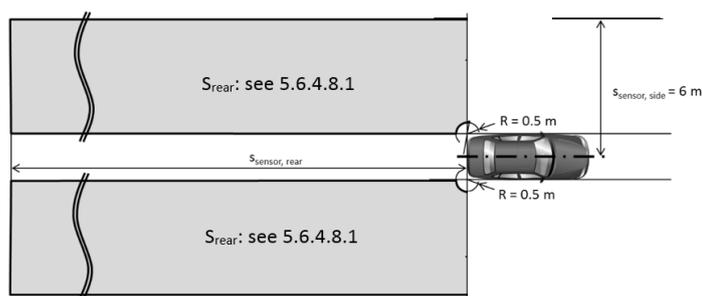
V_{smin} in [m/s] is The resulting minimum activation speed of the ACSF of Category C.

If the vehicle is operated in a country with a general maximum speed limit below 130 km/h, this speed limit may be used as an alternative for V_{app} in the above formula to calculate the minimum operation speed V_{smin} . In this case the vehicle shall be equipped with a means to detect the country of the operation and shall have information available on the general maximum speed limit of this country.

Notwithstanding the requirements above in this paragraph, the ACSF of Category C is permitted to perform a lane change manoeuvre at speeds lower than the calculated V_{smin} provided that the following conditions are met:

- (a) The system has detected another vehicle in the adjacent lane into which the lane change is planned at a distance lower than S_{rear} ; and
- (b) The situation is not deemed to be critical according to paragraph 5.6.4.7. (e.g. at low speed differences and $V_{app} < 130$ km/h);
- (c) The declared value S_{rear} is greater than the calculated value $S_{critical}$ from paragraph 5.6.4.7. above.

5.6.4.8.2. The vehicle system detection area on ground level shall be at minimum as shown in the figure below.



- 5.6.4.8.3. After each vehicle new engine start/run cycle (other than when performed automatically, e.g. the operation of a stop/start systems), the ACSF of Category C function shall be prevented from performing a lane change manoeuvre until the system has detected, at least once, a moving object at a distance greater than the minimum distance S_{rear} declared by the manufacturer in paragraph 5.6.4.8.1. above.
- 5.6.4.8.4. The ACSF of Category C shall be able to detect blindness of the sensor (e.g. due to accumulation of dirt, ice or snow). The ACSF of Category C shall be prevented, upon detection of blindness, from performing the lane change manoeuvre. The status of the system shall be signalled to the driver no later than on the initiation of the lane change procedure. The same warning as the one specified in paragraph 5.6.4.5.5. (system failure warning) may be used.
- 5.6.4.9. System information data
- 5.6.4.9.1. The following data shall be provided, together with the documentation package required in Annex 6 of this Regulation, to the Technical Service at the time of type approval.
- 5.6.4.9.1.1. The conditions under which the system can be activated and the boundaries for operation (boundary conditions). The vehicle manufacturer shall provide values for V_{smax} , V_{smin} and $a_{y\text{smax}}$ for every speed range as mentioned in the table of paragraph 5.6.2.1.3. of this Regulation.
- 5.6.4.9.1.2. Information about how the system detects that the driver is holding the steering control.
- 5.6.4.9.1.3. The means to override and to suppress or cancel.
- 5.6.4.9.1.4. Information about how the failure warning signal status and the confirmation of the valid software version related ACSF performance can be checked via the use of an electronic communication interface.*
- 5.6.4.9.1.5. Documentation about which system software version related ACSF performance is valid. This documentation shall be updated whenever a software version was amended.*

* This paragraph shall be reviewed once the Task Force on Cyber Security and Over the Air issues (TF CS/OTA) reporting to the World Forum for the Harmonization of Vehicle Regulations (WP.29) Informal Working Group on Intelligent Transport Systems / Automated Driving has finalized its work on measures for software identification and, if necessary, amended accordingly.

- 5.6.4.9.1.6. Information on the sensor range over lifetime. The sensor range shall be specified in such way that any influence on deterioration of the sensor shall not affect the fulfilment of paragraphs 5.6.4.8.3. and 5.6.4.8.4. of this Regulation.
- 5.6.4.10. The vehicle with ACSF of Category C shall be tested in accordance with relevant vehicle test(s) specified in Annex 8 of this Regulation. For driving situations not covered by the tests of Annex 8, the safe operation of the ACSF shall be demonstrated by the vehicle manufacturer on the base of Annex 6 of this Regulation."

Paragraph 12., amend to read:

"12. Transitional provisions

- 12.1. Transitional provisions applicable to the 02 series of amendments:
 - 12.1.1. As from the official date of entry into force of the 02 series of amendments, no Contracting Party applying this Regulation shall refuse to grant or refuse to accept type approvals under this Regulation as amended by the 02 series of amendments unless otherwise specified below.
 - 12.1.2. As from 1 April 2018, Contracting Parties applying this Regulation shall not be obliged to accept type approvals to any preceding series of amendments, first issued after 1 April 2018.
 - 12.1.3. Until 1 April 2021, Contracting Parties applying this Regulation shall continue to accept type approvals to the preceding series (01) of amendments to the UN Regulation, first issued before 1 April 2018.
 - 12.1.4. As from 1 April 2021, Contracting Parties applying this Regulation shall not be obliged to accept type approvals issued to the preceding series of amendments to this Regulation.
 - 12.1.5. Notwithstanding paragraph 12.1.4., type approvals to the preceding series of amendments to the UN Regulation, which are not affected by the 02 series of amendments shall remain valid and Contracting Parties applying the UN Regulation shall continue to accept them.
 - 12.1.6. Until 1 April 2020, type approvals according to the 02 series of amendment to this Regulation may be granted to new vehicle types not complying with the red colour for the hands-off warning signal, mandated in paragraph 5.6.2.2.5., and having multi information displays installed in the instrument cluster not capable of indicating red warning signals or using standalone tell-tales only.
- 12.2. Transitional Provisions applicable to the 03 series of amendments:
 - 12.2.1. As from the official date of entry into force of the 03 series of amendments, no Contracting Party applying this Regulation shall refuse to grant or refuse to accept type approvals under this Regulation as amended by the 03 series of amendments.
 - 12.2.2. As from 1 September 2019, Contracting Parties applying this Regulation shall not be obliged to accept type approvals to the preceding series (02) of amendments, first issued after 1 September 2019.
 - 12.2.3. Until 1 September 2021, Contracting Parties applying this Regulation shall continue to accept type approvals to the preceding series (02) of amendments to the UN Regulation, first issued before 1 September 2019.

- 12.2.4. As from 1 September 2021, Contracting Parties applying this Regulation shall not be obliged to accept type approval issued to the preceding series of amendments to this Regulation.
- 12.2.5. Notwithstanding paragraph and 12.2.4., Contracting Parties applying this Regulation shall continue to accept type approvals issued according to a preceding series of amendments to this Regulation, for vehicles which are not affected by the provisions introduced with the 03 series of amendments.
- 12.3. General transitional provisions:
- 12.3.1. Contracting Parties applying this Regulation shall not refuse to grant type approvals according to any preceding series of amendments to this Regulation or extension thereof."

Annex 6,

Title, amend to read:

"Special requirements to be applied to the safety aspects of electronic control systems"

Paragraph 1., amend to read (insert a last subparagraph):

"1. General

This annex defines the special requirements for documentation, fault strategy and verification with respect to the safety aspects of Complex Electronic Vehicle Control Systems (paragraph 2.4. below) as far as this Regulation is concerned.

This annex shall also apply to safety related functions identified in this Regulation which are controlled by electronic system(s) (paragraph 2.3.) as far as this Regulation is concerned.

This annex does not specify the performance criteria for "The System" but covers the methodology applied to the design process and the information which must be disclosed to the Technical Service, for type approval purposes.

This information shall show that "The System" respects, under non-fault and fault conditions, all the appropriate performance requirements specified elsewhere in this Regulation and that it is designed to operate in such a way that it does not induce safety critical risks.

The applicant (e.g. the manufacturer) may provide evidence that an Auxiliary Steering Equipment (ASE) (if fitted) has previously been assessed as part of an approval in accordance with the requirements of Annex 4 of this Regulation (as required under the original version of this Regulation, its 01 or its 02 series of amendments). In this case, the requirements of this Annex shall not be applied to that ASE for the purposes of an approval in accordance with the 03 series of amendments."

Insert a new paragraph 2.1., to read:

- "2.1. "The System" means an electronic control system or complex electronic control system that provides or forms part of the control transmission of a function to which this Regulation applies. This also includes any other system covered in the scope of this Regulation, as well as transmission links to or from other systems that are outside the scope of this Regulation, that acts on a function to which this Regulation applies."

Paragraph 2.1. (former), amend to read and renumber:

- "2.2. "Safety Concept" is a description of the measures designed into the system, for example within the electronic units, so as to address system integrity and thereby ensure safe operation under fault and non-fault conditions, including in the event of an electrical failure. The possibility of a fall-back to partial operation or even to a back-up system for vital vehicle functions may be a part of the safety concept."

Paragraph 2.2. (former), amend to read and renumber:

- "2.3. "Electronic Control System" means a combination of units, designed to cooperate in the production of the stated vehicle control function by electronic data processing. Such systems, often controlled by software, are built from discrete functional components such as sensors, electronic control units and actuators and connected by transmission links. They may include mechanical, electro-pneumatic or electro-hydraulic elements."

Paragraph 2.3. (former), renumber and amend to read:

- "2.4. "Complex Electronic Vehicle Control Systems" are those electronic control systems in which a function controlled by an electronic system or the driver may be over-ridden by a higher level electronic control system/function. A function which is over-ridden becomes part of the complex system, as well as any overriding system/function within the scope of this Regulation. The transmission links to and from overriding systems/function outside of the scope of this Regulation shall also be included."

Paragraph 2.4. (former), renumber and amend to read:

- "2.5. "Higher-Level Electronic Control" systems/functions are those which employ additional processing and/or sensing provisions to modify vehicle behaviour by commanding variations in the function(s) of the vehicle control system. This allows complex systems to automatically change their objectives with a priority which depends on the sensed circumstances."

Paragraphs 2.5. to 2.8. (former), no changes and renumber to 2.6. to 2.9.

Insert a new paragraph 2.10. to read:

- "2.10. "Safety Related Function" means a function of "The System" that is capable of changing the dynamic behaviour of the vehicle. "The System" may be capable of performing more than one safety related function.

Paragraph 3.1., amend to read:

- "3.1. ...
The Technical Service shall assess the documentation package to show that "The System":

- (a) Is designed to operate, under non-fault and fault conditions, in such a way that it does not induce safety critical risks;
- (b) Respects, under non-fault and fault conditions, all the appropriate performance requirements specified elsewhere in this Regulation; and,
- (c) Was developed according to the development process/method declared by the manufacturer."

Paragraph 3.1.1., amend to read:

"3.1.1. Documentation shall be made available in two parts:

- (a) The formal documentation package for the approval, containing the material listed in paragraph 3. (with the exception of that of paragraph 3.4.4.) which shall be supplied to the Technical Service at the time of submission of the type approval application. This documentation package shall be used by the Technical Service as the basic reference for the verification process set out in paragraph 4. of this annex. The Technical Service shall ensure that this documentation package remains available for a period determined in agreement with the Approval Authority. This period shall be at least 10 years counted from the time when production of the vehicle is definitely discontinued.
- (b) Additional material and analysis data of paragraph 3.4.4. which shall be retained by the manufacturer, but made open for inspection at the time of type approval. The manufacturer shall ensure that this material and analysis data remains available for a period of 10 years counted from the time when production of the vehicle is definitely discontinued."

Paragraph 3.2., amend to read:

"3.2. Description of the functions of "The System"

A description shall be provided which gives a simple explanation of all the control functions of "The System" and the methods employed to achieve the objectives, including a statement of the mechanism(s) by which control is exercised.

Any described function that can be over-ridden shall be identified and a further description of the changed rationale of the function's operation provided."

Paragraph 3.3.3., amend to read:

"3.3.3. Interconnections within "The System" shall be shown by a circuit diagram for the electric transmission links, by a piping diagram for pneumatic or hydraulic transmission equipment and by a simplified diagrammatic layout for mechanical linkages. The transmission links both to and from other systems shall also be shown."

Paragraph 3.3.4., discussion on amending to read:

"3.3.4. Signal flow, operating data and priorities

There shall be a clear correspondence between these transmission links and the signals and/or operating data carried between Units. Priorities of signals and/or operating data on multiplexed data paths shall be stated wherever priority may be an issue affecting performance or safety as far as this Regulation is concerned."

Paragraph 3.4.1., discussion on amending:

"3.4.1. The Manufacturer shall provide a statement which affirms that the strategy chosen to achieve "The System" objectives will not, under non-fault conditions, prejudice the safe operation of the vehicle."

Paragraph 3.4.2., amend to read:

"3.4.2. In respect of software employed in "The System", the outline architecture shall be explained and the design methods and tools used shall be identified. The manufacturer shall show evidence of the means by which they determined the realisation of the system logic, during the design and development process."

Paragraph 3.4.3., amend to read:

"3.4.3. The Manufacturer shall provide the Technical Service with an explanation of the design provisions built into "The System" so as to generate safe operation under fault conditions. Possible design provisions for failure in "The System" are for example:

..."

Paragraph 3.4.4., amend to read:

"3.4.4. The documentation shall be supported, by an analysis which shows, in overall terms, how the system will behave on the occurrence of any individual hazard or fault which will have a bearing on vehicle control performance or safety.

The chosen analytical approach(es) shall be established and maintained by the Manufacturer and shall be made open for inspection by the Technical Service at the time of the type approval.

The Technical Service shall perform an assessment of the application of the analytical approach(es). The audit shall include:

- (a) Inspection of the safety approach at the concept (vehicle) level with confirmation that it includes consideration of interactions with other vehicle systems. This approach shall be based on a Hazard / Risk analysis appropriate to system safety.
- (b) Inspection of the safety approach at the system level. This approach shall be based on a Failure Mode and Effect Analysis (FMEA), a Fault Tree Analysis (FTA) or any similar process appropriate to system safety.
- (c) Inspection of the validation plans and results. This validation shall use, for example, Hardware in the Loop (HIL) testing, vehicle on-road operational testing, or any means appropriate for validation.

The assessment shall consist of checks of hazards and faults chosen by the Technical Service to establish that the manufacturer's explanation of the safety concept is understandable, logical and that the validation plans are suitable and have been completed.

The Technical Service may perform or may require to perform tests as specified in paragraph 4. to verify the safety concept."

Insert a new paragraph 3.4.4.2., to read:

"3.4.4.2. This documentation shall describe the measures in place to ensure the "The System" does not prejudice the safe operation of the vehicle when the

performance of "The System" is affected by environmental conditions e.g. climatic, temperature, dust ingress, water ingress, ice packing."

Paragraph 4.1.1., amend to read:

"4.1.1. Verification of the function of "The System"

The Technical Service shall verify "The System" under non-fault conditions by testing a number of selected functions from those declared by the manufacturer in paragraph 3.2. above.

For complex electronic systems, these tests shall include scenarios whereby a declared function is overridden."

Paragraph 4.1.2., amend to read:

"4.1.2. Verification of the safety concept of paragraph 3.4.

The reaction of "The System" shall be checked under the influence of a failure in any individual unit by applying corresponding output signals to electrical units or mechanical elements in order to simulate the effects of internal faults within the unit. The Technical Service shall conduct this check for at least one individual unit, but shall not check the reaction of "The System" to multiple simultaneous failures of individual units.

The Technical Service shall verify that these tests include aspects that may have an impact on vehicle controllability and user information (HMI aspects)."

Insert a new paragraph 5., to read:

"5. Reporting by Technical Service

Reporting of the assessment by the Technical Service shall be performed in such a manner that allows traceability, e.g. versions of documents inspected are coded and listed in the records of the Technical Service.

An example of a possible layout for the assessment form from the Technical Service to the Type Approval Authority is given in Appendix 1 to this Annex."

Insert a new Appendix 1, to read:

"Annex 6 - Appendix 1

Model assessment form for electronic systems

Test report No:

1. Identification

1.1. Vehicle make:

1.2. Type:

1.3. Means of identification of type if marked on the vehicle:

1.3.1. Location of that marking:.....

1.4. Manufacturer's name and address:.....

- 1.5. If applicable, name and address of manufacturer's representative:.....
- 1.6. Manufacturer's formal documentation package:
Documentation reference No:
Date of original issue:
Date of latest update:
2. Test vehicle(s)/system(s) description
 - 2.1. General description:
 - 2.2. Description of all the control functions of "The System", and methods of operation: ..
 - 2.3. Description of the components and diagrams of the interconnections within "The System":.....
3. Manufacturer's safety concept
 - 3.1. Description of signal flow and operating data and their priorities:
 - 3.2. Manufacturer's declaration:
The manufacturer(s) affirm(s) that the strategy chosen to achieve "The System", objectives will not, under non-fault conditions, prejudice the safe operation of the vehicle.
 - 3.3. Software outline architecture and the design methods and tools used:
 - 3.4. Explanation of design provisions built into "The System" under fault conditions:
 - 3.5. Documented analyses of the behaviour of "The System" under individual hazard or fault conditions:
 - 3.6. Description of the measures in place for environmental conditions:
 - 3.7. Provisions for the periodic technical inspection of "The System":
 - 3.8. Results of "The System" verification test, as per para. 4.1.1. of Annex 6 to UN Regulation No. 79:
 - 3.9. Results of safety concept verification test, as per para. 4.1.2. of Annex 6 to UN Regulation No. 79:
 - 3.10. Date of test:
 - 3.11. This test has been carried out and the results reported in accordance with to UN Regulation No. 79 as last amended by the series of amendments.

Technical Service ^{1/} carrying out the test

Signed: Date:

3.12. Type Approval Authority ^{1/}

Signed: Date:

3.13. Comments:

¹ To be signed by different persons even when the Technical Service and Type Approval Authority are the same or alternatively, a separate Type Approval Authority authorization is issued with the report."

Annex 8,

Insert a new paragraph 3.3., to read:

"3.3. Tests for ESF

The vehicle shall be driven with an activated ESF on a road with lane markings on each side and positioned within those lane markings.

The test conditions and the vehicle speeds shall be within the operating range of the system as declared by the manufacturer.

Specific details of the mandatory tests described below shall be discussed and agreed between the vehicle manufacturer and the Technical Service to adapt the required testing to the declared use case(s) for which the ESF is designed to operate.

In addition, the manufacturer shall demonstrate to the satisfaction of the Technical Service that the requirements defined in paragraph 5.1.6.2.1. to 5.1.6.2.6. are fulfilled in the whole range of the ESF operation (specified by the vehicle manufacturer in the system information data) This may be achieved on the basis of appropriate documentation appended to the test report.

3.3.1. Test for ESF Type a i/ii: (unintentional lateral manoeuvre)

A target vehicle driving in the adjacent lane shall approach the vehicle under test and one of the vehicles shall minimize their lateral separation distance until an ESF intervention is started.

The tests requirements are fulfilled if:

- (a) The warnings specified in paragraph 5.1.6.2.6. of this Regulation are provided no later than the ESF intervention starts, and
- (b) The ESF intervention does not lead the vehicle to leave its original lane.

3.3.2. Test for ESF Type a iii: (intentional lateral manoeuvre)

The vehicle under test starts a lane change while another vehicle is driving in the adjacent lane such that no intervention of the ESF system would lead to a collision.

The test requirements are fulfilled if:

- (a) An ESF intervention is started, and
- (b) The warnings specified in paragraph 5.1.6.2.6. of this Regulation are provided no later than the ESF intervention starts, and
- (c) The ESF intervention does not lead the vehicle to leave its original lane.

3.3.3. Test for ESF Type b:

The vehicle under test shall approach an object positioned within its trajectory. The object shall be of such size and positioned in a way that the vehicle can pass the object without crossing the lane markings.

The tests requirements are fulfilled if:

- (a) The ESF intervention avoids or mitigates the collision, and
- (b) The warnings specified in paragraph 5.1.6.2.6. of this Regulation are provided no later than the ESF intervention starts, and
- (c) The ESF intervention does not lead the vehicle to leave its lane.

3.3.4. Tests for systems able to operate in the absence of lane markings

In case any system works in absence of lane markings the corresponding tests from paragraphs 3.3.1. to 3.3.3. need to be repeated on a test track without lane markings.

These test requirements are fulfilled if,

- (a) An ESF intervention is started; and
- (b) The warnings specified in paragraph 5.1.6.2.6. of this Regulation are provided no later than the ESF intervention starts; and
- (c) The lateral offset during the manoeuvre is 0.75 m, as specified in paragraph 5.1.6.2.2., at maximum; and
- (d) The vehicle has not left the road due to the ESF intervention.

3.3.5. False reaction test for ESF Type b

The vehicle under test shall approach a plastic sheet having a colour contrast to the road surface, a thickness less than 3 mm, a width of 0.8 m and a length of 2 m positioned between the lane markings in the trajectory of the vehicle. The plastic sheet shall be positioned in a way that the vehicle could pass the sheet without crossing the lane markings.

The test requirements are fulfilled, if the ESF does not start any intervention."

Insert a new paragraph 3.4., to read:

"3.4. (Reserved for ACSF of Category B2)"

Insert a new paragraph 3.5., to read:

"3.5. Tests for ACSF of Category C Systems

If not specified otherwise all vehicle test speeds shall be based on $V_{app} = 130$ km/h.

If not specified otherwise, the approaching vehicle shall be a type-approved high volume series production vehicle.

The vehicle manufacturer shall demonstrate to the satisfaction of the Technical Service that the requirements are fulfilled for the whole speed range. This may be achieved on the basis of appropriate documentation appended to the test report.

3.5.1. Lane change functional test

3.5.1.1. The test vehicle shall be driven in a lane of a straight test track, which has at least two lanes in the same direction of travel, with road markings on each side of the lanes. The vehicle speed shall be: $V_{\text{min}} + 10\text{km/h}$.

The ACSF of Category C shall be activated (standby mode) and another vehicle shall approach from the rear in order to enable the system as specified in paragraph 5.6.4.8.3. above.

The approaching vehicle shall then pass the vehicle under test entirely.

A lane change into the adjacent lane shall then be initiated by the driver.

The lateral acceleration and the lateral jerk shall be recorded during the test.

3.5.1.2. The requirements of the test are fulfilled if:

- (a) The lateral movement towards the marking does not start earlier than 1 second after the lane change procedure was initiated,
- (b) The lateral movement to approach the lane marking and the lateral movement necessary to complete the lane change manoeuvre are completed as one continuous movement,
- (c) The recorded lateral acceleration does not exceed 1 m/s^2 ,
- (d) The moving average over half a second of the lateral jerk does not exceed 5 m/s^3 ,
- (e) The measured time between the start of the lane change procedure and the start of the lane change manoeuvre is not less than 3.0 seconds and not more than 5.0 seconds,
- (f) The system provides information to the driver to indicate that the lane change procedure is ongoing,
- (g) The lane change manoeuvre is completed in less than 5 seconds for M_1 , N_1 vehicle categories and less than 10 s for M_2 , M_3 , N_2 , N_3 vehicle categories,
- (h) ACSF of Category B1 automatically resumes after the lane change manoeuvre is completed, and
- (i) The direction indicator is deactivated not before the end of the lane change manoeuvre and no later than 0.5 seconds after ACSF of Category B1 has resumed.

3.5.1.3. The test according to paragraph 3.5.1.1. shall be repeated with a lane change in the opposite direction.

3.5.2. Minimum activation speed test V_{min} .

3.5.2.1. Minimum activation speed test V_{min} based on $V_{\text{app}} = 130 \text{ km/h}$.

The test vehicle shall be driven within a lane of a straight track which has at least two lanes in the same direction of travel and road markings on each side of the lane.

The vehicle speed shall be: $V_{\text{min}} - 10\text{km/h}$.

The ACSF of Category C shall be activated (standby mode) and another vehicle shall approach from the rear in order to enable the system as specified in paragraph 5.6.4.8.3. above.

The approaching vehicle shall then pass the vehicle under test entirely.

A lane change procedure shall then be initiated by the driver.

The requirements of the test are fulfilled if the lane change manoeuvre is not performed.

- 3.5.2.2. Minimum activation speed test V_{min} based on country specific general maximum speed limit below 130 km/h.

In case V_{min} is calculated, based on a country specific general maximum speed limit instead of $V_{\text{app}}=130$ km/h as specified in paragraph 5.6.4.8.1., the tests described below shall be performed. For this purpose it is allowed to simulate the country of operation in agreement between the vehicle manufacturer and the Technical Service.

- 3.5.2.2.1. The test vehicle shall be driven within a lane of a straight track which has at least two lanes in the same direction of travel and road markings on each side of the lane.

The vehicle speed shall be: $V_{\text{min}} - 10\text{km/h}$.

The ACSF of Category C shall be activated (standby mode) and another vehicle shall approach from the rear in order to enable the system as specified in paragraph 5.6.4.8.3. above.

The approaching vehicle shall then pass the vehicle under test entirely.

A lane change procedure shall then be initiated by the driver.

The requirements of the test are fulfilled if the lane change manoeuvre is not performed.

- 3.5.2.2.2. The test vehicle shall be driven within a lane of a straight track which has at least two lanes in the same direction of travel and road markings on each side of the lane.

The vehicle speed shall be: $V_{\text{min}} + 10\text{km/h}$.

The ACSF of Category C shall be activated (standby mode) and another vehicle shall approach from the rear in order to enable the system as specified in paragraph 5.6.4.8.3. above.

The approaching vehicle shall then pass the vehicle under test entirely.

A lane change procedure shall then be initiated by the driver.

The requirements of the test are fulfilled if the lane change manoeuvre is performed.

- 3.5.2.2.3. The manufacturer shall demonstrate to the satisfaction of the Technical Service that the vehicle is able to detect the country of operation and that the general maximum speed limit of this country is known.

- 3.5.3. Overriding test

- 3.5.3.1. The test vehicle shall be driven in a lane of a straight test track, which has at least two lanes in the same direction of travel, with road markings on each side of the lanes.

The vehicle speed shall be: $V_{\text{min}} + 10\text{km/h}$.

The ACSF of Category C shall be activated (standby mode) and another vehicle shall approach from the rear in order to enable the system as specified in paragraph 5.6.4.8.3. above.

The approaching vehicle shall then pass the vehicle under test entirely.

A lane change into the adjacent lane shall then be initiated by the driver.

The steering control shall be firmly controlled by the driver to maintain the vehicle in the straight direction.

The force applied by the driver on the steering control during the overriding manoeuvre shall be recorded.

3.5.3.2. The test requirements are fulfilled if the measured overriding force does not exceed 50 N, as specified in paragraph 5.6.4.3. above.

3.5.3.3. The test according to paragraph 3.5.3.1. shall be repeated with a lane change in the opposite direction.

3.5.4. Lane Change Procedure suppression test

3.5.4.1. The test vehicle shall be driven in a lane of a straight test track, which has at least two lanes in the same direction of travel, with road markings on each side of the lanes.

The vehicle speed shall be: $V_{\text{min}} + 10\text{km/h}$.

The ACSF of Category C shall be activated (standby mode) and another vehicle shall approach from the rear in order to enable the system as specified in paragraph 5.6.4.8.3. above.

The approaching vehicle shall then pass the vehicle under test entirely.

A Lane Change Procedure shall then be initiated by the driver.

The test shall be repeated for each of the following conditions, which shall occur before the lane change manoeuvre has started:

- (a) The system is overridden by the driver;
- (b) The system is switched off by the driver;
- (c) The vehicle speed is reduced to: $V_{\text{min}} - 10\text{ km/h}$;
- (d) The driver has removed his hands from the steering control and the hands-off warning has been initiated;
- (e) The direction indicator lamps are manually deactivated by the driver;
- (f) The lane change manoeuvre has not commenced within 5.0 seconds following the initiation of the lane change procedure. (e.g. another vehicle is driving in the adjacent lane in a critical situation as described in paragraph 5.6.4.7.).

3.5.4.2. The requirements of the test are fulfilled if the lane change procedure is suppressed, for each of the test cases above.

3.5.5. Sensor performance test

3.5.5.1. The test vehicle shall be driven in a lane of a straight test track, which has at least two lanes in the same direction of travel, with road markings on each side of the lanes.

The vehicle speed shall be: $V_{\text{min}} + 10\text{km/h}$.

The ACSF of Category C shall be activated (standby mode).

Another vehicle shall approach from the rear on the adjacent lane, with a speed of 120 km/h.

The approaching vehicle shall be a type approved high volume series production motorcycle of category L₃¹ with an engine capacity not exceeding 600 cm³ without front fairing or windshield and shall aim to drive in the middle of the lane.

The distance between the rear end of the test vehicle and the front end of the approaching vehicle shall be measured (e.g. with a Differential Global Positioning System), and the value when the system detects the approaching vehicle shall be recorded.

- 3.5.5.2. The requirements of the test are fulfilled if the system detects the approaching vehicle no later than at the distance declared by the vehicle manufacturer (S_{rear}), as specified in 5.6.4.8.1. above.

- 3.5.6. Sensor blindness test

- 3.5.6.1. The test vehicle shall be driven in a lane of a straight test track, which has at least two lanes in the same direction of travel, with road markings on each side of the lanes.

The vehicle speed shall be: $V_{\text{min}} + 10\text{km/h}$.

The ACSF of Category C shall be activated (standby mode) and another vehicle shall approach from the rear in order to enable the system as specified in paragraph 5.6.4.8.3. above.

The approaching vehicle shall then pass the vehicle under test entirely.

The rear sensor(s) shall be made blind, with means agreed between the vehicle manufacturer and the Technical Service, which shall be recorded in the test report. This operation may be carried out at standstill, provided no new engine start /run cycle is performed.

The vehicle shall be driven to a speed of $V_{\text{min}} + 10\text{km/h}$, and a lane change procedure shall be initiated by the driver.

- 3.5.6.2. The requirements of the test are fulfilled if the system:

- (a) Detects the sensor blindness,
- (b) Provides a warning to the driver as defined in para. 5.6.4.8.4., and
- (c) Is prevented from performing the lane change manoeuvre.

In addition to the above mentioned test, the manufacturer shall demonstrate to the satisfaction of the Technical Service that the requirements defined in paragraph 5.6.4.8.4. are also fulfilled under different driving scenarios. This may be achieved on the basis of appropriate documentation appended to the test report.

- 3.5.7. Engine start/run cycle test

The test is divided in 3 consecutive phases as specified below.

The vehicle speed shall be: $V_{\text{min}} + 10\text{km/h}$.

- 3.5.7.1. Phase 1 – Default-off test
- 3.5.7.1.1. Following a new engine start /run cycle performed by the driver, the test vehicle shall be driven in a lane of a straight test track, which has at least two lanes in the same direction of travel, with road markings on each side of the lanes.
- The ACSF of Category C shall not be activated (off mode) and another vehicle shall approach from the rear and the approaching vehicle shall pass the vehicle entirely.
- The direction indicator used to initiate a lane change procedure shall be activated by the driver for a period greater than 5 seconds.
- 3.5.7.1.2. The requirements of the test phase 1 are fulfilled if the lane change manoeuvre is not initiated.
- 3.5.7.2. Phase 2
- The objective of the test is to check that the lane change manoeuvre is prevented if the system has not detected any moving object at a distance equal or greater than the distance S_{rear} (as specified in paragraph 5.6.4.8.3.).
- 3.5.7.2.1. Following a new engine start / run cycle performed by the driver, the test vehicle shall be driven in a lane of a straight test track, which has at least two lanes in the same direction of travel, with road markings on each side of the lanes.
- The ACSF of Category C shall be manually activated (standby mode).
- A lane change procedure shall then be initiated by the driver.
- 3.5.7.2.2. The requirements of the test phase 2 are fulfilled if the lane change manoeuvre has not started (as the pre-condition specified in 5.6.4.8.3. is not fulfilled).
- 3.5.7.3. Phase 3 – Lane change enabling conditions test
- The objective of the test is to check that the lane change manoeuvre is only possible once the system has detected a moving object at a distance equal or greater than the distance S_{rear} (as specified in paragraph 5.6.4.8.3.).
- 3.5.7.3.1. Following the completion of the test phase 2, another vehicle shall approach from the rear on the adjacent lane in order to enable the system as specified in paragraph 5.6.4.8.3. above.
- The distance between the rear end of the test vehicle and the front end of the approaching vehicle shall be measured (e.g. with a differential Global Positioning System), and the value when the system detects the approaching vehicle be recorded.
- After the rear coming vehicle has entirely passed the vehicle under test, a lane change procedure shall be initiated by the driver.
- 3.5.7.3.2. The requirements of the test phase 3 are fulfilled if:
- (a) The lane change manoeuvre is executed;
 - (b) The approaching vehicle is detected no later than at the distance declared by the vehicle manufacturer (S_{rear}).