

47 Steering equipment

Refer to: R79 01-S3, 01-Erratum

47.1 Effective date and Scope: As for the category symbols M, N and O, the new vehicle types from 2008/1/1 and all vehicle types from 2010/1/1, shall comply with this regulation.

47.2 It does not cover steering equipment with a purely pneumatic, purely electric or purely hydraulic transmission, except:

47.2.1 Auxiliary steering equipment (ASE) with a purely electric or purely hydraulic transmission for vehicles of categories M and N;

47.2.2 Steering equipment with a purely hydraulic transmission for vehicles of category O.

47.3 Definitions:

47.3.1 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 and the energy supply, if any.

47.3.2 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.

47.3.3 Steering transmission: includes all parts of the steering equipment which are the means of transmitting the steering forces between the steering control and the steered wheels; it includes all parts down from the point where the steering control effort is transformed by mechanical, hydraulic or electrical means.

47.3.4 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).

47.3.5 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 47.6.1.5 or its drive to the energy source).

47.3.6 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.

47.3.7 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.

47.3.8 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

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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.

47.3.9 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 over-ridden becomes part of the complex system.

47.3.10

47.4 Steering equipment shall according to suitable types and range of principle are as below :

47.4.1 The same vehicle category **symbol**.

47.4.2 The same axle set type.

47.4.3 The same brand and vehicle type series.

47.4.4 The chassis vehicle have had same axle set type.

47.4.5 The same chassis brand.

47.4.6 Chassis manufacturers announced that the same chassis vehicle type series.

47.4.7 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 :

47.4.7.1 The chassis vehicle have had same axle set type.

47.4.7.2 The same brand.

47.4.7.3 Chassis manufacturers announced that the same chassis vehicle type series.

47.5 Declaration of conformance of design: applicant shall ensure and announce to comply with this regulation.

47.5.1 General provisions:

47.5.1.1 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.

47.5.1.1.1 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.

47.5.1.2 If the vehicles are fitted with such a device ASE, they shall comply with the provisions:

47.5.1.2.1 Transmission

47.5.1.2.1.1 For mechanical steering transmissions, paragraph **47.5.1.9.1** below applies.

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

- 47.5.1.2.1.3 The electric steering transmission must be protected from excess energy supply.
- 47.5.1.2.1.4 A combination of mechanical, hydraulic and electric transmissions shall comply with the requirements specified in paragraphs 47.5.1.2.1.1 to 47.5.1.2.1.3 above.
- 47.5.1.2.2 Except for parts of ASE not considered susceptible to breakdown as specified in paragraph 47.5.1.9.1, the following failure of ASE shall be clearly brought to the attention of the driver:
 - 47.5.1.2.2.1 A general cut-off of ASE electrical or hydraulic control.
 - 47.5.1.2.2.2 Failure of the ASE energy supply.
 - 47.5.1.2.2.3 A break in the external wiring of the electrical control if fitted.
- 47.5.1.3 If any vehicles are so fitted with purely hydraulic steering transmissions, they shall comply with the provisions:
 - 47.5.1.3.1 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 manufacturer. Hose assemblies shall comply with ISO Standards 1402:1994, 6605:1986 and 7751:1991.
 - 47.5.1.3.2 The energy supply must be protected from excess pressure by a pressure limiting valve, which operates at the pressure T.
 - 47.5.1.3.3 The steering transmission must be protected from excess pressure by a pressure limiting valve, which operates at between 1.5T and 2.2T.
- 47.5.1.4 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.
- 47.5.1.5 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.
- 47.5.1.6 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 and when the system is not energized.
- 47.5.1.7 Steering transmission:

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- 47.5.1.7.1 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.
- 47.5.1.7.2 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.
- 47.5.1.8 Steered wheels:
- 47.5.1.8.1 The steered wheels shall not be solely the rear wheels. This requirement does not apply to semi-trailers.
- 47.5.1.8.2 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.
- 47.5.1.9 Failure provisions and performance
- 47.5.1.9.1 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.
- 47.5.1.9.2 The requirements of paragraphs 47.5.1.1, 47.5.1.6. and 47.6.2.1 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 47.5.1.6 shall not apply for full power steering systems when the vehicle is stationary.
- 47.5.1.9.3 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 47.5.2.6 is not exceeded.
- 47.5.1.9.4 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 47.5.1.10 and 47.5.11 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 2 below.
- 47.5.1.9.5 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 47.5.1.10 and 47.5.11 as applicable. After any failure in the steering equipment, or the energy supply, it shall

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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 3 below).

47.5.1.9.6 In the case of trailers, the requirements of paragraphs 47.5.1.8.2. shall also be met when there is a failure in the steering system.

47.5.1.10 Power assisted steering systems

47.5.1.10.1 Should the engine stop or a part of the transmission fail, with the exception of those parts listed in paragraph 47.5.1.9.1., 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 47.6, relating to a system with a failure, shall be met.

47.5.1.11 Full power steering systems

47.5.1.11.1 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 47.5.1.12.1.1.1.

47.5.1.11.2 In case of a failure within the control transmission, with the exception of those parts listed in paragraph 47.5.1.4, it shall still be possible to steer with the performance laid down in paragraph 5. for the intact steering system.

47.5.1.12 Warning signals

47.5.1.12.1 Special provisions for full-power steering equipment

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

47.5.1.12.1.1.1 A red warning signal, indicating failures defined in paragraph 47.5.1.9.3 within the main steering equipment.

47.5.1.12.1.1.2 Where applicable, a yellow warning signal indicating an electrically detected defect within the steering equipment, which is not indicated by the red warning signal.

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

47.5.1.12.1.1.4 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.

47.5.1.12.2 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.

47.5.1.13 Control systems: The requirements 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 Annex 6 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.

47.5.1.13.1 The functional operation of "The System", manufacturers have to provide related documentaries.

47.5.1.13.2 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.

47.5.1.13.3 Verification of the safety concept, 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.

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

Table 1. 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 ^{**/}	450 ^{*/}	6	20

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N1	200	4	12	300	4	20
N2	250	4	12	400	4	20
N3	200	4	12 ^{**/}	450 ^{*/}	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.

Table 2. Service braking

Category	V (km/h)	m/s ²	F (N)
M1	80	5.8	500
M2 M3	60	5.0	700
N1	80	5.0	700
N2 N3	60	5.0	700

Table 3. Secondary / residual braking efficiency

Category	V (km/h)	Secondary braking (m/s ²)	Residual braking (m/s ²)
M1	80	2.9	1.7
M2	60	2.5	1.5
M3	60	2.5	1.5
N1	70	2.2	1.3
N2	50	2.2	1.3
N3	40	2.2	1.3

47.6 Test requirements:

47.6.1 General provisions

47.6.1.1 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.

47.6.1.2 Before the test begins, the tire pressures shall be as prescribed by the manufacturer for the load specified in paragraph 47.6.1 above when the vehicle is stationary.

47.6.1.3 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.

47.6.2 Provisions for motor vehicles

47.6.2.1 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:

47.6.2.1.1 Vehicles of category symbol M1: 50 km/h.

47.6.2.1.2 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).

47.6.2.2 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.

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

47.6.2.4 The measurement of steering effort on motor vehicles with intact steering equipment: 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 1 below for the particular category of vehicle with intact steering. One steering movement shall be made to the right and one to the left.

47.6.2.5 The measurement of steering efforts on motor vehicles with a failure in the steering equipment: The test described in paragraph 47.6.2.4 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 1 below for the particular category of vehicle with a failure in the steering equipment. One steering movement shall be made to the right and one to the left.

47.6.3 Provisions for trailers:

47.6.3.1 The trailer must travel without excessive deviation or unusual vibration in its steering equipment when the towing vehicle is 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.

47.6.3.2 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 47.6.3.1. However, for trailers with self-tracking steering equipment a test under paragraph 6.3.1. is not necessary if the axle load ratio between the unsteered 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 unsteered or articulated steered axles and friction-steered axles shall be at least 1 under all loading conditions.

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47.6.4 Vehicle equipped with assistance steering equipment (ASE)

47.6.4.1 Malfunction or failure of any part of the ASE (except for parts not considered to be susceptible to breakdown as specified in paragraph 47.5.1.9.1 shall not result in a sudden significant change in vehicle behavior and the requirements of paragraph 47.6.2.1 to 47.6.2.3 and 47.6.2.5 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:

47.6.4.1.1 Transient test

47.6.4.1.2 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.

47.6.5 Advanced driver assistance steering systems:

47.6.5.1 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."

47.6.5.2 Whenever the Automatically Commanded Steering function becomes operational, this shall be indicated to the driver and the control action shall be automatically disabled if the vehicle speed exceeds the set limit of 10 km/h by more than 20 per cent or the signals to be evaluated are no longer being received. Any termination of control shall produce a short but distinctive driver warning by a visual signal and either an acoustic signal or by imposing a tactile warning signal on the steering control.

47.6.6 Energy supply:

47.6.6.1 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 below:

47.6.6.1.1 The maximum permitted steering time and the maximum permitted steering control effort with intact steering equipment are as specified in paragraph 47.6.2.4 for each category of vehicle.

47.6.6.1.2 The maximum permitted steering time and the maximum permitted steering control effort with a failure in the steering equipment are as specified in paragraph 47.6.2.5 for each category of vehicle.

47.6.7 Warning signals:

47.6.7.1 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 47.5.1.1.1 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.

47.6.7.2 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.