

## Attachment 47-1 Steering equipment

Refer to: UN R79 02 / R79 02-S1

### 47-1.1 Effective date and Scope

47-1.1.1 Start from 2025/1/1, all vehicle types of category symbols M, N and O shall comply with this regulation; If vehicle is equipped Advanced Driver Assistance Steering System, It shall comply with regard paragraphs.

47-1.1.1.1 For the vehicle is not equipped with Advanced Driver Assistance Steering System, and with “47 Steering equipment” approval documents, it could be deemed to comply with this regulation.

47-1.1.2 The same applicant applying for low volume safety approval and the amounts of vehicle not exceed 20 at same year, or applying for vehicle-by-vehicle low volume safety approval and the amounts of vehicle not exceed 20 at same year, could exempt from paragraphs 47-1.5.1.11, 47-1.9 and 47-1.11.

47-1.1.3 This Regulation does not apply to:

47-1.1.3.1 Steering equipment with a purely pneumatic transmission;

47-1.1.3.2 Autonomous Steering Systems as defined in paragraph 47-1.2.1.3;

47-1.1.3.3 Steering systems exhibiting the functionality defined as ACSF of Category B2, C, D or E in paragraphs 47-1.2.1.4.1.3, 47-1.2.1.4.1.4, 47-1.2.1.4.1.5, or 47-1.2.1.4.1.6, respectively, until specific provisions would be introduced in this Regulation.

47-1.1.4 Technical Service can carry out test according to UN Regulations that this direction harmonized with: UN R79 02 Series of amendments and following amendments of above-mentioned regulations.

### 47-1.2 Definitions:

47-1.2.1 Steering equipment: means all the equipment the purpose of which is to determine the direction of movement of the vehicle. The steering equipment consists of: The steering control, The steering transmission, The steered wheels, The energy supply, if any.

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47-1.2.1.1 Steering control: means the part of the steering equipment which controls its operation; it may be operated with or without direct intervention of the driver. For steering equipment in which the steering forces are provided solely or partly by the muscular effort of the driver the steering control includes all parts up to the point where the steering effort is transformed by mechanical, hydraulic or electrical means;

47-1.2.1.2 Steering transmission: means all components which form a functional link between the steering control and the road wheels. The transmission is divided into two independent functions: The control transmission and the energy transmission. Where the term "transmission" is used alone in this Regulation, it means both the control transmission and the energy transmission. A distinction is drawn between mechanical, electrical and hydraulic transmission systems or combinations thereof, according to the means by which the signals and/or energy is transmitted.

47-1.2.1.2.1 Control transmission: means all components by means of which signals are transmitted for control of the steering equipment.

47-1.2.1.2.2 Energy transmission: means all components by means of which the energy required for control/Regulation of the steering function of the wheels is transmitted.

47-1.2.1.3 Autonomous Steering System: means a system that incorporates a function within a complex electronic control system that causes the vehicle to follow a defined path or to alter its path in response to signals initiated and transmitted from off-board the vehicle.

The driver will not necessarily be in primary control of the vehicle.

47-1.2.1.4 Advanced Driver Assistance Steering System: means a system, additional to the main steering system, that provides assistance to the driver in steering the vehicle but in which the driver remains at all times in primary control of the vehicle. It comprises one or both of the following functions:

- 47-1.2.1.4.1 Automatically commanded steering function (ACSF): means a function within an electronic control system where actuation of the steering system can result from automatic evaluation of signals initiated on-board the vehicle, possibly in conjunction with passive infrastructure features, to generate control action in order to assist the driver.
- 47-1.2.1.4.1.1 ACSF of Category A: means a function that operates at a speed no greater than 10 km/h to assist the driver, on demand, in low speed or parking manoeuvring.
- 47-1.2.1.4.1.2 ACSF of Category B1: means a function which assists the driver in keeping the vehicle within the chosen lane, by influencing the lateral movement of the vehicle.
- 47-1.2.1.4.1.3 ACSF of Category B2: means a function which is initiated/activated by the driver and which keeps the vehicle within its lane by influencing the lateral movement of the vehicle for extended periods without further driver command/confirmation.
- 47-1.2.1.4.1.4 ACSF of Category C: means, a function which is initiated/activated by the driver and which can perform a single lateral manoeuvre (e.g. lane change) when commanded by the driver.
- 47-1.2.1.4.1.5 ACSF of Category D: means a function which is initiated/activated by the driver and which can indicate the possibility of a single lateral manoeuvre (e.g. lane change) but performs that function only following a confirmation by the driver.
- 47-1.2.1.4.1.6 ACSF of Category E: means a function which is initiated/activated by the driver and which can continuously determine the possibility of a manoeuvre (e.g. lane change) and complete these manoeuvres for extended periods without further driver command/ confirmation.
- 47-1.2.1.4.2 Corrective Steering Function (CSF)" means a control function within an electronic control system whereby, for a limited duration, changes to the steering angle of one or more wheels may result from the automatic evaluation of signals

initiated on-board the vehicle, in order:

47-1.2.1.4.2.1 To compensate a sudden, unexpected change in the side force of the vehicle; or

47-1.2.1.4.2.2 To improve the vehicle stability (e.g. side wind, differing adhesion road conditions "mu-split"); or

47-1.2.1.4.2.3 To correct lane departure. (e.g. to avoid crossing lane markings, leaving the road).

47-1.2.1.5 Steered wheels: means the wheels whose alignment may be altered directly or indirectly in relation to longitudinal axis of the vehicle in order to determine the vehicle's direction of movement. (The steered wheels including the axis around which they are rotated in order to determine the vehicle's direction of movement).

47-1.2.1.6 Energy supply: includes those parts of the steering equipment that provides it with energy, control the energy and where appropriate, process and store it. It also includes any storage reservoirs for the operating medium and the return lines, but not the vehicle's engine (except for the purpose of paragraph 47-1.5.3.2.1) or its drive to the energy source.

47-1.2.1.6.1 Energy source: means the part of the energy supply, which provides the energy in the required form.

47-1.2.1.6.2 Energy reservoir: means that part of the energy supply in which the energy provided by the energy source is stored, for example, a pressurised fluid reservoir or vehicle battery.

47-1.2.1.6.3 Storage reservoir: means that part of the energy supply in which the operating medium is stored at or near to the atmospheric pressure, for example a fluid reservoir.

#### 47-1.2.2 Steering parameters

47-1.2.2.1 Steering control effort: means the force applied to the steering control in order to steer the vehicle.

47-1.2.2.2 Steering time: means the period of time from the beginning of the movement of the steering control to the moment at which the steered wheels have reached a specific steering angle.

47-1.2.2.3 Steering angle: means the angle between the projection of a longitudinal axis of the vehicle and the line of intersection of the

wheel plane (being the central plane of the wheel, normal to the axis around which it rotates) and the road surface.

47-1.2.2.4 Steering forces: mean all the forces operating in the steering transmission.

47-1.2.2.5 Mean steering ratio: means the ratio of the angular displacement of the steering control to the mean of the swept steering angle of the steered wheels for a full lock-to-lock turn;

47-1.2.2.6 Turning circle: means the circle within which are located the projections onto the ground plane of all the points of the vehicle, excluding the external mirrors and the front direction indicators, when the vehicle is driven in a circle.

47-1.2.2.7 Nominal radius of steering control: means in the case of a steering wheel the shortest dimension from its centre of rotation to the outer edge of the rim.

In the case of any other form of control it means the distance between its centre of rotation and the point at which the steering effort is applied. If more than one such point is provided, the one requiring the greatest effort shall be used.

47-1.2.2.8 Remote Controlled Parking (RCP): means an ACSF of category A, actuated by the driver, providing parking or low speed manoeuvring. The actuation is made by remote control in close proximity to the vehicle.

47-1.2.2.9 Specified maximum RCP operating range ( $S_{RCPmax}$ ): means the maximum distance between the nearest point of the motor vehicle and the remote control device up to which ACSF is designed to operate.

47-1.2.2.10 Specified maximum speed  $V_{Smax}$ : means the maximum speed up to which an ACSF is designed to operate.

47-1.2.2.11 Specified minimum speed  $V_{Smin}$ : means the minimum speed down to which an ACSF is designed to operate.

47-1.2.2.12 Specified maximum lateral acceleration  $a_{y_{Smax}}$ : means the maximum lateral acceleration of the vehicle up to which an ACSF is designed to operate.

47-1.2.2.13 An ACSF is in "off mode" (or "switched off") when the function is prevented from generating a steering control action to assist the driver.

47-1.2.2.14 An ACSF is in "standby mode" when the function is switched on but the conditions (e.g. system operating conditions, deliberate action from driver) for being active are not all met. In this mode, the system is not ready to generate a steering control action to assist the driver.

47-1.2.2.15 An ACSF is in "active mode" (or "active") when the function is switched on and the conditions for being active are met. In this mode, the system continuously or discontinuously controls the steering system is generating, or is ready to generate, a steering control action to assist the driver.

### 47-1.2.3 Types of steering equipment

Depending on the way the steering forces are produced, the following types of equipment are distinguished:

#### 47-1.2.3.1 For motor vehicles:

47-1.2.3.1.1 Main steering system: means the steering equipment of a vehicle which is mainly responsible for determining the direction of travel. It may comprise:

47-1.2.3.1.1.1 Manual steering equipment: in which the steering forces result solely from the muscular effort of the driver.

47-1.2.3.1.1.2 Power assisted steering equipment: in which the steering forces result from both the muscular effort of the driver and the energy supply (supplies).

47-1.2.3.1.1.2.1 Steering equipment in which the steering forces result solely from one or more energy supplies when the equipment is intact, but in which the steering forces can be provided by the muscular effort of the driver alone if there is a fault in the steering (integrated power systems), is also considered to be power assisted steering equipment;

47-1.2.3.1.1.3 Full-power steering equipment: in which the steering forces are provided solely by one or more energy supplies;

47-1.2.3.1.2 Self-tracking steering equipment: means a system designed to create a change of steering angle on one or more wheels

only when acted upon by forces and/or moments applied through the tyre to road contact.

47-1.2.3.1.3 Auxiliary steering equipment (ASE): means a system in which the wheels on axle(s) of vehicles of categories M and N are steered in addition to the wheels of the main steering equipment in the same or opposite direction to those of the main steering equipment and/or the steering angle of the front and/or the rear wheels may be adjusted relative to vehicle behaviour.

47-1.2.3.2 For trailers:

47-1.2.3.2.1 Self-tracking steering equipment: means a system designed to create a change of steering angle on one or more wheels only when acted upon by forces and/or moments applied through the tyre to road contact.

47-1.2.3.2.2 Articulated steering: means equipment in which the steering forces are produced by a change in direction of the towing vehicle and in which the movement of the steered trailer wheels is linked to the relative angle between the longitudinal axis of the towing vehicle and that of the trailer;"

47-1.2.3.2.3 Self-steering: means equipment in which the steering forces are produced by a change in direction of the towing vehicle and in which the movement of the steered trailer wheels is firmly linked to the relative angle between the longitudinal axis of the trailer frame or a load replacing it and the longitudinal axis of the sub-frame to which the axle(s) is (are) attached;

47-1.2.3.2.4 Additional steering equipment: means a system, independent of the main steering system, by which the steering angle of one or more axle(s) of the steering system can be influenced selectively for manoeuvring purposes.

47-1.2.3.2.5 Full-power steering equipment: means equipment in which the steering forces are provided solely by one or more energy supplies;

47-1.2.3.3 Depending on the arrangement of the steered wheels, the following types of steering equipment are distinguished:

- 47-1.2.3.3.1 Front-wheel steering equipment: in which only the wheels of the front axle(s) are steered. This includes all wheels which are steered in the same direction;
- 47-1.2.3.3.2 Rear-wheel steering equipment: in which only the wheels of the rear axle(s) are steered. This includes all wheels which are steered in the same direction;
- 47-1.2.3.3.3 Multi-wheel steering equipment: in which the wheels of one or more of each of the front and the rear axle(s) are steered;
  - 47-1.2.3.3.3.1 All-wheel steering equipment: in which all the wheels are steered;
  - 47-1.2.3.3.3.2 Buckle steering equipment: in which the movement of chassis parts relative to each other is directly produced by the steering forces.

#### 47-1.2.4 Types of steering transmission

Depending on the way the steering forces are transmitted, the following types of steering transmission are distinguished:

- 47-1.2.4.1 Purely mechanical steering transmission: means a steering transmission in which the steering forces are transmitted entirely by mechanical means;
- 47-1.2.4.2 Purely hydraulic steering transmission: means a steering transmission in which the steering forces, somewhere in the transmission, are transmitted only by hydraulic means;
- 47-1.2.4.3 Purely electric steering transmission: means a steering transmission in which the steering forces, somewhere in the transmission, are transmitted only through electric means;
- 47-1.2.4.4 Hybrid steering transmission: means a steering transmission in which part of the steering forces is transmitted through one and the other part through another of the above mentioned means. However, in the case where any mechanical part of the transmission is designed only to give position feedback and is too weak to transmit the total sum of the steering forces, this system shall be considered to be purely hydraulic or purely electric steering transmission.

- 47-1.2.5 Electric control line: means the electrical connection which provides the steering control function to the trailer. It comprises the electrical wiring and connector and includes the parts for data communication and the electrical energy supply for the trailer control transmission.
- 47-1.2.6 Definitions for special requirements to be applied to the safety aspects of electronic control systems
- 47-1.2.6.1 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 even 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.
- 47-1.2.6.2 Electronic control system: means a combination of units, designed to co-operate 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. "The System", referred to herein, is the one for which type approval is being sought.
- 47-1.2.6.3 Complex electronic vehicle control systems: are those electronic control systems which are subject to a hierarchy of control in which a controlled function may be overridden by a higher level electronic control system/function. A function which is overridden becomes part of the complex system.
- 47-1.2.6.4 Higher-Level control: systems/functions are those which employ additional processing and/or sensing provisions to modify vehicle behaviour by commanding variations in the normal 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.
- 47-1.2.6.5 Units: are the smallest divisions of system components which will be considered in this regulation, since these combinations of components will be treated as single entities for purposes of identification, analysis or replacement.

47-1.2.6.6 Transmission links: are the means used for inter-connecting distributed units for the purpose of conveying signals, operating data or an energy supply. This equipment is generally electrical but may, in some part, be mechanical, pneumatic or hydraulic.

47-1.2.6.7 Range of control: refers to an output variable and defines the range over which the system is likely to exercise control.

47-1.2.6.8 Boundary of functional operation: defines the boundaries of the external physical limits within which the system is able to maintain control.

47-1.3 Steering equipment shall according to suitable types and range of principle are as below :

47-1.3.1 If use completed vehicle for testing, which shall according to suitable types and range of principle are as below :

47-1.3.1.1 The same vehicle brand.

47-1.3.1.2 The same type of steering equipment, steering control, steering transmission, steered wheels, and energy source.

47-1.3.2 If use chassis vehicle instead of completed vehicle for entire or partial testing, which shall according to suitable types and range of principle are as below :

47-1.3.2.1 The same vehicle brand.

47-1.3.2.2 The same type of steering equipment, steering control, steering transmission, steered wheels, and energy source.

47-1.4 Applicants apply for certification test shall provide at least one representative vehicle (or the essential part of vehicle for test) and submit the documents as below:

47-1.4.1 Vehicle specification documents, drawings and / or photographs described in paragraph 47-1.3.

47-1.4.1.1 A brief description of the steering equipment with a diagram of the steering equipment as a whole, showing the position on the vehicle of the various devices influencing the steering, includes type of steering equipment, steering control, steering transmission, steered wheels, and energy source.

47-1.4.1.2 In the case of full power steering systems and systems to which paragraph 47-1.9 of this Regulation applies, an overview of the system indicating the philosophy of the system and the fail-safe procedures, redundancies and warning systems

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necessary to ensure safe operation in the vehicle.

The necessary technical files relating to such systems shall be made available for discussion with the Type Approval Authority and/or Technical Service. Such files will be discussed on a confidential basis.

#### 47-1.4.1.3 Documentation regards paragraph 47-1.5:

47-1.4.1.3.1 Vehicles which equipped with automatically commanded steering function shall provide documents below according to its category of ACSF:

##### 47-1.4.1.3.1.1 ACSF of category A

47-1.4.1.3.1.1.1 The value for the specified maximum RCP operating range ( $S_{RCPmax}$ ) (according to paragraph 47-1.5.5.1.3.1.1);

47-1.4.1.3.1.1.2 The conditions under which the system can be activated, i.e. when the conditions for operation of the system are fulfilled (according to paragraph 47-1.5.5.1.3.1.2);

47-1.4.1.3.1.1.3 For RCP systems the manufacturer shall provide the technical authorities with an explanation how the system is protected against unauthorized activation (according to paragraph 47-1.5.5.1.3.1.3).

##### 47-1.4.1.3.1.2 ACSF of category B1

47-1.4.1.3.1.2.1 The conditions under which the system can be activated and the boundaries for operation (boundary conditions) (according to paragraph 47-1.5.5.2.3.1.1).

47-1.4.1.3.1.2.2 The vehicle manufacturer shall provide values for  $V_{Smax}$ ,  $V_{Smin}$  and  $a_{y_{smax}}$  for every speed range as mentioned in the table of paragraph 47-1.5.5.2.1.3 of this Regulation (according to paragraph 47-1.5.5.2.1.3 and 47-1.5.5.2.3.1.1);

47-1.4.1.3.1.2.3 Information about how the system detects that the driver is holding the steering control (according to

paragraph 47-1.5.5.2.3.1.2).

47-1.4.1.4 Documentation regards paragraph 47-1.9:

47-1.4.1.4.1 Description of requirements of paragraph 47-1.9.2.1.

47-1.4.1.4.2 Description of the functions of The System (according to paragraph 47-1.9.2.2).

47-1.4.1.4.3 Description of “System layout and schematics” and “Signal flow and priorities” (according to paragraph 47-1.9.2.3).

47-1.4.1.4.4 Description of Safety concept of the manufacturer (according to paragraph 47-1.9.2.4).

47-1.4.1.5 Trailers which equipped with steering equipment complied with paragraph 47-1.10 shall provide:

47-1.4.1.5.1 The maximum current required for the trailer steering system declared by manufacturer (according to paragraph 47-1.10.1.2.1.1)

47-1.4.1.5.2 Description of the trailer steering system is able to supply auxiliary equipment on the trailer with electrical energy or not.

47-1.4.1.6 Documentation regards of paragraph 47-1.11:

47-1.4.1.6.1 Description of load condition (according to paragraph 47-1.11.2.3.1).

47-1.4.2 Required documents for carry out the test of this regulation.

47-1.5 Construction provisions

47-1.5.1 General provisions

47-1.5.1.1 The steering equipment shall ensure easy and safe handling of the vehicle up to its maximum design speed or, in the case of a trailer up to its technically permitted maximum speed, manufacturer can assures and declares that vehicle applied for test can complied with this paragraph through document of compliance declaration.

47-1.5.1.2 It must be possible to travel along a straight section of road without unusual steering correction by the driver and without unusual vibration in the steering system at maximum design speed of the vehicle, manufacturer can assures and declares

that vehicle applied for test can comply with this paragraph through document of compliance declaration.

47-1.5.1.3 The direction of operation of the steering control shall correspond to the intended change of direction of the vehicle and there shall be a continuous relationship between the steering control deflection and the steering angle. These requirements do not apply to systems that incorporate an automatically commanded or corrective steering function, or to auxiliary steering equipment. These requirements may also not necessarily apply in the case of full power steering when the vehicle is stationary, during low speed manoeuvres at speeds up to a maximum speed of 15km/h and when the system is not energized, manufacturer can assure and declare that vehicle applied for test can comply with this paragraph through document of compliance declaration.

47-1.5.1.4 The steering equipment shall be designed, constructed and fitted in such a way that it is capable of withstanding the stresses arising during normal operation of the vehicle, or combination of vehicles. The maximum steering angle shall not be limited by any part of the steering transmission unless specifically designed for this purpose. Unless otherwise specified, it will be assumed that not more than one failure can occur in the steering equipment at any one time and two axles on one bogie shall be considered as one axle, manufacturer can assure and declare that vehicle applied for test can comply with this paragraph through document of compliance declaration.

47-1.5.1.5 The effectiveness of the steering equipment, including the electrical control lines, shall not be adversely affected by magnetic or electric fields. Conformity with the technical requirements, to the amendment in force at the time of Type Approval shall be demonstrated, manufacturer can assure and declare that vehicle applied for test can comply with this paragraph through document of compliance declaration.

47-1.5.1.6 Advanced driver assistance steering systems:

Advanced driver assistance steering systems shall only be approved in accordance with this Regulation where the function

does not cause any deterioration in the performance of the basic steering system. In addition they shall be designed such that the driver may, at any time and by deliberate action, override the function.

47-1.5.1.6.1 A CSF system shall be subject to the requirements of paragraph 47-1.9.

47-1.5.1.6.1.1 Every CSF intervention shall immediately be indicated to the driver by an optical warning signal which is displayed for at least 1s 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 VSTD Regulation (i.e. 'Dynamic Braking' or 'Electronic stability control systems'), 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.

47-1.5.1.6.1.2 In the case of a CSF intervention which is based on the evaluation of the presence and location of lane markings or boundaries of the lane the following shall apply additionally:

47-1.5.1.6.1.2.1 In the case of an intervention longer than:

- (a) 10 s for vehicles of category M1 and N1; or
- (b) 30 s for vehicles of category M2, M3 and N2, N3.

An acoustic warning signal shall be provided until the end of the intervention.

47-1.5.1.6.1.2.2 In the case of two or more consecutive interventions within a rolling interval of 180 seconds and in the absence of a steering input by the driver during the intervention, an acoustic warning signal shall be provided by the system during the second and any further intervention within a rolling interval of 180 seconds.

Starting with the third intervention (and subsequent interventions) the acoustic warning signal shall continue

for at least 10 seconds longer than the previous warning signal.

47-1.5.1.6.1.3 The steering control effort necessary to override the directional control provided by the system shall not exceed 50 N in the whole range of CSF operations.

47-1.5.1.6.1.4 The requirements in paragraphs 47-1.5.1.6.1.1, 47-1.5.1.6.1.2 and 47-1.5.1.6.1.3 for CSF, which are reliant on the evaluation of the presence and location of lane markings or boundaries of the lane, shall be tested in accordance with the relevant vehicle test(s) specified in paragraph 47-1.11 of this Regulation.

47-1.5.1.7 Towing vehicles equipped with a connection to supply electrical energy to the steering system of the trailer and trailers that utilise electrical energy from the towing vehicle to power the trailer steering system shall fulfil the relevant requirements of paragraph 47-1.10, manufacturer can assure and declares that vehicle applied for test can comply with this paragraph through document of compliance declaration.

47-1.5.1.8 Steering transmission:

Manufacturer can assure and declares that vehicle applied for test can comply with this paragraph through document of compliance declaration.

47-1.5.1.8.1 Adjustment devices for steering geometry must be such that after adjustment a positive connection can be established between the adjustable components by appropriate locking devices.

47-1.5.1.8.2 Steering transmission which can be disconnected to cover different configurations of a vehicle (e.g. on extendible semi-trailers), must have locking devices, which ensure positive relocation of components; where locking is automatic, there must be an additional safety lock which is operated manually.

47-1.5.1.9 Steered wheels:

The steered wheels shall not be solely the rear wheels. This requirement does not apply to semi-trailers, manufacturer can

assures and declares that vehicle applied for test can comply with this paragraph through document of compliance declaration.

47-1.5.1.10 Energy supply:

The same energy supply may be used for the steering equipment and other systems.

However, in the case of a failure in any system which shares the same energy supply steering shall be ensured in accordance with the relevant failure conditions of paragraph 47-1.5.3.

47-1.5.1.11 Control systems

The requirements of paragraph 47-1.9 shall be applied to the safety aspects of electronic vehicle control systems that provide or form part of the control transmission of the steering function including advanced driver assistance steering systems. However, systems or functions, that use the steering system as the means of achieving a higher level objective, are subject to paragraph 47-1.9 only insofar as they have a direct effect on the steering system.

If such systems are provided, they shall not be deactivated during type approval testing of the steering system.

47-1.5.2 Provisions for trailers:

47-1.5.2.1 Trailers (with the exception of semi-trailers and centre-axle trailers) which have more than one axle with steered wheels and semi-trailers and centre-axle trailers which have at least one axle with steered wheels must fulfil the conditions given in paragraph 47-1.6.3.1. However, for trailers with self-tracking steering equipment a test under paragraph 47-1.6.3.1 is not necessary if the axle load ratio between the un-steered and the self-tracking axles equals or exceeds 1.6. under all loading conditions. However for trailers with self-tracking steering equipment, the axle load ratio between un-steered or articulated steered axles and friction-steered axles shall be at least 1 under all loading conditions.

47-1.5.2.2 If the towing vehicle of a vehicle combination is moving straight forward, the trailer and towing vehicle must remain aligned.

If alignment is not retained automatically, the trailer must be equipped with a suitable adjustment facility for maintenance, manufacturer can assures and declares that vehicle applied for test can complied with this paragraph through document of compliance declaration.

#### 47-1.5.3 Failure provisions and performance

##### 47-1.5.3.1 General

Manufacturer can assures and declares that vehicle applied for test can complied with this paragraph through document of compliance declaration.

47-1.5.3.1.1 For the purposes of this Regulation the steered wheels, the steering control and all mechanical parts of the steering transmission shall not be regarded as liable to breakage if they are amply dimensioned, are readily accessible for maintenance, and exhibit safety features at least equal to those prescribed for other essential components (such as the braking system) of the vehicle. Where the failure of any such part would be likely to result in loss of control of the vehicle, that part must be made of metal or of a material with equivalent characteristics and must not be subject to significant distortion in normal operation of the steering system.

47-1.5.3.1.2 The requirements of paragraphs 47-1.5.1.2, 47-1.5.1.3 and 47-1.6.2.1 shall also be satisfied with a failure in the steering equipment as long as the vehicle can be driven with the speeds required in the respective paragraphs.

In this case paragraph 47-1.5.1.3 shall not apply for full power steering systems when the vehicle is stationary.

47-1.5.3.1.3 Any failure in a transmission other than purely mechanical must clearly be brought to the attention of the vehicle driver. When a failure occurs, a change in the average steering ratio is permissible if the steering effort given in paragraph 47-1.6.2.5 is not exceeded.

47-1.5.3.1.4 In the case where the braking system of the vehicle shares the same energy source as the steering system and this

energy source fails, the steering system shall have priority and shall be capable of meeting the requirements of paragraphs 47-1.5.3.2 and 47-1.5.3.3 as applicable. If an energy source failure occurs, service braking performance on the first brake application shall achieve the values no less than given in the table 1 below.

Table 1 - Service braking performance

Category	V (km/h)	Service braking(m/s <sup>2</sup> )	F (daN)
M1	100	6.43	50
M2 and M3	60	5.0	70
N1 <sup>a,b</sup>	(i)	80	5.0
	(ii)	100	6.43
N2 and N3	60	5.0	70

Note

- a) The applicant shall select the appropriate row (i) or (ii) and this choice shall be subject to the agreement of the Technical Service.
- b) Information: The values in row (i) are aligned with the corresponding non-M1 category, the values in row (ii) are aligned with the corresponding M1 category.

47-1.5.3.1.5 In the case where the braking system of the vehicle shares the same energy supply as the steering system and there is a failure in the energy supply, the steering system shall have priority and shall be capable of meeting the requirements of paragraphs 47-1.5.3.2 and 47-1.5.3.3 as applicable. After any failure in the steering equipment, or the energy supply, it shall be possible after eight full stroke actuations of the service brake control, to achieve at the ninth application, at

least the performance prescribed for the secondary (emergency) braking system (see table below). In the case where secondary performance requiring the use of stored energy is achieved by a separate control, it shall still be possible after eight full stroke actuations of the service brake control to achieve at the ninth application, the residual performance (see table 2 below).

Table 2 - Secondary / residual braking efficiency

Category	V (km/h)	Secondary braking (m/s <sup>2</sup> )	Residual braking (m/s <sup>2</sup> )
M1	100	2.44	-
M2 and M3	60	2.5	1.5
N1 <sup>a,b</sup>	(i) 70	2.2	1.3
	(ii) 100	2.44	-
N2	50	2.2	1.3
N3	40	2.2	1.3

Note

- a) The applicant shall select the appropriate row (i) or (ii) and this choice shall be subject to the agreement of the Technical Service.
- b) Information: The values in row (i) are aligned with the corresponding non-M1 category, the values in row (ii) are aligned with the corresponding M1 category.

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47-1.5.3.1.6 The requirements for the braking performance in paragraphs 47-1.5.3.1.4 and 47-1.5.3.1.5 above shall not apply if the braking system is such that in the absence of any energy reserve it is possible with the service brake control to achieve the safety requirement for the secondary braking system mentioned in:

47-1.5.3.1.6.1 Paragraph 5.3.2 of “Dynamic braking” of VSTD. (for M1, N1 vehicles);

47-1.5.3.1.6.2 Paragraph 6.3.2 and 6.3.4 of “Dynamic braking” of VSTD. (for M2, M3, N vehicles).

47-1.5.3.1.7 In the case of trailers, the requirements of paragraphs 47-1.5.2.2 shall also be met when there is a failure in the steering system.

#### 47-1.5.3.2 Power assisted steering systems

Manufacturer can assure and declares that vehicle applied for test can comply with this paragraph through document of compliance declaration.

47-1.5.3.2.1 Should the engine stop or a part of the transmission fail, with the exception of those parts listed in paragraph 47-1.5.3.1.1, there shall be no immediate changes in steering angle. As long as the vehicle is capable of being driven at a speed greater than 10 km/h the requirements given in paragraph 47-1.6, relating to a system with a failure, shall be met.

#### 47-1.5.3.3 Full power steering systems

Manufacturer can assure and declares that vehicle applied for test can comply with paragraph 47-1.5.3.3.1 and 47-1.5.3.3.2 through document of compliance declaration.

47-1.5.3.3.1 The system shall be designed such that the vehicle cannot be driven indefinitely at speeds above 10 km/h where there is any fault which requires operation of the warning signal referred to in paragraph 47-1.5.4.2.1.1.

47-1.5.3.3.2 In case of a failure within the control transmission, with the exception of those parts listed in paragraph 47-1.5.1.4, it

shall still be possible to steer with the performance laid down in paragraph 47-1.6 for the intact steering system.

47-1.5.3.3.3 In the event of a failure of the energy source of the control transmission, it shall be possible to carry out at least 24 "figure of eight" manoeuvres, where each loop of the figure is 40 m diameter at 10 km/h speed and at the performance level given for an intact system in paragraph 47-1.6. The test manoeuvres shall begin at an energy storage level given in paragraph 47-1.5.3.3.5.

47-1.5.3.3.4 In the event of a failure within the energy transmission, with the exception of those parts listed in paragraph 47-1.5.3.1.1, there shall not be any immediate changes in steering angle.

As long as the vehicle is capable of being driven at a speed greater than 10 km/h the requirements of paragraph 47-1.6 for the system with a failure shall be met after the completion of at least 25 "figure of eight" manoeuvres at 10 km/h minimum speed, where each loop of the figure is 40 m diameter.

The test manoeuvres shall begin at an energy storage level given in paragraph 47-1.5.3.3.5.

47-1.5.3.3.5 The energy level to be used for the tests referred to in paragraphs 47-1.5.3.3.3 and 47-1.5.3.3.4 shall be the energy storage level at which a failure is indicated to the driver.

In the case of electrically powered systems subject to paragraph 47-1.9, this level shall be the worst case situation outlined by the manufacturer in the documentation submitted in connection with paragraph 47-1.9 and shall take into account the effects of e.g. temperature and ageing on battery performance.

#### 47-1.5.4 Warning signals

##### 47-1.5.4.1 General provisions

47-1.5.4.1.1 Any fault which impairs the steering function and is not mechanical in nature must be signalled clearly to the driver of the vehicle.

Despite the requirements of 47-1.5.1.2 the deliberate application of vibration in the steering system may be used as an additional indication of a fault condition in this system. In the case of a motor vehicle, an increase in steering force is considered to be a warning indication; in the case of a trailer, a mechanical indicator is permitted.

47-1.5.4.1.2 Optical warning signals shall be visible, even by daylight and distinguishable from other alerts; the satisfactory condition of the signals shall be easily verifiable by the driver from the driver's seat; the failure of a component of the warning devices shall not entail any loss of the steering system's performance.

47-1.5.4.1.3 Acoustic warning signals shall be by continuous or intermittent sound signal or by vocal information. Where vocal information is employed, the manufacturer shall ensure that the alert uses the Chinese language.  
Acoustic warning signals shall be easily recognized by the driver.

47-1.5.4.1.4 If the same energy source is used to supply the steering system and other systems, an acoustic or optical warning shall be given to the driver, when the stored energy/fluid in the energy/storage reservoir drops to a level liable to cause an increase in steering effort. This warning may be combined with a device provided to warn of brake failure if the brake system uses the same energy source. The satisfactory condition of the warning device must be easily verifiable by the driver.

#### 47-1.5.4.2 Special provisions for full-power steering equipment

Manufacturer can assure and declares that vehicle applied for test can comply with this paragraph through document of compliance declaration.

47-1.5.4.2.1 Power-driven vehicles shall be capable of providing steering failure and defect warning signals, as follows:

47-1.5.4.2.1.1 A red warning signal, indicating failures defined in paragraph 47-1.5.3.1.3 within the main steering equipment.

47-1.5.4.2.1.2 Where applicable, a yellow warning signal indicating an electrically detected defect within the steering

equipment, which is not indicated by the red warning signal.

47-1.5.4.2.1.3 If a symbol is used, it must comply with symbol J 04, ISO/IEC registration number 7000-2441 as defined in ISO 2575: 2000.

47-1.5.4.2.1.4 The warning signal(s) mentioned above shall light up when the electrical equipment of the vehicle (and the steering system) is energised. With the vehicle stationary, the steering system shall verify that none of the specified failures or defects is present before extinguishing the signal.

Specified failures or defects which should activate the warning signal mentioned above, but which are not detected under static conditions, shall be stored upon detection and be displayed at start-up and at all times when the ignition (start) switch is in the "on" (run) position, as long as the failure persists.

47-1.5.4.3 In the case where additional steering equipment is in operation and/or where the steering angle generated by that equipment has not been returned to normal driving position a warning signal must be given to the driver.

#### 47-1.5.5 Provisions for ACSF

Any ACSF shall be subject to the requirements of paragraph 47-1.9.

##### 47-1.5.5.1 Special Provisions for ACSF of Category A

Any ACSF of Category A shall fulfil the following requirements.

##### 47-1.5.5.1.1 General

47-1.5.5.1.1.1 The system shall only operate until 10 km/h (+2 km/h tolerance)

47-1.5.5.1.1.2 The system shall be active only after a deliberate action of the driver and if the conditions for operation of the system are fulfilled (all associated functions - e.g. brakes, accelerator, steering, camera/radar/lidar. are working properly).

- 47-1.5.5.1.1.3 The system shall be able to be deactivated by the driver at any time.
- 47-1.5.5.1.1.4 In case the system includes accelerator and/or braking control of the vehicle, the vehicle shall be equipped with a means to detect an obstacle (e.g. vehicles, pedestrian) in the manoeuvring area and to bring the vehicle immediately to a stop to avoid a collision.\*
- 47-1.5.5.1.1.5 Whenever the system becomes operational, this shall be indicated to the driver. Any termination of control shall produce a short but distinctive driver warning by an optical warning signal and either an acoustic warning signal or by imposing a haptic warning signal (except for the signal on the steering control in parking manoeuvring). For RCP, the requirements for driver warning shown above shall be fulfilled by the provision of an optical warning signal at least at the remote control device.

#### 47-1.5.5.1.2 Additional provisions for RCP systems

- 47-1.5.5.1.2.1 The parking manoeuvre shall be initiated by the driver but controlled by the system. A direct influence on steering angle, value of acceleration and deceleration via the remote control device shall not be possible.
- 47-1.5.5.1.2.2 A continuous actuation of the remote control device by the driver is required during the parking manoeuvre.
- 47-1.5.5.1.2.3 If the continuous actuation is interrupted or the distance between vehicle and remote control device exceeds the specified maximum RCP operating range ( $S_{RCPmax}$ ) or the signal between remote control and vehicle is lost, the vehicle shall stop immediately.
- 47-1.5.5.1.2.4 If a door or trunk of the vehicle is opened during the parking manoeuvre, the vehicle shall stop immediately.
- 47-1.5.5.1.2.5 If the vehicle has reached its final parking position, either automatically or by confirmation from the driver, and the start/run switch is in the off position, the parking braking system shall be automatically engaged.
- 47-1.5.5.1.2.6 At any time during a parking manoeuvre that the vehicle becomes stationary, the RCP function shall prevent the

vehicle from rolling away.

47-1.5.5.1.2.7 The specified maximum RCP operating range shall not exceed 6m.

47-1.5.5.1.2.8 The system shall be designed to be protected against unauthorized activation or operation of the RCP systems and interventions into the system, manufacturer can assure and declares that vehicle applied for test can comply with this paragraph through document of compliance declaration.

#### 47-1.5.5.1.3 System information data

47-1.5.5.1.3.1 Following data shall be provided together with the documentation package required in paragraph 47-1.9 of this Regulation to the Technical Service at the time of type approval:

47-1.5.5.1.3.1.1 The value for the specified maximum RCP operating range ( $S_{RCPmax}$ );

47-1.5.5.1.3.1.2 The conditions under which the system can be activated, i.e. when the conditions for operation of the system are fulfilled;

47-1.5.5.1.3.1.3 For RCP systems the manufacturer shall provide the technical authorities with an explanation how the system is protected against unauthorized activation.

#### 47-1.5.5.2 Special Provisions for ACSF of Category B1

Any ACSF of Category B1 shall fulfil the following requirements.

##### 47-1.5.5.2.1 General

47-1.5.5.2.1.1 The activated system shall at any time, within the boundary conditions, ensure that the vehicle does not cross a lane marking for lateral accelerations below the maximum lateral acceleration specified by the vehicle manufacturer  $ay_{smax}$ .

The system may exceed the specified value  $ay_{smax}$  by not more than  $0.3m/s^2$ , while not exceeding the maximum

value specified in the table in paragraph 47-1.5.5.2.1.3 of this Regulation.

47-1.5.5.2.1.2 The vehicle shall be equipped with a means for the driver to activate (stand by mode) and deactivate (off mode) the system. It shall be possible to deactivate the system at any time by a single action of the driver. Following this action, the system shall only become active again as a result of a deliberate action by the driver.

47-1.5.5.2.1.3 The system shall be designed so that excessive intervention of steering control is suppressed to ensure the steering operability by the driver and to avoid unexpected vehicle behaviour, during its operation. To ensure this, the following requirements shall be fulfilled:

(a) The steering control effort necessary to override the directional control provided by the system shall not exceed 50 N;

(b) The specified maximum lateral acceleration  $a_{y_{\text{max}}}$  shall be within the limits as defined in the following table:

For vehicles of category M1, N1

Speed range	10-60 km/h	>60-100 km/h	>100-130 km/h	>130 km/h
Maximum value for the specified maximum lateral acceleration	3 m/s <sup>2</sup>	3 m/s <sup>2</sup>	3 m/s <sup>2</sup>	3 m/s <sup>2</sup>
Minimum value for the specified maximum lateral acceleration	0 m/s <sup>2</sup>	0.5 m/s <sup>2</sup>	0.8 m/s <sup>2</sup>	0.3 m/s <sup>2</sup>

For vehicles of category M2, M3, N2, N3

Speed range	10-30 km/h	>30-60 km/h	>60 km/h
Maximum value for the specified maximum lateral acceleration	2.5 m/s <sup>2</sup>	2.5 m/s <sup>2</sup>	2.5 m/s <sup>2</sup>

Minimum value for the specified maximum lateral acceleration	0 m/s <sup>2</sup>	0.3 m/s <sup>2</sup>	0.5 m/s <sup>2</sup>
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(c) The moving average over half a second of the lateral jerk generated by the system shall not exceed 5 m/s<sup>3</sup>.

47-1.5.5.2.1.4 The requirements in paragraphs 47-1.5.5.2.1.1 and 47-1.5.5.2.1.3 of this Regulation shall be tested in accordance with relevant vehicle test(s) specified in paragraph 47-1.11 of this Regulation.

#### 47-1.5.5.2.2 ACSF of Category B1 operation

47-1.5.5.2.2.1 If the system is active an optical signal shall be provided to the driver.

47-1.5.5.2.2.2 When the system is in standby mode, an optical signal shall be provided to the driver.

47-1.5.5.2.2.3 When the system reaches its boundary conditions set out in paragraph 47-1.5.5.2.3.1.1 of this Regulation (e.g. the specified maximum lateral acceleration  $a_{y_{\text{max}}}$ ) and both in the absence of any driver input to the steering control and when any front tyre of the vehicle starts to cross the lane marking, the system shall continue to provide assistance and shall clearly inform the driver about this system status by an optical warning signal and additionally by an acoustic or haptic warning signal.

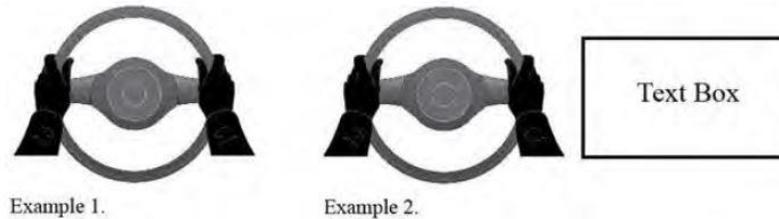
For vehicles of categories M2 M3 N2 and N3, the warning requirement above is deemed to be fulfilled if the vehicle is equipped with a Lane Departure Warning System (LDWS) fulfilling the technical requirements of VSTD regulation 'Lane departure warning system'.

47-1.5.5.2.2.4 A system failure shall be signaled to the driver by an optical warning signal. However, when the system is manually deactivated by the driver, the indication of the failure may be suppressed.

47-1.5.5.2.2.5 When the system is active and in the speed range between 10 km/h or  $V_{\text{Smin}}$ , whichever is higher, and  $V_{\text{Smax}}$ , it shall provide a means of detecting that the driver is holding the steering control.

If, after a period of no longer than 15 seconds the driver is not holding the steering control, an optical warning signal shall be provided. This signal may be the same as the signal specified below in this paragraph.

The optical warning signal shall indicate to the driver to place their hands on the steering control. It shall consist of pictorial information showing hands and the steering control and may be accompanied by additional explanatory text or warning symbols – see examples below:



If, after a period of no longer than 30 seconds the driver is not holding the steering control, at least the hands or steering control in the pictorial information provided as optical warning signal shall be shown in red and an acoustic warning signal shall be provided.

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

The system shall be automatically deactivated at the latest 30 seconds after the acoustic warning signal has started. After deactivation the system shall clearly inform the driver about the system status by an acoustic emergency signal which is different from the previous acoustic warning signal, for at least five seconds or until the driver holds the steering control again.

The above requirements shall be tested in accordance with the relevant vehicle test(s) specified in paragraph

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Attachment 47-1 Steering equipment

47-1.11 of this Regulation.

47-1.5.5.2.2.6 Unless otherwise specified, the optical signals described in 47-1.5.5.2.2 shall all be different from each other (e.g. different symbol, colour, blinking, text).

47-1.5.5.2.3 System information data

47-1.5.5.2.3.1 Following data shall be provided together with the documentation package required in paragraph 47-1.9 of this regulation to the Technical Service at the time of type approval;

47-1.5.5.2.3.1.1 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  $ay_{smax}$  for every speed range as mentioned in the table of paragraph 47-1.5.5.2.1.3 of this Regulation;

47-1.5.5.2.3.1.2 Information about how the system detects that the driver is holding the steering control.

47-1.6 Test requirements:

47-1.6.1 General provisions

47-1.6.1.1 The test shall be conducted on a level surface affording good adhesion.

47-1.6.1.2 During the test(s), the vehicle shall be loaded to its technically permissible maximum mass and its technically permissible maximum load on the steered axle(s). In the case of axles fitted with ASE, this test shall be repeated with the vehicle loaded to its technically permissible maximum mass and the axle equipped with ASE loaded to its maximum permissible mass.

47-1.6.1.3 Before the test begins, the tire pressures shall be as prescribed by the manufacturer for the load specified in paragraph 47-1.6.1.2 above when the vehicle is stationary.

47-1.6.1.4 In the case of any systems that use electrical energy for part or all of the energy supply, all performance tests shall be carried out under conditions of actual or simulated electrical load of all essential systems or systems components which share the

same energy supply. Essential systems shall comprise at least lighting systems, windscreen wipers, engine management and braking systems.

#### 47-1.6.2 Provisions for motor vehicles

47-1.6.2.1 It must be possible to leave a curve with a radius of 50 m at a tangent without unusual vibration in the steering equipment at the following speed:

47-1.6.2.1.1 Vehicles of category symbol M1: 50 km/h.

47-1.6.2.1.2 Vehicles of category symbols M2、M3 and N: 40 km/h, or the maximum design speed if this is below the speeds given above (40 km/h).

47-1.6.2.2 When the vehicle is driven in a circle with its steered wheels at approximately half lock and at a constant speed of at least 10 km/h, the turning circle must remain the same or become larger if the steering control is released.

47-1.6.2.3 During the measurement of the control effort, forces with a duration of less than 0.2 seconds shall not be taken into account.

47-1.6.2.4 The measurement of steering effort on motor vehicles with intact steering equipment:

47-1.6.2.4.1 The vehicle shall be driven from straight ahead into a spiral at a speed of 10 km/h. the steering effort shall be measured at the nominal radius of the steering control until the position of the steering control corresponds to turning radius given in the Table 3 below for the particular category of vehicle with intact steering. One steering movement shall be made to the right and one to the left.

47-1.6.2.4.2 The maximum permitted steering time and the maximum permitted steering control effort with intact steering equipment are given in the table 3 below for each category of vehicle.

47-1.6.2.5 The measurement of steering efforts on motor vehicles with a failure in the steering equipment:

47-1.6.2.5.1 The test described in paragraph 47-1.6.2.4 shall be repeated with a failure in the steering equipment. The steering effort

shall be measured until the position of the steering control corresponds to the turning radius given in Table 3 below for the particular category of vehicle with a failure in the steering equipment.

47-1.6.2.5.2 The maximum permitted steering time and the maximum permitted steering control effort with intact steering equipment are given in the table 3 below for each category of vehicle.

Table 3 Steering control effort requirements

Vehicle Category	Intact			With failure		
	Maximum effort (N)	Time (s)	Turning Radius (m)	Maximum effort (N)	Time (s)	Turning Radius (m)
M1	150	4	12	300	4	20
M2	150	4	12	300	4	20
M3	200	4	12 <sup>**/</sup>	450 <sup>*/</sup>	6	20
N1	200	4	12	300	4	20
N2	250	4	12	400	4	20
N3	200	4	12 <sup>**/</sup>	450 <sup>*/</sup>	6	20

1.\*/ 500 for rigid vehicles with 2 or more steered axles excluding self-tracking equipment.

2. \*\*/ or full lock if 12m is not attainable.

### 47-1.6.3 Provisions for trailers

47-1.6.3.1 The trailer shall travel without excessive deviation or unusual vibration in its steering equipment when the towing vehicle is

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travelling in a straight line on a flat and horizontal road at a speed of 80 km/h or the technically permissible maximum speed indicated by the trailer manufacturer if this is less than 80 km/h.

#### 47-1.7 Additional provisions for vehicles equipped with Auxiliary Steering Equipment

Manufacturer can assure and declares that vehicle applied for test can comply with paragraph 47-1.7.2.1 and 47-1.7.2.3 through document of compliance declaration.

##### 47-1.7.1 General Provisions

Vehicles fitted with Auxiliary Steering Equipment (ASE) in addition to the requirements given in the body of this Regulation shall also comply with the provisions of this paragraph.

##### 47-1.7.2 Specific Provisions

###### 47-1.7.2.1 Transmission

47-1.7.2.1.1 For mechanical steering transmissions, paragraph 47-1.5.3.1.1 below applies.

47-1.7.2.1.2 The hydraulic steering transmission must be protected from exceeding the maximum permitted service pressure (T).

47-1.7.2.1.3 The electric steering transmission must be protected from excess energy supply.

47-1.7.2.1.4 A combination of mechanical, hydraulic and electric transmissions shall comply with the requirements specified in paragraphs 47-1.7.2.1.1 to 47-1.7.2.1.3 above.

###### 47-1.7.2.2 Testing requirements for failure

47-1.7.2.2.1 Malfunction or failure of any part of the ASE (except for parts not considered to be susceptible to breakdown as specified in paragraph 47-1.5.3.1.1) shall not result in a sudden significant change in vehicle behavior and the requirements of paragraph 47-1.6.2.1 to 47-1.6.2.3 and 47-1.6.2.5 shall still be met. Furthermore, it must be possible to control the vehicle without abnormal steering correction. This shall be verified by the following tests:

47-1.7.2.2.1.1 Transient test

47-1.7.2.2.1.1.1 Unless uniform test procedures have been agreed, the vehicle manufacturer shall provide the technical services with their test procedures and results for transient behavior of the vehicle in the case of failure.

47-1.7.2.3 Warning signals in case of failure.

47-1.7.2.3.1 Except for parts of ASE not considered susceptible to breakdown as specified in paragraph 47-1.5.3.1.1, the following failure of ASE shall be clearly brought to the attention of the driver:

47-1.7.2.3.1.1 A general cut-off of ASE electrical or hydraulic control.

47-1.7.2.3.1.2 Failure of the ASE energy supply.

47-1.7.2.3.1.3 A break in the external wiring of the electrical control if fitted.

47-1.8 Provisions for trailers having hydraulic steering transmissions

Manufacturer can assures and declares that vehicle applied for test can complied with this paragraph through document of compliance declaration.

47-1.8.1 General provisions

Vehicles fitted with hydraulic steering transmission, in addition to the requirements given in the body of this Regulation shall also comply with the provisions of paragraph 47-1.8.

47-1.8.2 Specific provisions

47-1.8.2.1 The hydraulic lines of purely hydraulic transmission must be capable of withstanding a pressure of at least four times the maximum normal service pressure (T) specified by the applicant. Hose assemblies shall comply with ISO Standards 1402:1994, 6605:1986 and 7751:1991.

47-1.8.2.2 The energy supply must be protected from excess pressure by a pressure limiting valve, which operates at the pressure T.

47-1.8.2.3 The steering transmission must be protected from excess pressure by a pressure limiting valve, which operates at between 1.1T and 2.2T. The operating pressure of the pressure limiting valve shall be of a value that is compatible with the operating characteristics of the steering system installed on the vehicle. This shall be confirmed by the vehicle manufacturer at the time of type approval.

#### 47-1.9 Special requirements to be applied to the safety aspects of complex electronic vehicle control systems

##### 47-1.9.1 General

Manufacturer can assure and declare that vehicle applied for test can comply with this paragraph through document of compliance declaration.

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

This paragraph may also be called, by special paragraphs in this Regulation, for safety related functions which are controlled by electronic system(s).

This paragraph 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 normal and fault conditions, all the appropriate performance requirements specified elsewhere in this Regulation.

##### 47-1.9.2 Documentation

###### 47-1.9.2.1 Requirements

The manufacturer shall provide a documentation package which gives access to the basic design of "The System" and the means by which it is linked to other vehicle systems or by which it directly controls output variables.

The function(s) of "The System" and the safety concept, as laid down by the manufacturer, shall be explained. Documentation shall be brief, yet provide evidence that the design and development has had the benefit of expertise from all the system fields which are involved.

47-1.9.2.1.1 Documentation shall be made available in two parts:

(a) The formal documentation package for the approval, containing the material listed in paragraph 47-1.9.2 (with the exception of that of paragraph 47-1.9.2.4.4) which shall be supplied to the technical service at the time of submission of the type approval application. This will be taken as the basic reference for the verification process set out in paragraph 47-1.9.3.

(b) Additional material and analysis data of paragraph 47-1.9.2.4.4 which shall be retained by the manufacturer, but made open for inspection at the time of type approval.

47-1.9.2.2 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.

47-1.9.2.2.1 A list of all input and sensed variables shall be provided and the working range of these defined.

47-1.9.2.2.2 A list of all output variables which are controlled by "The System" shall be provided and an indication given, in each case, of whether the control is direct or via another vehicle system. The range of control (paragraph 47-1.2.6.7) exercised on each such variable shall be defined.

47-1.9.2.2.3 Limits defining the boundaries of functional operation (paragraph 47-1.2.6.8) shall be stated where appropriate to system performance.

47-1.9.2.3 System layout and schematics

47-1.9.2.3.1 Inventory of components.

A list shall be provided, collating all the units of "The System" and mentioning the other vehicle systems which are needed to achieve the control function in question.

An outline schematic showing these units in combination, shall be provided with both the equipment distribution and the interconnections made clear.

47-1.9.2.3.2 Functions of the units

The function of each unit of "The System" shall be outlined and the signals linking it with other units or with other vehicle systems shall be shown.

This may be provided by a labelled block diagram or other schematic, or by a description aided by such a diagram.

47-1.9.2.3.3 Interconnections

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.

47-1.9.2.3.4 Signal flow and priorities

There shall be a clear correspondence between these transmission links and the signals carried between Units.

Priorities of signals on multiplexed data paths shall be stated wherever priority may be an issue affecting performance or safety as far as this Regulation is concerned.

47-1.9.2.3.5 Identification of units

Each unit shall be clearly and unambiguously identifiable (e.g. by marking for hardware and marking or software output for software content) to provide corresponding hardware and documentation association.

Where functions are combined within a single unit or indeed within a single computer, but shown in multiple blocks in the block diagram for clarity and ease of explanation, only a single hardware identification marking shall be used.

The manufacturer shall, by the use of this identification, affirm that the equipment supplied conforms to the corresponding document.

47-1.9.2.3.5.1 The identification defines the hardware and software version and, where the latter changes such as to alter the function of the Unit as far as this Regulation is concerned, this identification shall also be changed.

#### 47-1.9.2.4 Safety concept of the manufacturer

47-1.9.2.4.1 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 systems which are subject to the prescriptions of this Regulation.

47-1.9.2.4.2 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 be prepared, if required, to show some evidence of the means by which they determined the realisation of the system logic, during the design and development process.

47-1.9.2.4.3 The Manufacturer shall provide the technical authorities 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:

- (a) Fall-back to operation using a partial system.
- (b) Change-over to a separate back-up system.
- (c) Removal of the high level function.

In case of a failure, the driver shall be warned for example by warning signal or message display.

When the system is not deactivated by the driver, e.g. by turning the ignition (run) switch to "off", or by switching off that particular function if a special switch is provided for that purpose, the warning shall be present as long as the fault condition persists.

47-1.9.2.4.3.1 If the chosen provision selects a partial performance mode of operation under certain fault conditions, then these conditions shall be stated and the resulting limits of effectiveness defined.

47-1.9.2.4.3.2 If the chosen provision selects a second (back-up) means to realise the vehicle control system objective, the principles of the change-over mechanism, the logic and level of redundancy and any built in back-up checking features shall be explained and the resulting limits of back-up effectiveness defined.

47-1.9.2.4.3.3 If the chosen provision selects the removal of the Higher Level Function, all the corresponding output control signals associated with this function shall be inhibited, and in such a manner as to limit the transition disturbance.

47-1.9.2.4.4 The documentation shall be supported, by an analysis which shows, in overall terms, how the system will behave on the occurrence of any one of those specified faults which will have a bearing on vehicle control performance or safety. This may be based on a Failure Mode and Effect Analysis (FMEA), a Fault Tree Analysis (FTA) or any similar process appropriate to system safety considerations. 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.

47-1.9.2.4.4.1 This documentation shall itemize the parameters being monitored and shall set out, for each fault condition of the type defined in paragraph 47-1.9.2.4.4, the warning signal to be given to the driver and/or to service/technical inspection personnel.

### 47-1.9.3 Verification and test

47-1.9.3.1 The functional operation of "The System", as laid out in the documents required in paragraph 47-1.9.2, shall be tested as

follows:

47-1.9.3.1.1 Verification of the function of "The System" As the means of establishing the normal operational levels, verification of the performance of the vehicle system under non-fault conditions shall be conducted against the manufacturer's basic benchmark specification unless this is subject to a specified performance test as part of the approval procedure of this or another Regulation.

47-1.9.3.1.2 Verification of the safety concept of paragraph 47-1.9.2.4. The reaction of "The System" shall, at the discretion of the type approval authority, 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.

47-1.9.3.1.2.1 The verification results shall correspond with the documented summary of the failure analysis, to a level of overall effect such that the safety concept and execution are confirmed as being adequate.

47-1.10 Special provisions for the powering of trailer steering systems from the towing vehicle

47-1.10.1 Requirements for trailers

47-1.10.1.1 Demonstration of the operation of the steering system

47-1.10.1.1.1 At the time of type approval the trailer manufacturer shall demonstrate to the Technical Service the functionality of the steering system by fulfilling the relevant performance requirements specified within the Regulation.

47-1.10.1.1.2 Failure Conditions:

47-1.10.1.1.2.1 Under steady state conditions: In the event of the trailer being coupled to a towing vehicle that does not have an electrical supply for the trailer steering system, or there is a break in the electrical supply to the trailer steering system or there is a failure in the electric control transmission of the trailer steering control system it shall be demonstrated that the trailer fulfils all relevant requirements of paragraph 47-1.6.3 of the Regulation for the

intact system.

47-1.10.1.1.2.2 Under transient conditions: The transient behaviour of the vehicle in the case of failure within the electric control transmission of the steering system shall be evaluated to ensure vehicle stability is maintained during the transition following the failure and shall be assessed by fulfilling the following:

47-1.10.1.1.2.2.1 By applying the test procedure and requirements defined within paragraph 47-1.6.3.1 of the Regulation.

47-1.10.1.1.3 If the trailer steering system utilises hydraulic transmission to operate the steering, the paragraph 47-1.8 shall apply.

#### 47-1.10.1.2 Marking

47-1.10.1.2.1 Trailers equipped with a connector for the supply of electrical energy to the trailer steering system shall be marked to include the following information:

47-1.10.1.2.1.1 The maximum current requirement for the trailer steering system.

47-1.10.1.2.1.2 The functionality of the trailer steering system including the impact on manoeuvrability when the connector is connected and disconnected.

The marking shall be in indelible form and positioned so that it is visible when connecting to the electrical interface.

#### 47-1.11 Test requirements for corrective and automatically commanded steering functions

##### 47-1.11.1 General Provisions

Vehicles fitted with CSF and/or ACSF systems shall fulfil the appropriate tests requirements of this paragraph.

If technical service can't execute the test due to testing speed is limited by test field, after technical service and manufacturer reach consensus by negotiation, the test speed can be adjusted to 110 km/h.

##### 47-1.11.2 Testing conditions

The official directions are written in Chinese, this English edition is for your reference only.

Attachment 47-1 Steering equipment

The tests shall be performed on a flat, dry asphalt or concrete surface affording good adhesion. The ambient temperature shall be between 0 deg. C and 45 deg. C.

#### 47-1.11.2.1 Lane markings

The lane markings on the road used for the tests shall be in line with one of those described in paragraph 6 of VSTD regulation 'Lane departure warning system'. The markings shall be in good condition and of a material conforming to the standard for visible lane markings.

The lane-marking layout used for the tests shall be recorded in the test report.

The width of the lane shall be minimum 3.5m, for the purpose of the tests of this paragraph.

The test shall be performed under visibility conditions that allow safe driving at the required test speed.

The vehicle manufacturer shall demonstrate, through the use of documentation, compliance with all other lane markings identified in paragraph 6 of VSTD regulation 'Lane departure warning system'. Any of such documentation shall be appended to the test report.

#### 47-1.11.2.2 Tolerances

All vehicle speeds specified for the tests described in this paragraph shall be met within a tolerance of +/- 2 km/h.

#### 47-1.11.2.3 Vehicle conditions

##### 47-1.11.2.3.1 Test mass

The vehicle shall be tested in a load condition agreed between the manufacturer and the Technical Service. No load alteration shall be made once the test procedure has begun.

The vehicle manufacturer shall demonstrate, through the use of documentation, that the system works at all load conditions.

47-1.11.2.3.2 The vehicle shall be tested at the tyre pressures recommended by the vehicle manufacturer.

#### 47-1.11.2.4 Lateral acceleration

The position representing the centre of gravity, at which the lateral acceleration shall be measured, shall be determined in agreement between the vehicle manufacturer and the Technical Service. This position shall be identified in the test report.

The lateral acceleration shall be measured without taking into account the additional effects due to the movements of the vehicle body (e.g. roll of sprung mass).

### 47-1.11.3 Tests procedures

#### 47-1.11.3.1 Tests for CSF

The following test applies to CSF functions defined in subparagraph (c) of CSF definition in paragraph 47-1.2.1.4.2 of this Regulation.

##### 47-1.11.3.1.1 Warning test for CSF

47-1.11.3.1.1.1 The vehicle shall be driven with an activated CSF on a road with lane markings on each side of the lane. In case of a CSF whose interventions are solely based on the evaluation of the presence and location of lane boundaries, the vehicle shall be driven on a road delimited by the boundaries as declared by the manufacturer (e.g. road edge).

The test conditions and the vehicle test speed shall be within the operating range of the system.

During the test, the duration of the CSF interventions and of the optical and acoustic warning signals shall be recorded.

47-1.11.3.1.1.2 In the case of paragraph 47-1.5.1.6.1.2.1 of this Regulation, the vehicle shall be driven such that it attempts to leave the lane and causes CSF intervention to be maintained for a period longer than 10s (for M1, N1) or 30s

(for M2, M3, N2, N3). If such a test cannot be practically achieved due to e.g. the limitations of the test facilities, with the consent of the type approval authority this requirement may be fulfilled through the use of documentation.

The test requirements are fulfilled if:

(a) The acoustic warning is provided no later than 10 s (for M1, N1) or 30 s (for M2, M3, N2, N3) after the beginning of the intervention.

47-1.11.3.1.1.3 In the case of paragraph 47-1.5.1.6.1.2.2 of this Regulation, the vehicle shall be driven such that it attempts to leave the lane and causes at least three interventions of the system within a rolling interval of 180 s.

The test requirements are fulfilled if:

(a) An optical warning signal is provided for each intervention, as long as the intervention exists; and

(b) An acoustic warning signal is provided at the second and third intervention; and

(c) The acoustic warning signal at the third intervention is at least 10 s longer than the one at the second intervention.

47-1.11.3.1.1.4 In addition, the manufacturer shall demonstrate to the satisfaction of the Technical Service that the requirements defined in paragraphs 47-1.5.1.6.1.1 and 47-1.5.1.6.1.2 are fulfilled in the whole range of CSF operation. This may be achieved on the basis of appropriate documentation appended to the test report.

#### 47-1.11.3.1.2 Overriding force test

47-1.11.3.1.2.1 The vehicle shall be driven with an activated CSF on a road with lane markings on each side of the lane.

The test conditions and the vehicle test speed shall be within the operating range of the system.

The vehicle shall be driven such that it attempts to leave the lane and causes CSF intervention. During the intervention, the driver shall apply a force on the steering control to override the intervention.

The force applied by the driver on the steering control to override the intervention shall be recorded.

47-1.11.3.1.2.2 The test requirements are fulfilled if the force applied by the driver on the steering control to override the intervention does not exceed 50 N.

47-1.11.3.1.2.3 In addition, the manufacturer shall demonstrate to the satisfaction of the Technical Service that the requirements defined in paragraph 47-1.5.1.6.1.3 are fulfilled in the whole range of CSF operation. This may be achieved on the basis of appropriate documentation appended to the test report.

#### 47-1.11.3.2 Tests for ACSF Category B1 Systems

##### 47-1.11.3.2.1 Lane keeping functional test

47-1.11.3.2.1.1 The vehicle speed shall remain in the range from  $V_{Smin}$  up to  $V_{Smax}$ .

The test shall be carried out for each speed range specified in paragraph 47-1.5.5.2.1.3 of this Regulation separately or within contiguous speed ranges where the  $ay_{smax}$  is identical.

The vehicle shall be driven without any force applied by the driver on the steering control (e.g. by removing the hands from the steering control) with a constant speed on a curved track with lane markings at each side.

The necessary lateral acceleration to follow the curve shall be between 80 and 90% of the maximum lateral acceleration specified by the vehicle manufacturer  $ay_{smax}$ .

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

47-1.11.3.2.1.2 The test requirements are fulfilled if:

The vehicle does not cross any lane marking. The moving average over half a second of the lateral jerk does not exceed 5 m/s<sup>3</sup>.

47-1.11.3.2.1.3 The vehicle manufacturer shall demonstrate to the satisfaction of the Technical Service that the requirements

for the whole lateral acceleration and speed range are fulfilled. This may be achieved on the basis of appropriate documentation appended to the test report.

#### 47-1.11.3.2.2 Maximum lateral acceleration test

47-1.11.3.2.2.1 The vehicle speed shall remain in the range from  $V_{Smin}$  up to  $V_{Smax}$ .

The test shall be carried out for each speed range specified in paragraph 47-1.5.5.2.1.3 of this Regulation separately or within contiguous speed ranges where the  $ay_{Smax}$  is identical. The vehicle shall be driven without any force applied by the driver on the steering control (e.g. by removing the hands from the steering control) with a constant speed on a curved track with lane markings at each side.

The technical service defines a test speed and a radius which would provoke a higher acceleration than  $ay_{Smax} + 0.3 \text{ m/s}^2$  (e.g. by travelling with a higher speed through a curve with a given radius). The lateral acceleration and the lateral jerk shall be recorded during the test.

47-1.11.3.2.2.2 The test requirements are fulfilled if:

The recorded acceleration is within the limits specified in paragraph 47-1.5.5.2.1.3 of this Regulation.

The moving average over half a second of the lateral jerk does not exceed  $5 \text{ m/s}^3$ .

#### 47-1.11.3.2.3 Overriding force test

47-1.11.3.2.3.1 The vehicle speed shall remain in the range from  $V_{Smin}$  up to  $V_{Smax}$ .

The vehicle shall be driven without any force applied by the driver on the steering control (e.g. by removing the hands from the steering control) with a constant speed on a curved track with lane markings at each side.

The necessary lateral acceleration to follow the curve shall be between 80 and 90% of the minimum value specified in the table of paragraph 47-1.5.5.2.1.3 of this Regulation. The driver shall then apply a force on the

steering control to override the system intervention and leave the lane.

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

47-1.11.3.2.3.2 The test requirements are fulfilled if the force applied by the driver on the steering control during the overriding manoeuvre is less than 50N.

The manufacturer shall demonstrate through appropriate documentation that this condition is fulfilled throughout the ACSF operation range.