FINALIZED DRAFT

AUTOMOTIVE INDUSTRY STANDARD

Automotive Vehicles —Steering Equipments — method of evaluation

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INTRODUCTION

The Government of India felt the need for a permanent agency to expedite the publication of standards and development of test facilities in parallel when the work on the preparation of the standards is going on, as the development of improved safety critical parts can be undertaken only after the publication of the standard and commissioning of test facilities. To this end, the erstwhile Ministry of Surface Transport (MOST) has constituted a permanent Automotive Industry Standards Committee (AISC) vide order No. RT-11028/11/97-MVL dated September 15, 1997. The standards prepared by AISC will be approved by the permanent CMVR Technical Standing Committee (CMVR-TSC). After approval, the Automotive Research Association of India, (ARAI), Pune, being the Secretariat of the AIS Committee, will publish this standard. For better dissemination of this information ARAI may publish this document on their Website.

Based on the discussion in the 66th meeting of AISC held on 14th July, 2021, Committee agreed to formulate an Automotive Industry Standard (AIS) for type approval procedure for Automated Command Steering Functions (ACSF), as defined in this standard. The purpose of this Standard is to establish uniform provisions for Automated Command Steering Functions (ACSF) fitted to motor vehicles of categories M, N and T primarily used under Autonomous driving conditions. The vehicles equipped with ACSF will be beneficial especially in the field of Autonomous driving situations. ACSF would control the lateral and longitudinal movement of the vehicle for extended periods without further driver command. ACSF is a system whereby the driver remains in primary control of the vehicle but may be helped by the steering system being influenced by signals initiated on-board, the vehicle is defined as "Advanced Driver Assistance Steering Systems". Such systems can incorporate an "Automatically Commanded Steering Function", for example, using passive infrastructure features to assist the driver in keeping the vehicle on an ideal path (Lane Guidance, Lane Keeping or Heading Control), to assist the driver in maneuvering the vehicle at low speed in confined spaces or to assist the driver in coming to rest at a pre-defined point (Bus Stop Guidance).

Advanced Driver Assistance Steering Systems can also incorporate a "Corrective Steering Function" that, for example, warns the driver of any deviation from the chosen lane (Lane Departure Warning), corrects the steering angle to prevent departure from the chosen lane (Lane Departure Avoidance) or corrects the steering angle of one or more wheels to improve the vehicle's dynamic behavior or stability. In the case of any Advanced Driver Assistance Steering System, the driver can, at all times, choose to override the assistance function by deliberate action, for example, to avoid an unforeseen object in the road. It is anticipated that future technology will also allow steering to be influenced or controlled by sensors and signals generated either on or off-board the vehicle. This has led to several concerns regarding responsibility for the primary control of the vehicle and the absence of any internationally agreed data transmission protocols with respect to off-board or external control of steering. Therefore, the Standard does not permit the general approval of systems that incorporate functions by which the steering can be controlled by external signals, for example, transmitted from roadside beacons or active features embedded into the road surface. Such systems, which do not require the presence of a driver, have been defined as "Autonomous Steering Systems". This Regulation also prevents the approval of positive steering of trailers by means of electrical control from the towing vehicle as there are currently no standards applicable to this application.

For preparation of this standard considerable assistance is derived from UNR 79 Revision 4 Amendment 6 (04 series of amendments – date of entry into force 7th January 2022)

The AISC panel and the Automotive Industry Standards Committee (AISC) responsible for preparation of this standard are given in Annexure-H and Annexure-I respectively

Automotive Vehicles — Steering Equipment — method of evaluation

	Automotive Vehicles — Steering Equipment's— Method of Evaluation	
1.0	**SCOPE**	
1.1	This standard specifies the method of evaluation of steering efforts of automotive vehicles. This standard applies to the steering equipment of vehicles of categories M, N and T as defined in IS 14272: 2011 'Automotive Vehicles – Types – Terminology, as amended from time to time.	
1.2	This standard does not apply to,	
1.2.1	Steering equipment with a purely pneumatic transmission;	
1.2.2	Autonomous steering systems as defined in 3.3.3;	
1.2.3	Full power steering systems fitted to trailers where the energy necessary for operation is transmitted from the towing vehicle; and	
1.2.4	The electrical control of full power steering systems fitted to trailers, other than additional steering equipment as defined in 3.5.2.4.	
1.2.5	Steering systems exhibiting the functionality defined, as ACSF of Category B2, D or E, in clause 3.3.4.1.3.,3.3.4.1.5., or 3.3.4.1.6, respectively, until specific provisions are introduced in this Standard.	
2.0	**REFERENCES**	
	The following standards contain provisions, which through reference in this text, constitute provisions of the standard. At the time of publication, the edition indicated were valid. All standards are subject to revision and parties to agreements based on this standard are encouraged to investigate the possibility of applying the most recent editions of the standard indicated below:	
	IS No	Title
	7079 : 2008	Automotive vehicles — Brake hose assemblies for hydraulic braking systems used with non-petroleum base brake fluid — Specification (third revision)
	14272 : 2011	Automotive vehicles — Types — Terminology
	ISO 2575 : 2004	Road vehicles — Symbols for controls, indicators and tell-tales
3.0	**DEFINITIONS**	
	For the purposes of this standard the following definitions shall apply.	
3.1	**Approval of a Vehicle,**	
	Means the approval of a vehicle type with regard to its steering equipment	
3.2	**Vehicle Type**	
	Means the vehicle, which does not differ with respect to the manufacturer's designation of the vehicle type and in essential characteristics, such as type of steering equipment, steering control, steering transmission, steered wheels, and energy source.	

3.3	**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 steering control, steering transmission, steered wheels and the energy supply, if any.
3.3.1	**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.
3.3.2	**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 standard, 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.
3.3.2.1	**Control transmission**
	Means all components by means of which signals are transmitted for control of the steering equipment.
3.3.2.2	**Energy transmission**
	Means all components by means of which the energy required for control/ Standard of the steering function of the wheels is transmitted.
3.3.3	**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.
3.3.4	**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:
3.3.4.1	**Automatically commanded steering function**
	Means the function within a complex 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 continuous control action in order to assist the driver.

3.3.4.1.1	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 maneuvering.
3.3.4.1.2	"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.
3.3.4.1.3	"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.
3.3.4.1.4	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.
3.3.4.1.5	"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.
3.3.4.1.6	"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."
3.3.4.2	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:
	(a) To compensate a sudden, unexpected change in the side force of the vehicle; or
	(b) To improve the vehicle stability (e.g. side wind, differing adhesion road conditions "μ-split"); or
	(c) To correct lane departure. (e.g. to avoid crossing lane markings, leaving the road)."
3.3.4.3	Emergency Steering Function (ESF)" means a control function which can automatically detect a potential collision and automatically activate the vehicle steering system for a limited duration, to steer the vehicle with the purpose of avoiding or mitigating a collision, with
	(a) Another vehicle driving* in an adjacent lane:
	(i) Drifting towards the path of the subject vehicle and/or;
	(ii) Into which path the subject vehicle is drifting and/or;
	(iii) Into which lane the driver initiates a lane change manoeuver.
	(b) An obstacle obstructing the path of the subject vehicle or when the obstruction of the subject vehicle's path is deemed imminent.
	ESF shall cover one or more use cases from the list above.
	* The vehicle may be driving in the same or the opposite direction as the subject vehicle.

3.3.4.4	Remote Control Maneuvering (RCM)" means a function actuated by the driver that provides direct control on steering angle, acceleration, and deceleration for low speed maneuvering. The actuation is made by a remote control device in close proximity to the vehicle."
3.3.4.5	"Specified maximum RCM operating range (SRCMmax)" means the maximum distance between the nearest point of the motor vehicle and the remote-control device up to which RCM is designed to operate."
3.3.4.5	"Risk Mitigation Function (RMF)" means an emergency function which can, in the event the driver becomes unresponsive, automatically activate the vehicle steering system for a limited duration to steer the vehicle with the purpose of bringing the vehicles to a safe stop within a target stop area.
3.3.5	**Steered Wheels**
	Means the wheels the alignment of which may be altered directly or indirectly in relation to the longitudinal axis of the vehicle in order to determine the direction of movement of the vehicle (the steered wheels include the axis around which they are rotated in order to determine the direction of movement of the vehicle).
3.3.6	**Energy Supply**
	Includes those parts of the steering equipment, which provide it with energy, regulate that 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 or its drive to the energy source.
3.3.6.1	**Energy source**
	Means the part of the energy supply, which provides the energy in the required form.
3.3.6.2	**Energy reservoir**
	Means that part of the energy supply in which the energy provided by the energy source is stored, for example, a pressurized fluid reservoir or vehicle battery.
3.3.6.3	**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.
3.4	**Steering Parameters**
3.4.1	**Steering Control Effort**
	Means the force applied to the steering control in order to steer the vehicle.
3.4.2	**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.
3.4.3	**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.
3.4.4	**Steering Forces**
	Mean all the forces operating in the steering transmission
3.4.5	**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
3.4.6	**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 devices for indirect vision and the front direction indicators, when the vehicle is driven in a circle;"
3.4.7	**Nominal Radius of Steering Control**
	Means in the case of a steering wheel the shortest dimension from its center of rotation to the outer edge of the rim. In the case of any other form of control it means the distance between its center 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.
3.4.8	Remote Controlled Parking (RCP)" means an ACSF of category A, actuated by the driver, providing parking or low speed maneuvering. The actuation is made by remote control in close proximity to the vehicle.
3.4.9	"Specified maximum RCP operating range (SRCPmax)" 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.
3.4.10	Specified maximum speed Vsmax " means the maximum speed up to which an ACSF is designed to operate.
3.4.11	Specified minimum speed Vsmin" means the minimum speed down to which an ACSF is designed to operate.
3.4.12	"Specified maximum lateral acceleration aysmax" means the maximum lateral acceleration of the vehicle up to which an ACSF is designed to operate."
3.4.13	An ACSF is in "off mode" (or "switched off") when the function is prevented from generating a steering control action to assist the driver.
3.4.14	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.
3.4.15	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."

3.4.16	A "Lane Change Procedure" starts when the direction indicator lamps are activated and ends when the direction indicator lamps are deactivated. It comprises the following operations:
	(a) Activation of the direction indicator lamps;
	(b) Lateral movement of the vehicle towards the lane boundary;
	(c) Lane Change Manoeuvre;
	(d) Resumption of the lane keeping function;
	(e) Deactivation of direction indicator lamps."
3.4.17	A "Lane Change Manoeuvre" is part of the Lane Change Procedure and,
	(a) Starts when the outside edge of the tyre tread of the vehicle's front wheel closest to the lane markings touches the inside edge of the lane marking to which the vehicle is being maneuvered,
	(b) Ends when the rear wheels of the vehicle have fully crossed the lane marking."
3.4.19	"Target stop area" means a potential stopping area (e.g. emergency lane, hard shoulder, beside the road, slowest lane of traffic, own lane of travel)."
3.4.20	"Beside the road" means the area of road surface beyond the boundaries of the carriageway which is not a hard shoulder or refuge area."
3.5	**Types of Steering Equipment**
	Depending on the way the steering forces are produced, the following types of equipment are distinguished:
3.5.1	**For Motor Vehicles**
3.5.1.1	Main steering system, means the steering equipment of a vehicle, which is mainly responsible for determining the direction of travel. It may comprise:
3.5.1.1.1	Manual steering equipment, in which the steering forces result solely from the muscular effort of the driver.
3.5.1.1.2	Power assisted steering equipment, in which the steering forces result from both the muscular effort of the driver and the energy supply (supplies). 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.
3.5.1.1.3	Full-power steering equipment, in which the steering forces are provided solely by one or more energy supplies

3.5.1.2	**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.
3.5.1.3	**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 behavior.
3.5.2	For Trailers
3.5.2.1	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.
3.5.2.2	**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 firmly linked to the relative angle between the longitudinal axis of the towing vehicle and that of the trailer
3.5.2.3	**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.
3.5.2.4	**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 maneuvering purposes.
3.5.2.5	"Full-power steering equipment" means equipment in which the steering forces are provided solely by one or more energy supplies;
3.5.3	**Steering Equipment**
	Depending on the arrangement of the steered wheels, the following types of steering equipment are distinguished:
3.5.3.1	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.
3.5.3.2	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.

3.5.3.3	Multi-wheel steering equipment, in which the wheels of one or more of each of the front and the rear axle(s) are steered.
3.5.3.3.1	All-wheel steering equipment, in which all the wheels are steered
3.5.3.3.2	Buckle steering equipment, in which the movement of chassis parts relative to each other is directly produced by the steering forces.
3.6	**Types of Steering Transmission**
	Depending on the way the steering forces are transmitted, the following types of steering transmission are distinguished:
3.6.1	**Purely Mechanical Steering Transmission**
	Means a steering transmission in which the steering forces are transmitted entirely by mechanical means.
3.6.2	**Purely Hydraulic Steering Transmission**
	Means a steering transmission in which the steering forces, somewhere in the transmission, are transmitted only by hydraulic means.
3.6.3	**Purely Electric Steering Transmission**
	Means a steering transmission in which the steering forces, somewhere in the transmission, are transmitted only through electric means.
3.6.4	**Hybrid Steering Transmission**
	Means a steering transmission in which part of the steering forces are 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.
3.7	**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.
4.0	**CONSTRUCTION PROVISIONS**
4.1	**General Provisions**
4.1.1	The steering equipment shall ensure easy and safe handling of the vehicle up to its maximum design speed or in case of a trailer up to its technically permitted maximum speed. There must be a tendency to self-center when tested in accordance with clause 5.2 with the intact steering equipment. The vehicle shall meet the requirements of clause 5.2 in the case of motor vehicles and of clause 5.3 in the case of trailers. If a vehicle is fitted with an Auxiliary Steering system (ASE), it shall also meet the requirements of Annex B. Trailers equipped with hydraulic steering transmissions shall also comply with Annex C.

4.1.2	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 the maximum design speed of the vehicle.
4.1.3	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 Manoeuvre at speeds up to a maximum speed of 15km/h and when the system is not energized.
4.1.4	The steering equipment shall be designed, constructed and fitted in such a way 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 for the purpose of this standard, 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.
4.1.5	The effectiveness of the steering equipment, including the electrical control lines, shall not be adversely affected by magnetic or electric fields. This shall be demonstrated by fulfilling the technical requirements of AIS-004 (Part 3), as amended from time to time.
4.1.6	Advanced driver assistance steering systems shall only be approved in accordance with this standard 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.
4.1.6.1	ACSF system shall be subject to the requirements of Annex D.
4.1.6.1.1	Every CSF intervention shall immediately be indicated to the driver by an optical warning signal which is displayed for at least 1 s or as long as the intervention exists, whichever is longer.
	When a flashing mode is used, a lighting phase shall be visible at the end of the intervention or later.
	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 AIS or IS Standard (i.e. AIS 150, AIS 151 or IS 15986:2015 or AIS 133, as applicable**)** the ESC flashing telltale indicating the interventions of ESC may be used, as long as the intervention exists, as an alternative to the optical warning signal specified above.
4.1.6.1.2	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:
4.1.6.1.2.1	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
4.1.6.1.2.2	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.
4.1.6.1.2.3	For vehicles of categories M2 and M3 equipped with a Lane Departure Warning System (LDWS), fulfilling the technical requirements of AIS 188 for LDWS, the acoustic warning signal specified in clause 4.1.6.1.2.1. and 4.1.6.1.2.2. may be replaced by a haptic warning, provided it is not solely given via the steering wheel."
4.1.6.1.3	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.
4.1.6.1.4	The requirements in clause 4.1.6.1.1., 4.1.6.1.2. and 4.1.6.1.3. 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 Annex F of this Standard."
4.1.6.2	Vehicles equipped with an ESF shall fulfil the following requirements.
	An ESF system shall be subject to the requirements of Annex D.
4.1.6.2.1	Any ESF shall only start an intervention in the case where a risk of a collision is detected.
4.1.6.2.2	Any vehicle fitted with ESF shall be equipped with means to monitor the driving environment (e.g. lane markings, road edge, other road users) in line with the specified use case. These means shall monitor the driving environment at any time the ESF is active.
4.1.6.2.3	An automatic avoidance manoeuvre initiated by an ESF shall not lead the vehicle to leave the road.
4.1.6.2.3.1	In the case of an ESF intervention on a road or a lane delimited with lane markings on one or both side(s), an automatic avoidance manoeuver initiated by an ESF shall not lead the vehicle to cross a lane marking. However, if the intervention starts during a lane change performed by the driver or during an unintentional drift into the adjacent lane, the system may steer the vehicle back into its original lane of travel.
4.1.6.2.3.2	In the absence of a lane marking on one or on both side(s) of the vehicle, a single ESF intervention is permitted, provided that it does not produce a lateral offset of the vehicle greater than 0.75 m in a direction where the lane marking is absent. The lateral offset during the automatic avoidance manoeuvre shall be determined using a fixed point on the front of the vehicle at the start and at the conclusion of the ESF intervention.
4.1.6.2.4	The ESF intervention shall not lead the vehicle to collide with another road user.*

	* Until uniform test procedures have been agreed, the manufacturer shall provide the Technical Service with documentation and supporting evidence to demonstrate compliance with this provision. This information shall be subject to discussion and agreement between the Technical Service and the vehicle manufacturer.
4.1.6.2.5	The manufacturer shall demonstrate during type approval, to the satisfaction of the Technical Service, which means to monitor the driving environment are fitted to the vehicle to satisfy the provisions in the subparagraphs of Clause 4.1.6.2. above.
4.1.6.2.6	Any intervention of an ESF shall be indicated to the driver with an optical and with an acoustic or haptic warning signal to be provided at the latest with the start of the ESF intervention and maintained as long as the intervention exists.
	For this purpose appropriate signals used by other warning systems (e.g. blind spot detection, lane departure warning, forward collision warning) are deemed to be sufficient to fulfil the requirements for the respective optical, acoustic or haptic signals above
4.1.6.2.7	A system failure shall be indicated to the driver with an optical warning signal. However, when the system is manually deactivated, the indication of failure mode may be suppressed.
4.1.6.2.8	The steering control effort necessary to override the directional control provided by the system shall not exceed 50 N.
4.1.6.2.9	The vehicle shall be tested in accordance with the relevant vehicle tests specified in Annex F of this Standard
4.1.6.2.10	System information data
	The following data shall be provided, together with the documentation package required in Annex D of this Standard, to the Technical Service at the time of type approval:
	(a) Use case(s) where ESF is designed to operate (among the use cases a i, a ii, a iii and b. specified in the ESF definition in Clause 3.3.4.3.),
	(b) The conditions under which the system is active, e.g. the vehicle speed range V_{smax} , V_{smin},
	(c) How ESF detects a risk of a collision,
	(d) Description of the means to detect the driving environment,
	(e) How to deactivate/reactivate the function,
	(f) How it is ensured that the overriding force does not exceed the limit of 50 N."
4.1.6.3	Vehicles equipped with an RMF shall fulfil the following requirements.
	An RMF system shall be subject to the requirements of Annex D.
4.1.6.3.1	Any RMF shall start an intervention only:

	(a) If the driver is either directly (e.g. through a driver monitoring system) or indirectly (e.g. prolonged failed response to a warning, failure to control the vehicle) assessed to be unresponsive; or
	(b) If it is manually activated.
	If the system provides a means for manual activation, this means shall be protected against unintentional operation and accessible to the driver and to passengers adjacent to the driver.
5.1.6.3.2	Unless a request for action (e.g. hands-on warning) was already given or the system was manually activated, there shall be an optical and additionally an acoustic and/or haptic (e.g. brake jerks) warning signal before every RMF intervention in order to stimulate the driver to take back control.
	This warning phase shall start at least 5 seconds before the RMF starts an intervention, unless vehicle control by the system is required sooner to prevent the vehicle from crossing the lane markings or to keep an appropriate distance to other vehicles.
	Every RMF intervention shall be indicated to the driver by an optical and additionally an acoustic and/or haptic (e.g. brake jerks) warning signal for as long as the intervention exists.
	These warning signals shall be distinct and of a great urgency.
4.1.6.3.3	An RMF intervention shall not unreasonably deactivate or suppress the functionality of activated assistance systems (e.g. AEBS).
4.1.6.3.4	The signal to activate the hazard warning lights shall be generated with the start of the intervention.
4.1.6.3.5	It shall be possible to override the RMF intervention of the function at any time by a distinct action of the driver.
	The RMF shall implement strategies to provide protection against unintentional override by inputs to the driving controls (e.g. by requiring a significant change in a single input to the accelerator or brake pedal or multiple inputs to override the RMF).
	These strategies shall be demonstrated to the Technical Service at the time of type approval.
4.1.6.3.6	During the RMF intervention the vehicle shall slow down with a deceleration demand not greater than 4m/s², unless required by the surrounding traffic (e.g. a decelerating lead vehicle).
	Higher deceleration demand values are also permissible for very short durations, e.g. as haptic warning to stimulate the driver to take back control.
4.1.6.3.7	Once the RMF has brought the vehicle to a safe stop in the target stop area, the vehicle shall not move away without manual input.
4.1.6.3.8	If the RMF system detects any failures preventing it from performing an intervention, this shall be signaled to the driver.
4.1.6.3.9	Additional provisions for systems with the purpose of bringing the vehicle to a safe

	stop outside its own lane of travel.
4.1.6.3.9.1	The RMF shall only be permitted to change lanes, if the vehicle is equipped with detection capabilities to the front, side and rear.
4.1.6.3.9.2	Lane change procedures shall only be performed in an uncritical way as described in clause 4.1.6.3.9.7. and 4.1.6.3.9.8. In case the target stop area cannot be reached in an uncritical way the RMF shall aim to keep the vehicle within its current lane of travel while the vehicle is stopping.
4.1.6.3.9.3	Before initiating a lane change procedure, RMF shall, if deemed appropriate, reduce the vehicle speed to minimize the risk related to that lane change (e.g. by adapting the speed of the vehicle to that of other vehicles in the target lane).
	A lane change procedure shall not start within the first 5s following the start of the RMF intervention.
4.1.6.3.9.4	During the intervention the system may perform a single or multiple lane change(s) across regular lanes of traffic and/or to the hard shoulder. Lane changes shall be made only if under the traffic situation these lane changes can be considered to minimize the risk to safety of the vehicle occupants and other road users.
4.1.6.3.9.5	A lane change during the intervention shall only be performed if the system has sufficient information about its surrounding to the front, side and rear (as defined in clause 4.1.6.3.9.17.) in order to assess the criticality of that lane change.
4.1.6.3.9.6	A lane change during the intervention shall not be performed towards a lane intended for traffic moving in the opposite direction.
4.1.6.3.9.7	The intervention shall not cause a collision with another vehicle or road user in the predicted path of the vehicle during a lane change.
4.1.6.3.9.8	A lane change procedure shall be predictable and manageable for other road users.
4.1.6.3.9.8.1	During the lane change manoeuvre, the RMF shall aim to avoid a lateral acceleration of more than 1 m/s^2 in addition to the lateral acceleration generated by the lane curvature.
4.1.6.3.9.8.2	A lane change manoeuvre shall only be started if a vehicle in the target lane is not forced to unmanageably decelerate due to the lane change of the vehicle.
4.1.6.3.9.8.2.1	During the lane change manoeuvre, RMF shall aim to avoid inducing a longitudinal deceleration of more than 3.7 m/s^2 for a vehicle approaching from the rear.
4.1.6.3.9.8.2.2	A lane change manoeuvre shall only be started if there is sufficient space to a vehicle following behind or approaching from the rear in the adjacent lane.
4.1.6.3.9.8.2.3	In case the RMF decelerates the vehicle during a lane change procedure, this deceleration shall be factored in when assessing the distance to a vehicle approaching from the rear, and the deceleration shall be manageable for the vehicle approaching from the rear.
4.1.6.3.9.8.2.4	Where there is not sufficient headway time for the vehicle behind at the end of the lane change procedure, the RMF shall not increase the rate of deceleration for a certain period of time after the completion of the lane change procedure except for the purpose of avoiding or mitigating the risk of an imminent collision.

4.1.6.3.9.8.2.5	How the provisions of clause 4.1.6.3.9.8.2 and its sub clauses are implemented in the system design shall be demonstrated to the Technical Service during type approval.
4.1.6.3.9.9	The lane change manoeuvre shall aim to be one continuous movement.
4.1.6.3.9.10	A lane change during the intervention shall be completed without undue delay.
4.1.6.3.9.11	A lane change manoeuvre shall only be started if the manoeuvre is anticipated to be completed before the vehicle comes to a standstill (i.e. in order to avoid coming to standstill while in the middle of two regular lanes due to stopped traffic ahead).
4.1.6.3.9.12	Additional provisions for system behaviour for the vehicle's final lane change during a lane change manoeuvre that is bringing the vehicle to a safe stop beside the road.
4.1.6.3.9.12.1	All provisions of clause 4.1.6.3.9. shall be applied except clause 4.1.6.3.9.11, 4.1.6.3.9.13, 4.1.6.3.9.14. and 4.1.6.3. 9.16.
4.1.6.3.9.12.2	The vehicle may come to a standstill on the lane mark beside the road.
4.1.6.3.9.12.3	In addition to the provisions of clause 4.1.6.3.9.7, an acoustic warning may be given as warning to other road users unless traffic rules in the country prohibits using an acoustic warning.
4.1.6.3.9.12.4	When bringing the vehicle to a stop beside the road the vehicle speed shall not exceed 10 km/h.
4.1.6.3.9.13	A lane change manoeuvre during an intervention shall be indicated in advance to other road users by activating the appropriate direction indicator lamps instead of the hazard warning lights.
4.1.6.3.9.14	Once the lane change manoeuvre is completed the direction indicator lamps shall be deactivated in a timely manner, and the hazard warning lights shall become active again.
4.1.6.3.9.15	(Reserved)
4.1.6.3.9.16	Notwithstanding clause 4.1.6.3.9.14, when several consecutive lane changes are performed as part of the RMF intervention, the direction indicator may remain active throughout these lane changes while the lateral behavior shall ensure that each lane change manoeuvre can be perceived as an individual manoeuvre by following traffic.
4.1.6.3.9.17	If the vehicle is equipped with the capability to perform lane changes during the RMF intervention, the manufacturer shall declare the detection ranges to the front, side and rear. The declared ranges shall be sufficient to assess that a change into a lane immediately to the left or to the right of the vehicle does not cause a critical situation with another vehicle or road user during a lane change.
	The Technical Service shall assess the correspondence of declared detection ranges and lane change strategy and shall verify that the vehicle's sensing system detects vehicles during the relevant test in Annex F. These ranges shall be equal or greater than the declared ranges.

4.1.6.3.10	The system shall implement strategies to draw external attention to the emergency situation (e.g. triggering an emergency call, activating the horn, keeping the hazard warning lights active), when the driver remains unresponsive once RMF has brought the vehicle to standstill.
4.1.6.3.11	Special provisions for M2/M3 vehicles
4.1.6.3.11.1	In case the system provides a means for manual activation by a passenger, the RMF system shall provide an indication to this passenger upon activation of the RMF. This indication shall continue until the RMF intervention starts or the activation is overridden by the driver. The driver shall be enabled to override the request from the passenger in order to suppress the RMF intervention.
4.1.6.3.11.2	An RMF fitted to a vehicle of Class I, II or A as defined in the Consolidated Resolution on the Construction of Vehicles (R.E.3) shall provide an acoustic and optical indication to the passengers before the intervention would start.
4.1.6.3.12	System information data
	The following data shall be provided, together with the documentation package required in Annex D of this Regulation, to the Technical Service at the time of type approval:
	(a) Information on how the system confirms that the driver is unresponsive;
	(b) Information on whether the system is capable of performing lane changes and what is considered a target stop area by the system
	(c) Description of the means to detect the driving environment;
	(d) Information/specification on which road types (e.g. motorway, country roads, urban areas, etc.) the system is designed to intervene and how this is ensured;
	(e) Means to override the function and how the system provides protection against unintentional override;
	(f) Description of the driver warning and information concept, including warning before and during an RMF intervention
	(g) In case of lane change capability
	i. A detailed description of the design provisions implemented to ensure safety of the manoeuvre
	ii. The means by which the vehicle detects others road users, obstacles and the target stop area
	iii. Description of how the system selects an appropriate target stop area and a description of the safety criteria on which this selection is based
	(h) Information/specification of the maximum speed the system operates with regards to different traffic environments (highway, urban, etc.) as well as information/specification on how the speed is reduced (e.g. adapted to surrounding traffic; no harsh braking endangering other road users) in order to come to a safe stop."

4.1.7	**Steering Transmission**
4.1.7.1	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.
4.1.7.2	Steering transmission, which can be disconnected to cover different configurations of a vehicle (for example on extendable 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.
4.1.8	**Steered Wheels**
	The steered wheels shall not be solely the rear wheels. This requirement does not apply to semi-trailers.
4.1.9	**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 4.3.
4.1.10	**Control Systems**
	The requirements of Annex D 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 D only in so far 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.
4.1.11	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 Annex G.
4.2	**Special Provisions for Trailers**
4.2.1	Trailers (with the exception of semi-trailers and center-axle trailers) which have more than one axle with steered wheels and semi-trailers and center-axle trailers which have at least one axle with steered wheels must fulfil the conditions given in 5.3. However, for trailers with self-tracking steering equipment a test under 5.3 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.
4.2.2	If the towing vehicle of a vehicle combination is driving straight ahead, 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.

4.3	Failure Provisions and Performance
4.3.1	General
4.3.1.1	For the purposes of this standard, 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.
4.3.1.2	The requirements of 4.1.2, 4.1.3 and 5.2.1 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 clauses. In this case 4.1.3 shall not apply for full power steering systems when the vehicle is stationary.
4.3.1.3	Any failure in a transmission other than purely mechanical must clearly be brought to the attention of the vehicle driver as given in 4.4.
4.3.1.4	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 4.3.2 and 4.3.3 as applicable. In addition the braking performance on the first subsequent application shall not drop below the prescribed service brake performance, as given in Annex A.
4.3.1.5	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 4.3.2 and 4.3.3 as applicable. In addition the braking performance on the first subsequent application shall comply with the requirements of A-3.
4.3.1.6	The requirements for the braking performance in paragraphs 4.3.1.4. and 4.3.1.5. 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:
	(a) Clause B-2.2. of IS Standard No. 15986:2015, Annex B or Clause B- 2.2. of AIS-151, Annex B (for M1-, N1- vehicles) as applicable.
	(b) Clause C-2.2. of IS Standard No. 11852:2013, Annex C or Clause C-2.2 of AIS 150, Annex C (for M2-, M3-, N vehicles) as applicable
4.3.2	Power Assisted Steering Systems
4.3.2.1	Should the engine stop or a part of the transmission fail, with the exception of those parts listed in 4.3.1.1. 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 5, relating to a system with a failure, shall be met.
4.3.3	Full Power Steering Systems

4.3.3.1	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 4.4.2.1.
4.3.3.2	In case of a failure within the control transmission, with the exception of those parts listed in 4.1.4, it shall still be possible to steer with the performance laid down in 7 for the intact steering system.
4.3.3.3	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 5. The test manoeuvres shall begin at an energy storage level given in 4.3.3.5.
4.3.3.4	In the event of a failure within the energy transmission, with the exception of those parts listed in 4.3.1.1, 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 5 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 4.3.3.5.
4.3.3.5	The energy level to be used for the tests referred to in 4.3.3.3 and 4.3.3.4 shall be the energy storage level at which a failure is indicated to the driver. In the case of electrically powered systems subject to Annex D, this level shall be the worst case situation outlined by the manufacturer in the documentation submitted in connection with Annex D and shall take into account the effects of, for example temperature and ageing on battery performance.
4.4	Warning Signals
4.4.1	General Provisions
4.4.1.1	Any fault which impairs the steering function and is not mechanical in nature must be signaled clearly to the driver of the vehicle. Despite the requirements of 4.1.2 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.
4.4.1.2	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.
4.4.1.3	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.
4.4.1.4	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 language(s) of the market into which the vehicle is sold.	
	Acoustic warning signals shall be easily recognized by the driver."	
4.4.2	Special Provisions for Full-Power Steering Equipment	
4.4.2.1	Power-driven vehicles shall be capable of providing steering failure and defect warning signals, as follows:	
	a)	A red warning signal, indicating failures defined in clause 4.3.1.3 within the main steering equipment.
	b)	Where applicable, a yellow warning signal indicating an electrically detected defect within the steering equipment, which is not indicated by the red warning signal.
	c)	If a symbol is used, it must comply with Symbol J 04, ISO/IEC registration number 7000-2441 as defined in ISO 2575.
	d)	The warning signal(s) mentioned above shall light up when the electrical equipment of the vehicle (and the steering system) is energized. 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.
4.4.3	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.	
4.5	Provisions for the periodic technical inspection of steering equipment	
4.5.1	As far as practicable and subject to agreement between the vehicle manufacturer and the type approval authority, the steering equipment and its installation shall be so designed that, without disassembly, its operation can be checked with, if necessary, commonly used measuring instruments, methods or test equipment.	
4.5.2	It must be possible to verify in a simple way the correct operational status of those Electronic Systems, which have control over steering. If special information is needed, this shall be made freely available.	
4.5.2.1	At the time of Type Approval the means implemented to protect against simple unauthorized modification to the operation of the verification means chosen by the manufacturer (e.g. warning signal) shall be confidentially outlined.	
	Alternatively this protection requirement is fulfilled when a secondary means of checking the correct operational status is available.	
4.6	Provisions for ACSF	
	Any ACSF shall be subject to the requirements of Annex D	

4.6.1	Special Provisions for ACSF of Category A
	Any ACSF of Category A shall fulfil the following requirements
4.6.1.1	General
4.6.1.1.1	The system shall only operate until 10 km/h (+2 km/h tolerance)
4.6.1.1.2	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).
4.6.1.1.3	The system shall be able to be deactivated by the driver at any time
4.6.1.1.4	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 maneuvering area and to bring the vehicle immediately to a stop to avoid a collision.*
	*Until uniform test procedures have been agreed, the manufacturer shall provide the testing agency the documentation and supporting evidence to demonstrate compliance with these provisions. This information shall be subject to discussion and agreement between the testing agency and vehicle manufacturer.
4.6.1.1.5	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 maneuvering). 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.
4.6.1.2	Additional provisions for RCP
4.6.1.2.1	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.
4.6.1.2.2	A continuous actuation of the remote control device by the driver is required during the parking manoeuvre.
4.6.1.2.3	If the continuous actuation is interrupted or the distance between vehicle and remote control device exceeds the specified maximum RCP operating range (SRCPmax) or the signal between remote control and vehicle is lost, the vehicle shall stop immediately.
4.6.1.2.4	If a door or trunk of the vehicle is opened during the parking manoeuvre, the vehicle shall stop immediately.
4.6.1.2.5	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.
4.6.1.2.6	At any time during a parking manoeuvre that the vehicle becomes stationary, the

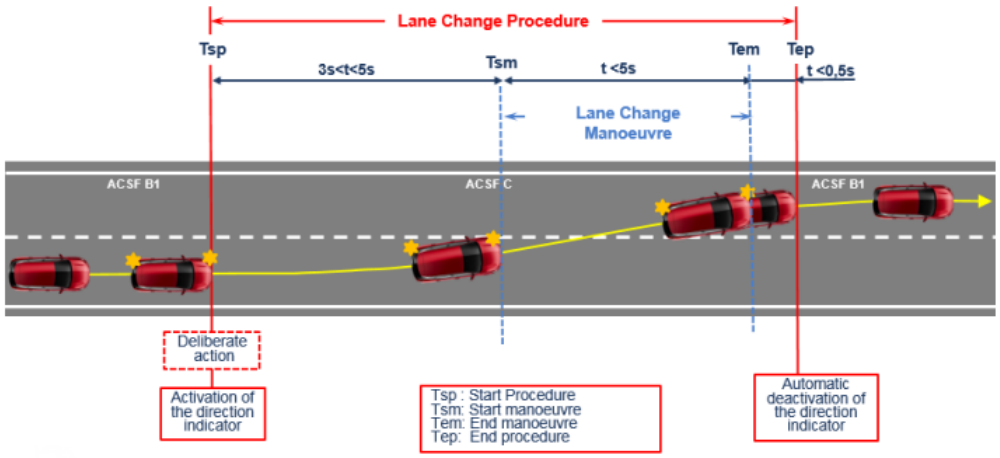
	RCP function shall prevent the vehicle from rolling away.
4.6.1.2.7	The specified maximum RCP operating range shall not exceed 6m.
4.6.1.2.8	The system shall be designed to be protected against unauthorized activation or operation of the RCP systems and interventions into the system.
4.6.1.3	System information data
4.6.1.3.1	Following data shall be provided together with the documentation package required in Annex D of this Standard to the Technical Service at the time of type approval:
4.6.1.3.1.1	The value for the specified maximum RCP operating range ($SRCP_{max}$);
4.6.1.3.1.2	The conditions under which the system can be activated, i.e. when the conditions for operation of the system are fulfilled;
4.6.1.3.1.3	For RCP systems the manufacturer shall provide the technical authorities with an explanation how the system is protected against unauthorized activation.
4.6.2	Special Provisions for ACSF of Category B1
	Any ACSF of Category B1 shall fulfil the following requirements.
4.6.2.1	General
4.6.2.1.1	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 $ay_{smax.}$
	It is recognized that the maximum lateral acceleration specified by the vehicle manufacturer ay_{smax} may not be achievable under all conditions (e.g. inclement weather, different tyres fitted to the vehicle, laterally sloped roads). The system shall not deactivate or unreasonably switch the control strategy in these other conditions 2.4
	The system may exceed the specified value ay_{smax} by not more than 0.3 m/s^2, while not exceeding the maximum value specified in the table in Clause 4.6.2.1.3. of this Standard.
	Notwithstanding the sentence above, for time periods of not more than 2 s the lateral acceleration of the system may exceed the specified value ay_{smax} by not more than 40 per cent, while not exceeding the maximum value specified in the table in Clause 4.6.2.1.3. of this Standard by more than 0.3 m/s2 .
4.6.2.1.2	The vehicle shall be equipped with a means for the driver to activate (standby 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.
4.6.2.1.3	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 behavior, during its operation. To ensure this, the following requirements shall be fulfilled:

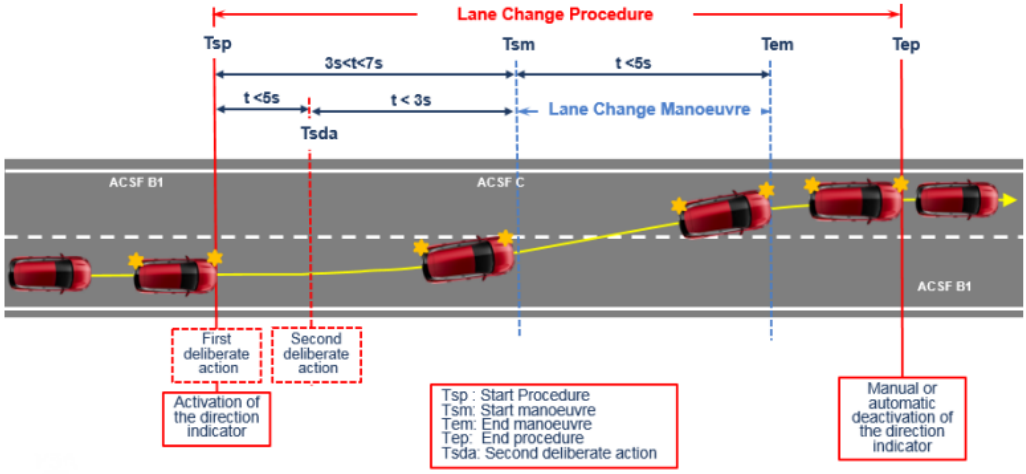
<table>
<tr><td></td><td colspan="5">(a) The steering control effort necessary to override the directional control provided by the system shall not exceed 50 N;</td></tr>
<tr><td></td><td colspan="5">(b) The specified maximum lateral acceleration ay_{smax} shall be within the limits as defined in the following table:</td></tr>
<tr><td></td><td colspan="5">For vehicles of category M1, N1</td></tr>
<tr><td></td><td>Speed Range</td><td>10-60 km/h</td><td>>60-100 km/h</td><td>>100-130 km/h</td><td>>130 km/h</td></tr>
<tr><td></td><td>Maximum value for the specified maximum lateral acceleration</td><td>3 m/s^2</td><td>3 m/s^2</td><td>3 m/s^2</td><td>3 m/s^2</td></tr>
<tr><td></td><td>Minimum value for the specified maximum lateral acceleration</td><td>0 m/s^2</td><td>0.5 m/s^2</td><td>0.8 m/s^2</td><td>0.3 m/s^2</td></tr>
<tr><td></td><td colspan="5">For vehicles of category M2, M3, N2, N3</td></tr>
<tr><td></td><td>Speed Range</td><td>10-30Km/h</td><td>>30-60 km/h</td><td>>60 km/h</td><td></td></tr>
<tr><td></td><td>Maximum value for the specified maximum lateral acceleration</td><td>2.5 m/s^2</td><td>2.5 m/s^2</td><td>2.5 m/s^2</td><td></td></tr>
<tr><td></td><td>Minimum value for the specified maximum lateral acceleration</td><td>0 m/s^2</td><td>0.3 m/s^2</td><td>0.5 m/s^2</td><td></td></tr>
<tr><td></td><td colspan="5">(c) The moving average over half a second of the lateral jerk generated by the system shall not exceed 5 m/s^3.</td></tr>
<tr><td>4.6.2.1.4</td><td colspan="5">The requirements in clauses 4.6.2.1.1. and 4.6.2.1.3. of this Standard shall be tested in accordance with relevant vehicle test(s) specified in Annex F of this Standard.</td></tr>
<tr><td>4.6.2.2</td><td colspan="5">ACSF of Category B1 operation</td></tr>
<tr><td>4.6.2.2.1</td><td colspan="5">If the system is active an optical signal shall be provided to the driver.</td></tr>
<tr><td>4.6.2.2.2</td><td colspan="5">When the system is in standby mode, an optical signal shall be provided to the driver.</td></tr>
<tr><td>4.6.2.2.3</td><td colspan="5">When the system reaches its boundary, conditions set out in Clause 4.6.2.3.1.1. of this Standard (e.g. the specified maximum lateral acceleration ay_{smax}) 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</td></tr>
</table>

	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 AIS 188.
4.6.2.2.4	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.
4.6.2.2.5	When the system is active and in the speed range between 10 km/h or V_{smin}, whichever is higher, and $V_{smax,}$ 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:
	 Example 1. Example 2.
	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 Annex F of this Standard.
4.6.2.2.6	Unless otherwise specified, the optical signals described in 4.6.2.2. shall all be different from each other (e.g. different symbol, color, blinking, text).
4.6.2.3	System information data
4.6.2.3.1	Following data shall be provided together with the documentation package required in Annex D of this Standard to the Technical Service at the time of type approval;

4.6.2.3.1.1	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 Clause 4.6.2.1.3, of this Standard;
4.6.2.3.1.2	Information about how the system detects that the driver is holding the steering control.
4.6.2.3.1.3	Information about inputs other than lane markings (e.g. road boundaries, infrastructural separation, surrounding traffic, map data) that the system uses to reliably determine the course of the lane.
4.6.3	**(Reserved for ACSF of Category B2)**
4.6.4	Special Provisions for ACSF of Category C
	Vehicles equipped with an ACSF system of Category C shall fulfil the following requirements
4.6.4.1	General
4.6.4.1.1	A vehicle equipped with an ACSF of Category C shall also be equipped with an ACSF of Category B1 complying with the requirements of this Standard.
4.6.4.1.2	When the ACSF of Category C is
	in standby mode, the ACSF of Category B1 shall aim to center the vehicle in the lane, unless a different position in lane is deemed reasonable due to the situation or resulting from driver input (e.g. when another vehicle is driving close beside).
	This shall be demonstrated by the vehicle manufacturer to the Technical Service during type approval.
4.6.4.2	Activation/deactivation of the ACSF of Category C system
4.6.4.2.1	The default status of the system shall be off at the initiation of each new engine start/run cycle.
	This requirement does not apply when a new engine start/run cycle is performed automatically, e.g. the operation of a stop/start system.
4.6.4.2.2	The vehicle shall be equipped with a means for the driver to activate (standby mode) and deactivate (off mode) the system. The same means as for an ACSF of Category B1 may be used.
4.6.4.2.3	The system shall only be activated (standby mode) after a deliberate action by the driver.
	Activation by the driver shall only be possible on roads where pedestrians and cyclists are prohibited and which, by design, are equipped with a physical separation that divides the traffic moving in opposite directions and which have at least two lanes in the direction the vehicles are driving. These conditions shall be ensured by the use of at least two independent means.
	In the case of a transition from a road type with a classification permitting an ACSF of Category C, to a type of road where an ACSF of Category C is not permitted, the system shall be deactivated automatically (off mode), unless a missing second

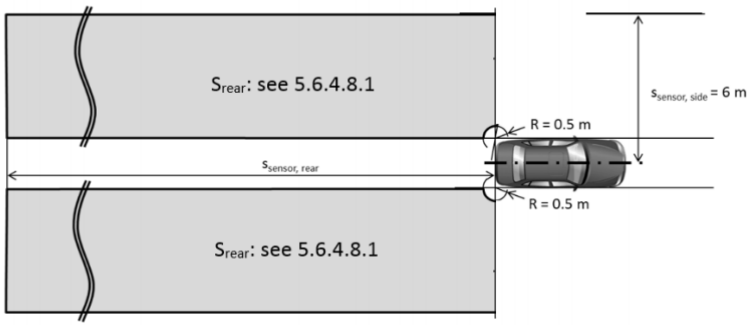
	lane in driving direction is the only condition not fulfilled from the above (e.g. connector between two highways).
4.6.4.2.4	It shall be possible to deactivate the system (off mode) at any time by a single action of the driver. Following this action, the system shall only be able to be reactivated (standby mode) by a deliberate action of the driver.
4.6.4.2.5	Notwithstanding the requirements above it shall be possible to perform the corresponding tests in Annex F of this Standard on a test track.
4.6.4.3	Overriding
	A steering input by the driver shall override the steering action of the system. The steering control effort necessary to override the directional control provided by the system shall not exceed 50 N.
	The system may remain active, provided that priority is given to the driver during the overriding period.
4.6.4.4	Lateral acceleration
	The lateral acceleration induced by the system during the lane change manoeuvre:
	(a) Shall not exceed 1 m/s^2 in addition to the lateral acceleration generated by the lane curvature, and
	(b) Shall not cause the total vehicle lateral acceleration to exceed the maximum values indicated in tables of Clause 4.6.2.1.3, above.
	The moving average over half a second of the lateral jerk generated by the system shall not exceed 5 m/s^3.
4.6.4.5	Human Machine Interface (HMI)
4.6.4.5.1	Unless otherwise specified, the optical signals identified in Clause 4.6.4.5, shall be easily distinguishable from each other (e.g. different symbol, color, blinking, text).
4.6.4.5.2	When the system is in standby mode (i.e. ready to intervene), an optical signal shall be provided to the driver.
4.6.4.5.3	When the lane change procedure is ongoing an optical signal shall be provided to the driver.
4.6.4.5.4	When the lane change procedure is suppressed, in accordance with Clause 4.6.4.6.8, the system shall clearly inform the driver about this system status by an optical warning signal and additionally by an acoustic or haptic warning signal. In case the suppression is initiated by the driver, an optical warning is sufficient.
4.6.4.5.5	A system failure shall be signaled immediately to the driver by an optical warning signal. However, when the system is manually deactivated by the driver, the indication of failure mode may be suppressed.
	If a system failure occurs during a lane change manoeuvre, the failure shall be signaled to the driver by an optical, and an acoustic or haptic warning.
4.6.4.5.6	The system shall provide a means of detecting that the driver is holding the steering control and shall warn the driver in accordance with the warning strategy below:

	If, after a period of no longer than 3s after the initiation of the lane change procedure and before the start of the lane change manoeuvre, the driver is not holding the steering control, an optical warning signal shall be provided. This signal shall be the same as the signal specified in Clause 4.6.2.2.5, above.
	The warning signal shall be active until the driver is holding the steering control, or until the system is deactivated, either manually or automatically according to clause 4.6.4.6.8.
4.6.4.6	Lane Change Procedure
4.6.4.6.1	The initiation of a lane change procedure of an ACSF of Category C shall only be possible if an ACSF of Category B1 is already active.
4.6.4.6.2	The lane change procedure requires, and shall start immediately after, a manual activation by the driver of the direction indicator to the intended side for the lane change.
4.6.4.6.3	When the lane change procedure starts, the ACSF of Category B1 shall be suspended and the ACSF of Category C shall carry on the lane keeping function of ACSF of category B1, until the lane change manoeuvre starts.
4.6.4.6.4	The lateral movement of the vehicle towards the intended lane shall not start earlier than 1.0 second after the start of the lane change procedure. Additionally, the lateral movement to approach the lane marking and the lateral movement necessary to complete the lane change manoeuvre, shall be completed as one continuous movement.
	The lane change manoeuvre shall be initiated either automatically or by a second deliberate action of the driver. A vehicle shall not be equipped with both these means of initiation.
4.6.4.6.4.1	Automatic initiation of the lane change manoeuvre
	In case of an automatic initiation the lane change manoeuvre shall commence between 3.0 seconds and 5.0 seconds after the manual activation of the procedure as described in Clause 4.6.4.6.2, and shown in the Figure below.
	ACSF C – Case where the lateral movement is initiated automatically (1 Step HMI) 

4.6.4.6.4.2	Initiation of the lane change manoeuvre by a second deliberate action
	In case of an initiation by a second deliberate action the lane change manoeuvre shall commence between 3.0 and 7.0 seconds after the manual activation of the procedure as described in Clause 4.6.4.6.2.
	Additionally, the lane change manoeuvre shall commence at the latest 3.0 seconds after the second deliberate action as shown in the Figure below.
	ACSF C – Case where the lateral movement is initiated by a second deliberate action by the driver (2 Step HMI) 
	The control to operate the second deliberate action shall be located in the steering control area."
4.6.4.6.5	The lane change manoeuvre shall be completed in less than:
	(a) 5 seconds for M1, N1 vehicle categories;
	(b) 10 seconds for M2, M3, N2, N3 vehicle categories.
4.6.4.6.6	Once the lane change manoeuvre has completed, ACSF of Category B1 lane keeping function shall resume automatically.
4.6.4.6.7	The direction indicator shall remain active throughout the whole period of the lane change manoeuvre and shall be automatically deactivated by the system no later than 0.5 seconds after the resumption of ACSF of Category B1 lane keeping function as described in Clause 4.6.4.6.6, above. Automatic deactivation by the system of the direction indicator is required only if the lane change manoeuvre is initiated automatically, and if the direction indicator control is not fully engaged (Latched position) during the lane change Manoeuvre.
4.6.4.6.8	Suppression of the Lane Change Procedure
4.6.4.6.8.1	The lane change procedure shall be suppressed automatically by the system when at least one of the following situations occurs before the lane change manoeuvre has started:

	(a) The system detects a critical situation (as defined in Clause 4.6.4.7);	
	(b) The system is overridden or switched off by the driver;	
	(c) The system reaches its boundaries (e.g. lane markings are no longer detected);	
	(d) The system has detected that the driver is not holding the steering control at the start of the lane change manoeuvre;	
	(e) The direction indicator lamps are manually deactivated by the driver;	
	(f) Following the deliberate action of the driver to start the procedure described in Clause 4.6.4.6.2, the lane change manoeuvre has not commenced:	
	(i) At the latest after 5.0 seconds, in the case of an automatic initiation,	
	(ii) At the latest after 7.0 seconds, in the case of an initiation by a second deliberate action,	
	(iii) At the latest after 3.0 seconds after the second deliberate action, in the case of an initiation by a second deliberate action,	
	Whatever is appropriate.	
	(g) The system, with an initiation of the lane change manoeuvre by a second deliberate action, has not detected the second deliberate action at the latest 5.0 seconds after the start of the lane change procedure.	
	(h) The lateral movement described in Clause 4.6.4.6.4, is not continuous.	
4.6.4.6.8.2	Manual deactivation of the lane change procedure, using the manual control of the direction indicator, shall be possible for the driver at any time.	
4.6.4.7	Critical situation	
	A situation is deemed to be critical when, at the time a lane change manoeuvre starts, an approaching vehicle in the target lane would have to decelerate at a higher level than 3m/s², 0.4 seconds after the lane change manoeuvre has started, to ensure the distance between the two vehicles is never less than that which the lane change vehicle travels in 1 second.	
	The resulting critical distance at the start of the lane change manoeuvre shall be calculated using the following formula:	
	$S_{critical} = (V_{rear} - V_{ACSF}) * t_B + (V_{rear} - V_{ACSF})^2 / (2 * a) + V_{ACSF} * t_G$	
	Where;	
	V_{rear}	The actual speed of the approaching vehicle or 130 km/h whatever value is lower
	V_{ACSF}	The actual speed of the ACSF vehicle
	a	3 m/s² (Deceleration of the approaching vehicle)
	t_B	0.4 s (Time after the start of the lane change manoeuvre at which the deceleration of the approaching vehicle starts)

	t_G	1 s (Remaining gap of the vehicles after the deceleration of the approaching vehicle).
4.6.4.8	Minimum distance and minimum operation speed	
4.6.4.8.1	The ACSF of Category C shall be able to detect vehicles approaching from the rear in an adjacent lane up to a distance S_{rear} as specified below:	
	The minimum distance S_{rear} shall be declared by the vehicle manufacturer. The declared value shall not be less than 55 m.	
	The declared distance shall be tested according to the relevant test in Annex F using a two-wheeled motor vehicle of Category L3 as the approaching vehicle.	
	The minimum operation speed V_{smin} , down to which the ACSF of Category C is permitted to perform a lane change manoeuvre, shall be calculated with minimum distance S_{rear} using the following formula:	
	$V_{smin} = a * (t_B - t_G) + v_{app} - \sqrt{a^2 * (t_B - t_G)^2 - 2 * a * (v_{app} * t_G - S_{rear})}$	
	Where:	
	S_{rear}	is the minimum distance declared by the manufacturer in [m];
	V_{app}	36.1 m/s (the speed of the approaching vehicle is 130 km/h i.e. 36.1 m/s);
	A	3 m/s² (deceleration of the approaching vehicle);
	t_B	0.4 s (time after the start of the manoeuvre at which the deceleration of the approaching vehicle starts);
	t_G	1 s (remaining gap of the vehicles after the deceleration of the approaching vehicle);
	V_{min}	in [m/s] is the resulting minimum activation speed of the ACSF of Category C.
	If the vehicle is operated in a country with a general maximum speed limit below 130 km/h, this speed limit may be used as an alternative for V_{app} in the above formula to calculate the minimum operation speed V_{smin}. In this case the vehicle shall be equipped with a means to detect the country of the operation and shall have information available on the general maximum speed limit of this country.	
	Notwithstanding the requirements above in this paragraph, the ACSF of Category C is permitted to perform a lane change manoeuvre at speeds lower than the calculated V_{smin} provided that the following conditions are met:	
	(a) The system has detected another vehicle in the adjacent lane into which the lane change is planned at a distance lower than S_{rear} ; and	
	(b) The situation is not deemed to be critical according to Clause 4.6.4.7. (e.g. at low speed differences and V_{app} < 130 km/h);	
	(c) The declared value S_{rear} is greater than the calculated value $S_{critical}$ from Clause 4.6.4.7. above.	

4.6.4.8.2	The vehicle system detection area on ground level shall be at minimum as shown in the figure below.
	
4.6.4.8.3	After each vehicle new engine start/run cycle (other than when performed automatically, e.g. the operation of a stop/start systems), the ACSF of Category C function shall be prevented from performing a lane change manoeuvre until the system has detected, at least once, a moving object at a distance greater than the minimum distance S_{rear} declared by the manufacturer in Clause 4.6.4.8.1. above.
4.6.4.8.4	The ACSF of Category C shall be able to detect blindness of the sensor (e.g. due to accumulation of dirt, ice or snow). The ACSF of Category C shall be prevented, upon detection of blindness, from performing the lane change manoeuvre. The status of the system shall be signaled to the driver no later than on the initiation of the lane change procedure. The same warning as the one specified in Clause 4.6.4.5.5. (system failure warning) may be used.
4.6.4.9	System information data
4.6.4.9.1	The following data shall be provided, together with the documentation package required in Annex D of this Standard, to the Technical Service at the time of type approval.
4.6.4.9.1.1	The conditions under which the system can be activated and the boundaries for operation (boundary conditions). The vehicle manufacturer shall provide values for V_{smax} , V_{smin} and ay_{smax} for every speed range as mentioned in the table of Clause 4.6.2.1.3. of this Standard.
4.6.4.9.1.2	Information about how the system detects that the driver is holding the steering control.
4.6.4.9.1.3	The means to override and to suppress or cancel
4.6.4.9.1.4	Information about how the failure warning signal status and the confirmation of the valid software version related ACSF performance can be checked via the use of an electronic communication interface.*
4.6.4.9.1.5	Documentation about which system software version related ACSF performance is valid. This documentation shall be updated whenever a software version was amended.*
	* This Clause shall be reviewed once the Task Force on Cyber Security and Over the Air issues (TF CS/OTA) reporting to the World Forum for the Harmonization of Vehicle Standards (WP.29) Informal Working Group on Intelligent Transport Systems / Automated Driving has finalized its work on measures for software

	identification and, if necessary, amended accordingly.
4.6.4.9.1.6	Information on the sensor range over lifetime. The sensor range shall be specified in such way that any influence on deterioration of the sensor shall not affect the fulfilment of clauses 4.6.4.8.3 and 4.6.4.8.4, of this Standard
4.6.4.10	The vehicle with ACSF of Category C shall be tested in accordance with relevant vehicle test(s) specified in Annex F of this Standard. For driving situations not covered by the tests of Annex F, the safe operation of the ACSF shall be demonstrated by the vehicle manufacturer on the base of Annex D of this Standard.
4.7	Provisions for RCM fitted to vehicles of category M1 and N1. Any RCM shall be subject to the requirements of Annex D.
4.7.1	Vehicles of category M1 and N1 meeting the requirements of Category G may be equipped with RCM provided the system fulfils the following requirements.
4.7.1.1	The RCM function shall consist of software and hardware on a vehicle that enables the vehicle to be manoeuvred remotely, and an actuator that operates the function located on a separate remote-control device.
4.7.1.2	The RCM function 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).
4.7.1.3	The RCM function shall only operate if there is a continuous actuation of a dedicated button/switch on the remote-control device by the driver. Another button/switch on the remote-control device may be used to control the maneuvering of the vehicle.
4.7.1.4	Whenever the RCM function is operated, this shall be indicated to the driver by an optical signal at least at the remote-control device.
4.7.1.5	The RCM function shall only operate until 5 km/h (+1 km/h tolerance).
4.7.1.6	At any time during a manoeuvre that the vehicle becomes stationary, the RCM function shall prevent the vehicle from rolling away.
4.7.1.7	If the continuous actuation is interrupted or the distance between the vehicle and the remote control device exceeds the specified maximum RCM operating range ($SRCM_{max}$) or the secure connection between the remote control device and the vehicle is lost, the vehicle shall stop immediately.
4.7.1.8	The specified maximum RCM operating range ($SRCM_{max}$) shall not exceed 6 m.
4.7.1.9	It shall be possible for the driver to deactivate the RCM function at any time.
4.7.1.10	If a door or trunk of the vehicle is opened during the manoeuvre, the vehicle shall stop immediately, and the RCM function shall be deactivated.
4.7.1.11	Security
4.7.1.11.1	The RCM function shall be protected against unauthorized activation or operation of the RCM function and interventions into the function
4.7.1.11.2	The connection between the remote-control device and the vehicle shall be secured and encrypted. It shall be ensured by technical means that the RCM function can only be operated by an authorized remote-control device

4.7.1.12	System information data
	The Following data shall be provided together with the documentation package required in Annex D of this Standard to the Technical Service at the time of type approval:
4.7.1.12.1	The value for the specified maximum RCM operating range ($SRCM_{max}$);
4.7.1.12.2	The conditions under which the RCM function can be activated, i.e. when the conditions for operation of the system are fulfilled;
4.7.1.12.3	The Manufacturer shall provide the technical authorities with an explanation of how the function is protected against unauthorized activation or operation.
4.7.1.13	The RCM function shall be so designed that its activation can only be achieved provided the vehicle is not in any of the following locations:
	(a) A public road/highway;
	(b) A public car park;
	(c) An area designated exclusively for use by pedestrians and/or pedal cyclists.
	The vehicle shall be capable of confirming that it is not located in any of the above locations whilst the RCM function is active and this shall be achieved by at least two independent technical means.[2] If navigation maps are used for this purpose, the RCM function shall be disabled if the map data has not been updated in the previous 12 months.
	[2]Two different types of map (e.g. navigation and topographical) supplied by two different suppliers are satisfactory for this requirement.
4.7.1.14	The vehicle shall be equipped with a means to detect an obstacle (e.g. vehicles, pedestrian) in the maneuvering area and to bring the vehicle immediately to a stop to avoid a collision.
4.7.1.15	If the vehicle stops having detected an obstacle in the maneuvering area, subsequent operation shall only be possible following confirmation from the driver. The vehicle shall respond to any subsequent objects detected in the maneuvering area as prescribed in Clause 4.7.1.14.
4.7.1.16	It shall only be possible to operate the RCM function when drive is provided to at least one front axle and one rear axle simultaneously
4.7.1.17	The vehicle shall detect if, while the RCM function is active, the vehicle enters any of the locations listed under Clause 4.7.1.13. In such a case, the vehicle shall stop immediately, and the RCM function shall be deactivated.
4.7.1.18	The RCM function shall only operate for a maximum total distance travelled of 100m. This distance may be reset if there is no input on the remote control device for at least 1 minute or if the system has been deactivated and a time period of at least 1 minute has elapsed. The distance shall be subsequently measured from the next point at which the RCM function is operated.
4.7.1.19	The driver shall be issued with a warning signal when the total distance travelled is 75m (+5m tolerance). This shall be fulfilled by the provision of an optical

	warning signal and either a haptic or acoustic warning signal at least at the remote control device.
4.7.1.20	If the vehicle reaches or exceeds the maximum total distance travelled defined in Clause 4.7.1.18, the vehicle shall stop immediately and the RCM function shall be deactivated. It shall not be possible to subsequently activate the RCM function until a time period of at least 1 minute has elapsed. This shall be indicated to the driver at least at the remote control device.
4.7.1.21	The manufacturer shall provide the Technical Service with documentation and supporting evidence to demonstrate compliance with the provisions of paragraphs 4.7.1.13, 4.7.1.14, 4.7.1.15 and 4.7.1.17. This information shall be subject to discussion and agreement between the Technical Service and vehicle manufacturer.
5.0	**TEST PROVISIONS**
5.1	**General Provisions**
5.1.1	The test shall be conducted on a level surface affording good adhesion.
5.1.2	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 Auxiliary Steering Equipment (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 load.
5.1.3	Before the test begins, the tyre pressures shall be as prescribed by the manufacturer for the mass specified in 5.1.2, when the vehicle is stationary.
5.1.4	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.
5.2	Provisions for Motor Vehicles
5.2.1	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:
	Category M1 vehicles: 50 km/h.
	Category M2, M3, N1, N2 and N3 vehicles: 40 km/h or the maximum design speed if this is below the speeds given above
5.2.2	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.
5.2.3	During the measurement of the control effort, forces with duration of less than 0.2 s shall not be taken into account.
5.2.4	Measurement of Steering Efforts on Motor Vehicles with Intact Steering Equipment
5.2.4.1	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 below for the particular category of vehicle with intact steering. One steering movement shall be made to the right and one to the left.
5.2.4.2	The maximum permitted steering time and the maximum permitted steering control effort with intact steering equipment are given in the table below for each category of vehicle.
5.2.5	Measurement of Steering Efforts on Motor Vehicles with a Failure in the Steering Equipment
5.2.5.1	The test described in 5.2.4 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 the table below for the particular category of vehicle with a failure in the steering equipment.
5.2.5.2	The maximum permitted steering time and the maximum permitted steering control effort with a failure in the steering equipment are given in the Table 1 for each category of vehicle.

Table 1

Steering Control Effort Requirements

Sr. No	**Vehicle Category**	**Intact**			**With a Failure**		
		Maximum Effort daN	Times	Turning Radius m	Maximum Effort daN	Times	Turning Radius m
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
i)	**M1**	**15**	**4**	**12**	**30**	**4**	**20**
ii)	**M2**	**15**	**4**	**12**	**30**	**4**	**20**
iii)	**M3**	**20**	**4**	**12 [1)]**	**45 [2)]**	**6**	**20**
iv)	**N1**	**20**	**4**	**12**	**30**	**4**	**20**
v)	**N2**	**25**	**4**	**12**	**40**	**4**	**20**
vi)	**N3**	**20**	**4**	**12 [1)]**	**45 [2)]**	**6**	**20**

	[1)] Or full lock, if 12 m radius is not attainable
	[2)] 50 for rigid vehicles with 2 or more steered axles excluding self-tracking equipment.
5.3	**Provisions for Trailers**
5.3.1	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.	
5.3.2	With the towing vehicle and trailer having adopted a steady state turn corresponding to a turning circle radius of 25 m (see 3.4.6) at a constant speed of 5 km/h, the circle described by the rearmost outer edge of the trailer shall be measured. This manoeuvre shall be repeated under the same conditions but at a speed of 25 ± 1 km/h. During these manoeuvres, the rearmost outer edge of the trailer travelling at a speed of 25 ± 1 km/h shall not move outside the circle described at a constant speed of 5 km/h by more than 0.7 m.	
5.3.3	No part of the trailer must move more than 0.5 m beyond the tangent to a circle with a radius of 25 m when towed by a vehicle leaving the circular path described in 5.3.2 along the tangent and travelling at a speed of 25 km/h. This requirement must be met from the point the tangent meets the circle to a point 40 m along the tangent. After that point the trailer must fulfill the condition specified in 5.3.1.	
5.3.4	The annular ground area swept by the towing vehicle/trailer combination with an intact steering system, driving at no more than 5 km/h in a constant radius circle with the front outer corner of the towing vehicle describing a radius of 0.67 × vehicle combination length but not less than 12.5 m is to be measured.	
5.3.4.1	If, with a fault in the steering system, the measured swept annular width is greater than 8.3 m, then this shall not be an increase of more than 15 percent compared with the corresponding value measured with the intact steering system. There shall not be any increase in the outer radius of the swept annular width.	
5.3.5	The tests described in 5.3.2, 5.3.3 and 5.3.4 shall be conducted in both clockwise and anti-clockwise directions.	
6.0	**VEHICLE CHARACTERISTICS**	
	Vehicle characteristics declared by the vehicle manufacturer to the testing agency shall contain at least the details given in Annex E.	
	NOTE — If the vehicle, submitted for type approval of the vehicle contain details given in Annex A, it is not necessary to submit them again.	
7.0	**CHANGES IN VEHICLE CHARACTERISTICS**	
7.1	In case the test is conducted for verification of compliance to statutory requirements the following shall be carried out.	
7.2	Every modification to vehicle characteristics declared in accordance with 6 shall be intimated by the manufacturer to the testing agency	
	The testing agency may then consider, whether,	
	a)	The model with changes specifications still complies with the requirements of this standard, or
	b)	any further verification is required to establish compliance to this standard
7.3	Changes where testing is considered necessary for establishing compliance to this standard are as follows:	
	a)	Any increase of weight on steered axle in excess of 10 percent in case of M1 and N1 type of vehicles and 5 percent for other vehicles.

	b)	Any increase in wheel base in excess of 10 percent in case of M1 and N1 type of vehicles and 5 percent for other vehicles.
	c)	Any decrease in steering wheel diameter [see 7.3 (a)].
	d)	Any change in steering linkage/steering gear box ratio which decreases the number of turns of steering wheel from lock to lock.
	e)	Type of construction of steering gear box (such as re-circulating ball type to rack and pinion type, power steering, etc).
	f)	An increase of caster angle.
	g)	Increase of tyre size.
	h)	Change of tyre type from diagonal or cross ply to radial ply.
	i)	Any change in wheel lock angle that affects the test turning circle.
	j)	Increase in number of axles.
	k)	If steered axle becomes driven:
	1)	In the case of decrease in the steering wheel diameter, if the effort calculated from the previous test using the new steering wheel diameter is within limits, are re-test need not be carried out.
	2)	Change other than those listed above, are considered to be having no adverse effect on steering effort.
	3)	In 7.2 (a) or after results of further verification as per 7.2 (b) are successful, the test results shall be validated for the changes carried out.

Annex A –

(Clause 4.3.1.4)

BRAKING PERFORMANCE FOR VEHICLES USING THE SAME ENERGY SOURCE TO SUPPLY STEERING EQUIPMENT AND BRAKING DEVICE

A-1.0	For tests carried out in accordance with this Annex the following vehicle conditions shall be met.
A-1.1	The vehicle shall be loaded to its technically permissible maximum mass distributed between the axles as declared by the vehicle manufacturer. Where provision is made for several arrangements of the mass on the axles, the distribution of the maximum mass between the axles shall be such that the mass on each axle is proportional to the maximum permissible mass for each axle. In the case of tractors for semi-trailers, the mass may be repositioned approximately half way between the kingpin position resulting from the above loading conditions and the center line of the rear axle(s);
A-1.2	The tyres shall be inflated to the cold inflation pressure prescribed for the mass to be borne by the tyres when the vehicle is stationary; and
A-1.3	Before the start of the tests the brakes shall be cold, that is, with a disc or outer brake drum surface temperature less than 100°C.
A-2.0	If an energy source failure occurs, service braking performance on the first brake application shall achieve the values given in Table 2.

Table 2

Service Braking Performance

Sr. No	**Category**	**V km/h**	**m/s^2**	**F daN**
(1)	(2)	(3)	(4)	(5)
i)	M1	80	5.8	50
ii)	M2 and M3	60	5.0	70
iii)	N1	80	5.0	70
iv)	N2 and N3	60	5.0	70

A-3.0	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 3). 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 actuation's of the service brake control to achieve at the ninth application, the residual performance (see Table 3).

	Table 3 Secondary and Residual Efficiency				
	Sr. No	**Category**	**V (km/h)**	**Secondary Braking**	**Residual Braking**
	(1)	(2)	(3)	(4)	(5)
	i)	M1	80	2.9	1.7
	ii)	M2	60	2.5	1.5
	iii)	M3	60	2.5	1.5
	iv)	N1	70	2.2	1.3
	v)	N2	50	2.2	1.3
	vi)	N3	40	2.2	1.3

ANNEX B -

(Clause 4.1.1)

ADDITIONAL PROVISIONS FOR VEHICLES EQUIPPED WITH ASE

B-1.0	**GENERAL PROVISIONS**
	Vehicles fitted with Auxiliary Steering Equipment (ASE) in addition to the requirements given in the body of this standard shall also comply with the provisions of this Annex.
B-2.0	**SPECIFIC PROVISIONS**
B-2.1	Transmission
B-2.1.1	Mechanical Steering Transmissions (see 4.3.1.1)
B-2.1.2	Hydraulic Steering Transmissions
	The hydraulic steering transmission must be protected from exceeding the maximum permitted service pressure T.
B-2.1.3	Electric Steering Transmissions
	The electric steering transmission must be protected from excess energy supply
B-2.1.4	Combination of Steering Transmissions
	A combination of mechanical, hydraulic and electric transmissions shall comply with the requirements specified in B-2.1.1, B-2.1.2 and B-2.1.3.
B-2.2	Testing Requirements for Failure
B-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 4.3.1.1) shall not result in a sudden significant change in vehicle behavior and the relevant requirements of 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:
B-2.2.1.1	Circular test
	The vehicle shall be driven into a test circle with a radius R (m) and a speed V (km/h) corresponding to its category and the values given in the Table 4. The failure shall be introduced when the specified test speed has been reached. The test shall include driving in a clockwise direction and in a counter-clockwise direction.

Table 4
Circular Test

Sr. No	**Vehicle Category**	**R[1)]**	**V [2) 3)]**
(1)	(2)	(3)	(4)
i)	M1 and N1	100	80
ii)	M2 and N2	50	50
iii)	M3 and N3	50	45

	[1] If, due to the configuration of the test site, the values of the radii cannot be observed, the tests may be carried out on tracks with other radii, (maximum variation: ± 25 percent) provided that the speed is varied to obtain the transverse acceleration resulting from the radius and speed indicated in the table for the particular category of vehicle.	
	[2] If the ASE is in a mechanically locked position at this specified speed, the test speed will be modified to correspond to the maximum speed where the system is functioning. Maximum speed means the speed when the ASE becomes locked, minus 5 km/h.	
	[3] If the dimensional characteristics of the vehicle imply an overturning risk, the manufacturer shall provide to the Technical Service behavior simulation data demonstrating a lower maximum safe speed for conducting the test. Then the Technical Service will choose this test speed.	
B-2.2.1.2	Transient test	
	Until 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.	
B-2.3	Warning Signals in Case of Failure	
	Except for parts of ASE not considered susceptible to breakdown as specified in 4.3.1.1, the following failure of ASE shall be clearly brought to the attention of the driver:	
	a)	A general cut-off of the ASE electrical or hydraulic control,
	b)	Failure of the ASE energy supply, and
	c)	A break in the external wiring of the electrical control, if fitted.

ANNEX C - (Clause 4.1.1) **PROVISIONS FOR TRAILERS HAVING HYDRAULIC STEERING TRANSMISSIONS**	
C-1.0	**GENERAL PROVISIONS**
	Vehicles fitted with hydraulic steering transmission, in addition to the requirements given in the body of this standard shall also comply with the provisions of this Annex.
C-2.0	**SPECIFIC PROVISIONS**
C-2.1	Performance of Hydraulic Lines and Hose Assemblies
C-2.1.1	The hydraulic lines of hydraulic transmission shall be capable of a burst pressure at least four times the maximum normal service pressure (T) specified by the vehicle manufacturer. Hose assemblies shall comply with ISO Standards 1402:1994, 6605:1986 and 7751:1991."
C-2.2	In systems dependent on an energy supply.
C-2.2.1	The energy supply must be protected from excess pressure by a pressure limiting valve which operates at the pressure T.
C-2.3	Protection of Steering Transmission
C-2.3.1	The steering transmission shall be protected from excess pressure by a pressure limiting valve which operates at between 1.1 T and 2.2 T. 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."`

ANNEX D - (Clause 4.1.10) **SPECIAL REQUIREMENTS TO BE APPLIED TO THE SAFETY ASPECTS OF ELECTRONIC CONTROL SYSTEMS**	
D-1.0	**GENERAL**
	This annex defines the special requirements for documentation, fault strategy and verification with respect to the safety aspects of Electronic System(s) (Clause 2.3.) and Complex Electronic Vehicle Control System(s) (Clause 2.4. below) as far as this Standard is concerned.
	This annex does not specify the performance criteria for "The System" but covers the methodology applied to the design process and the information which must be disclosed to the Technical Service, for type approval purposes.
	This information shall show that "The System" respects, under non-fault and fault conditions, all the appropriate performance requirements specified elsewhere in this Standard and that it is designed to operate in such a way that it does not induce safety critical risks.
	The applicant (e.g. the manufacturer) may provide evidence that an Auxiliary Steering Equipment (ASE) (if fitted) has previously been assessed as part of an approval in accordance with the requirements of Annex 4 of this Standard (as required under the original version of this Standard. In this case, the requirements of this Annex shall not be applied to that ASE for the purposes of an approval in accordance with the 03 series of amendments covered in this standard.
D-2.0	DEFINITIONS
	For the purposes of this Annex following definitions shall apply:
D-2.1	**The System**" means an electronic control system or complex electronic control system that provides or forms part of the control transmission of a function to which this Standard applies. This also includes any other system covered in the scope of this Standard, as well as transmission links to or from other systems that are outside the scope of this Standard, that acts on a function to which this Standard applies.
D-2.2	"**Safety Concept"** is a description of the measures designed into the system, for example within the electronic units, so as to address system integrity and thereby ensure safe operation under fault and non-fault conditions, including in the event of an electrical failure. The possibility of a fallback to partial operation or even to a back-up system for vital vehicle functions may be a part of the safety concept."
D-2.3	Electronic control system" means a combination of units, designed to cooperate in the production of the stated vehicle control function by electronic data processing. Such systems, commonly 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.
D-2.4	**"Complex Electronic Vehicle Control Systems"** are those electronic control systems in which a function controlled by an electronic system or the driver may be over-ridden by a higher level electronic control system/function. A function which is over-ridden becomes part of the complex system, as well as any overriding

	system/function within the scope of this Standard. The transmission links to and from overriding systems/function outside of the scope of this Standard shall also be included.
D-2.5	"**Higher-Level Electronic Control**" systems/functions are those which employ additional processing and/or sensing provisions to modify vehicle behavior by commanding variations in the function(s) of the vehicle control system. This allows complex systems to automatically change their objectives with a priority which depends on the sensed circumstances."
D-2.6	**Units**, are the smallest divisions of system components which will be considered in this Annex, since these combinations of components will be treated as single entities for purposes of identification, analysis or replacement.
D-2.7	**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.
D-2.8	**Range of Control**, refers to an output variable and defines the range over which the system is likely to exercise control.
D-2.9	**Boundary of Functional Operation,** defines the boundaries of the external physical limits within which the system is able to maintain control.
D-2.10	"**Safety Related Function**" means a function of "The System" that is capable of changing the dynamic behavior of the vehicle. "The System" may be capable of performing more than one safety related function.
D-2.11	"**Control strategy**" means a strategy to ensure robust and safe operation of the function(s) of "The System" in response to a specific set of ambient and/or operating conditions (such as road surface condition, traffic intensity and other road users, adverse weather conditions, etc.). This may include the automatic deactivation of a function or temporary performance restrictions (e.g. a reduction in the maximum operating speed, etc.)."
D-3.0	**DOCUMENTATION**
D-3.1	**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", including the control strategies, 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. For periodic technical inspections, the documentation shall describe how the current operational status of "The System" can be checked.
	The Technical Service shall assess the documentation package to show that "The System":
	(a) Is designed to operate, under non-fault and fault conditions, in such a way that it does not induce safety critical risks;

	(b) Respects, under non-fault and fault conditions, all the appropriate performance requirements specified elsewhere in this Standard; and,	
	(c) Was developed according to the development process/method declared by the manufacturer and that this includes at least the steps listed in Clause 3.4.4.	
D-3.1.1	Documentation shall be made available in two parts:	
	a)	The formal documentation package for the approval, containing the material listed in Clause 3. (with the exception of that of Clause D-3.4.4.) which shall be supplied to the Technical Service at the time of submission of the type approval application. This documentation package shall be used by the Technical Service as the basic reference for the verification process set out in Clause 4. of this Annex. The Technical Service shall ensure that this documentation package remains available for a period determined in agreement with the Test Agency. This period shall be at least 10 years counted from the time when production of the vehicle is definitely discontinued.
	b)	Additional material and analysis data of Clause 3.4.4, which shall be retained by the manufacturer, but made open for inspection at the time of type approval. The manufacturer shall ensure that this material and analysis data remains available for a period of 10 years counted from the time when production of the vehicle is definitely discontinued."
D-3.2	Description of the functions of 'The System'	
	A description shall be provided which gives a simple explanation of all the functions including control strategies of "The System" and the methods employed to achieve the objectives, including a statement of the mechanism(s) by which control is exercised. Any described function that can be over-ridden shall be identified and a further description of the changed rationale of the function's operation provided. Any enabled or disabled safety related functions providing assistance to the driver as defined in Clause 2.3.4, of this Regulation, when the hardware and software are present in the vehicle at the time of production, shall be declared and are subject to the requirements of this annex, prior to their use in the vehicle.	
D-3.2.1	A list of all input and sensed variables shall be provided and the working range of these defined, along with a description of how each variable affects system behavior	
D-3.2.2	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 (see D-2.8) exercised on each such variable shall be defined.	
D-3.2.3	Limits defining the boundaries of functional operation (see D-2.9) shall be stated where appropriate to system performance.	
D-3.3	System Layout and Schematics	
D-3.3.1	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.
D-3.3.2	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.
D-3.3.3	Interconnections within "The System" shall be shown by a circuit diagram for the electric transmission links, by a piping diagram for pneumatic or hydraulic transmission equipment and by a simplified diagrammatic layout for mechanical linkages. The transmission links both to and from other systems shall also be shown."
D-3.3.4	Signal Flow operating data and Priorities
	There shall be a clear correspondence between these transmission links and the signals and/or operating data carried between Units. Priorities of signals and/or operating data on multiplexed data paths shall be stated wherever priority may be an issue affecting performance or safety as far as this Standard is concerned."
D-3.3.5 I	Identification of Units
	Each unit shall be clearly and unambiguously identifiable (for example 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
D-3.3.5.1	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 standard is concerned, this identification shall also be changed.
D-3.4	Safety Concept of the Manufacturer
D-3.4.1	The Manufacturer shall provide a statement which affirms that the strategy chosen to achieve "The System" objectives will not, under non-fault conditions, prejudice the safe operation of the vehicle."
D-3.4.2	In respect of software employed in "The System", the outline architecture shall be explained and the design methods and tools used shall be identified. The manufacturer shall show evidence of the means by which they determined the realization of the system logic, during the design and development process."
D-3.4.3	The Manufacturer shall provide the Technical Service with an explanation of the design provisions built into "The System" so as to generate safe operation under fault conditions. Possible design provisions for failure in "The System" are for example:
	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
D-3.4.3.1	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.
D-3.4.3.2	If the chosen provision selects a second (back-up) means to realize 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.
D-3.4.3.3	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.
D-3.4.4	The documentation shall be supported, by an analysis which shows, in overall terms, how the system will behave on the occurrence of any of those hazard or fault which will have a bearing on vehicle control performance or safety.
	The chosen analytical approach(es) shall be established and maintained by the Manufacturer and shall be made open for inspection by the Technical Service at the time of the type approval.
	The Technical Service shall perform an assessment of the application of the analytical approach(es). The audit shall include:
	(a) Inspection of the safety approach at the concept (vehicle) level with confirmation that it includes consideration of
	(i) Interactions with other vehicle systems;
	(ii) Malfunctions of the system, within the scope of this Standard
	(iii) For functions defined in Clause2.3.4. of this Standard
	(a) Situations when a system free from faults may create safety critical risks (e.g. due to a lack of or wrong comprehension of the vehicle environment);
	(b) Reasonably foreseeable misuse by the driver;
	(c) Intentional modification of the system.
	This approach shall be based on a Hazard / Risk analysis appropriate to system safety.
	(b)) Inspection of the safety approach at the system level. This may be based on a Failure Mode and Effect Analysis (FMEA), a Fault Tree Analysis (FTA) or any

	similar process appropriate to system safety.
	(c) Inspection of the validation plans and results. This shall include validation testing appropriate for validation, for example, Hardware in the Loop (HIL) testing, vehicle on-road operational testing, or any other testing appropriate for validation.
	The assessment shall consist of spot checks of selected hazards and faults to establish that argumentation supporting the safety concept is understandable and logical and validation plans are suitable and have been completed.
	The Technical Service may perform or may require to perform tests as specified in clause 4. to verify the safety concept."
D-3.4.4.1	This documentation shall itemize the parameters being monitored and shall set out, for each fault condition of the type defined in D-3.4.4, the warning signal to be given to the driver and/or to service/technical inspection personnel.
D-3.4.4.2	This documentation shall describe the measures in place to ensure the "The System" does not prejudice the safe operation of the vehicle when the performance of "The System" is affected by environmental conditions e.g. climatic, temperature, dust ingress, water ingress, ice packing."
D-4	**VERIFICATION AND TEST**
D-4.1	The functional operation of 'The System', as laid out in the documents required in D-3 shall be tested as follows:
D-4.1.1	Verification of the Function of 'The System'
	The Technical Service shall verify "The System" under non-fault conditions by testing a number of selected functions from those declared by the manufacturer in ClauseD-3.2. above. For complex electronic systems, these tests shall include scenarios whereby a declared function is overridden."
D-4.1.1.1	The verification results shall correspond with the description, including the control strategies, provided by the manufacturer in Clause 3.2.
D-4.1.2	Verification of the Safety Concept of D-3.4
	The reaction of "The System" shall be checked under the influence of a failure in any individual unit by applying corresponding output signals to electrical units or mechanical elements in order to simulate the effects of internal faults within the unit. The Technical Service shall conduct this check for at least one individual unit, but shall not check the reaction of "The System" to multiple simultaneous failures of individual units. The Technical Service shall verify that these tests include aspects that may have an impact on vehicle controllability and user information (HMI aspects).
D-4.1.2.1	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.
D-5.0	Reporting by Technical Service
	Reporting of the assessment by the Technical Service shall be performed in such a manner that allows traceability, e.g. versions of documents inspected are coded and

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

Appendix 1 to ANNEX D (Clause D-5.0) MODEL ASSESSMENT FORM FOR ELECTRONIC SYSTEMS	
	Test report No:
1.0	Identification
1.1	Vehicle Make:
1.2	Type
1.3	Means of identification of type if marked on the vehicle :
1.3.1	Location of that marking:
1.4	Manufacturer's name and address:
1.5	If applicable, name and address of manufacturer's representative:
1.6	Manufacturer's formal documentation package:
	Documentation reference No:
	Date of original issue:
	Date of latest update:
2.0	Test vehicle(s)/system(s) description
2.1	General Description:
2.2	Description of all the control functions of "The System", and methods of operation:
2.3	Description of the components and diagrams of the interconnections within "The System":
2.4	General description:
2.5	Description of all the control functions of "The System", and methods of operation:.
2.6	Description of the components and diagrams of the interconnections within "The System"

3.0	Manufacturer's safety concept	
3.1	Description of signal flow and operating data and their priorities:	
3.2	Manufacturer's declaration:	
	The manufacturer(s) ..... affirm(s) that the strategy chosen to achieve "The System", objectives will not, under non-fault conditions, prejudice the safe operation of the vehicle.	
3.3	Software outline architecture and the design methods and tools used:	
3.4	Explanation of design provisions built into "The System" under fault conditions:	
3.5	Documented analyses of the behavior of "The System" under individual hazard or fault conditions:	
3.6	Description of the measures in place for environmental conditions:	
3.7	Provisions for the periodic technical inspection of "The System":	
3.8	Results of "The System" verification test, as per para. D- 4.1.1. of Annex D above:	
3.9	Results of safety concept verification test, as per para. D- 4.1.2. of Annex D above:	
3.10	Date of test :	
3.11	This test has been carried out and the results reported in accordance with ….. to this standard.	
	Technical Service[1] carrying out the test	
	Signed:	Date:
3.12	Type Approval Authority[1]	
	Signed:	Date:
3.13	Comments:	
	[1]To be signed by different persons even when the Technical Service and Type Approval Authority are the same or alternatively, a separate Type Approval Authority authorization is issued with the report."	

ANNEX E (Clause 6) **VEHICLE CHARACTERISTICS**			
E-1.0	Model		
E-2.0	Number of axles (Steered/Non-steered)		
E-3.0	Gross vehicular weight (GVW)		
E-4.0	Maximum recommended mass for:		
	a) Front axle:		
	b) Rear axle:		
	c) Intermediate axle:		
E-5.0	Wheel base (Laden)		
E-6.0	Track of steered axle(s) (Laden)		
E-7.0	Steering gear type		
E-8.0	Steering gear ratio		
E-9.0	Steering wheel diameter		
E-10.0	Tyre size and ply rating and tyre pressure		
E-11.0	Tyre type (radial/diagonal/cm)		
E-12.0	Wheel lock angle		
		Inner	Outer
	Left		
	Right		
E-13.0	Number of steering wheel rotations from lock to lock		
E-14.0	Caster angle (Laden)		
E-15.0	Minimum turning circle diameter		
E-16.0	Co-ordination of outermost point which defines the turning circle		
E-17.0	Pressure setting in case of power steering		

ANNEX F TEST REQUIREMENTS FOR CORRECTIVE AND AUTOMATICALLY COMMAND STEERING FUNCTIONS	
F-1.0	General Provisions
	Vehicles fitted with CSF and/or ACSF systems shall fulfil the appropriate tests requirements of this annex.
F-2.0	Testing conditions
	The tests shall be performed on a flat, dry asphalt or concrete surface affording good adhesion. The ambient temperature shall be between 0° C and 45° C.
	At the request of the manufacturer and with the agreement of the Technical Service tests may be conducted under deviating test conditions (suboptimal conditions, e.g. on a not dry surface; below the specified minimum ambient temperature), whilst the performance requirements are still to be met.
F-2.1	Lane markings
	The lane markings on the road used for the tests shall be in line with one of those described in AIS 188 for LDWS. 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 Annex. At the manufacturer's discretion and with the agreement of the Technical Service, a lane with a width of less than 3.5 m may be used, if the correct function of the system on roads with wider lanes can be demonstrated.
	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 AIS 188 for LDWS. Any of such documentation shall be appended to the test report.
F-2.2	Tolerances
	All vehicle speeds specified for the tests described in this annex shall be met within a tolerance of ±2 km/h.
F-2.3	Vehicle conditions
F-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.
F-2.3.2	The vehicle shall be tested at the tyre pressures recommended by the vehicle manufacturer
F-2.4	Lateral acceleration
	The lateral acceleration and the lateral jerk at vehicle's center of gravity shall be determined. The raw lateral acceleration data shall be measured closest as

	possible to the position of the vehicle's center of gravity. The position at which the lateral acceleration is measured and the center of gravity of the vehicle shall be identified in the test report. The sampling rate shall be at least 100 Hz.
	To determine the lateral acceleration, the raw data shall be filtered by applying a fourth order Butterworth filter with a cut-off frequency of 0.5 Hz. To determine the lateral jerk, the 500ms moving average of the time derivation of the filtered lateral acceleration shall be considered. The lateral acceleration data at the vehicle center of gravity shall be determined by removing additional effects due to the movements of the vehicle body (e.g. roll of sprung mass) and by correcting for sensor placement via the use of coordinate transformation. As reference, the intermediate axis system as described in ISO 8855:2011 shall be used."
F-2.5	Overriding force
	The measurement of the overriding force during the test can be performed by two methods: either through the internal driver torque signal or by an external measurement device fitted, which doesn't induce any deactivation of the system
	Prior to performing the overriding force test, by the internal driver torque signal, it shall be verified by an external measurement device that there are no relevant differences between the both measured values. Differences shall be less than or equal to 3N. This requirement is deemed to be fulfilled if the correlation between the values of the internal driver torque signal and the external measurement device was determined and is applied in the overriding force test."
F-3.0	Tests procedures
F-3.1	Tests for CSF
	The following test applies to CSF functions defined in sub Clause(c) of CSF definition in Clause 3.3.4.2, of this Standard.
F-3.1.1	Warning test for CSF
F-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 or haptic warning signals as relevant shall be recorded.
	In the case of Clause 4.1.6.1.2.1, of this Standard, 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 or haptic warning as relevant is provided no later than 10 s (for M1, N1) or 30 s (for M2, M3, N2, N3) after the beginning of the intervention.
	In the case of Clause 4.1.6.1.2.2, of this Standard, 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 or haptic warning signal as relevant is provided at the second and third intervention; and
	(c) The acoustic or haptic warning signal as relevant at the third intervention is at least 10 s longer than the one at the second intervention.
F-3.1.1.2	In addition, the manufacturer shall demonstrate to the satisfaction of the Technical Service that the requirements defined in clauses 4.1.6.1.1 and 4.1.6.1.2 are fulfilled in the whole range of CSF operation. This may be achieved on the basis of appropriate documentation appended to the test report.
F-3.1.2	Overriding force test
F-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.
F-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.
F-3.1.2.3	In addition, the manufacturer shall demonstrate to the satisfaction of the Technical Service that the requirements defined in Clause 4.1.6.1.3, are fulfilled in the whole range of CSF operation. This may be achieved on the basis of appropriate documentation appended to the test report.
F-3.2	Tests for ACSF Category B1 System
F-3.2.1	Lane keeping functional test
F-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 Clause 4.6.2.1.3. of this Standard 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 or with a predefined initial speed when using an embedded

	vehicle speed control system (e.g. for vehicles automatically decelerating in curves) 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 measured lateral acceleration during the test execution can be outside of the above-mentioned limits.
	The lateral acceleration and the lateral jerk shall be recorded during the test
F-3.2.1.2	The test requirements are fulfilled if:
	No outside edge of the tyre tread of the vehicle's front wheel does cross the outside edge of any lane marking.
	The moving average over half a second of the lateral jerk does not exceed 5 m/s^3.
F-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.
F-3.2.2	Maximum lateral acceleration test
F-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 Clause 4.6.2.1.3, of this Standard 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. If an embedded vehicle speed control system will automatically decelerate the vehicle in the curve, it shall be inhibited.
	The technical service defines a test speed and a radius which would provoke a higher acceleration than ay_{smax} + 0.3 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.
F-3.2.2.2	The test requirements are fulfilled if:
	The recorded acceleration is within the limits specified in Clause 4.6.2.1.3 of this Standard
	The moving average over half a second of the lateral jerk does not exceed 5 m/s^3.
F-3.2.3	Overriding force test
F-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 maximum lateral acceleration specified by the vehicle manufacturer a_{ymax}

	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.
F-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.
F-3.2.4	Transition test; hands-on test
F-3.2.4.1	The vehicle shall be driven with activated ACSF with a vehicle test speed between V_{smin} + 10 km/h and V_{smin} + 20 km/h on a track with lane markings at each side of the lane.
	The driver shall release the steering control and continue to drive until the ACSF is deactivated by the system. The track shall be selected such that it allows driving with activated ACSF for at least 65 s without any driver intervention.
	The test shall be repeated with a vehicle test speed between V_{smax} - 20 km/h and V_{smax} – 10 km/h or 130 km/h whichever is lower and may be stopped upon the start of the optical warning
	Additionally, the vehicle manufacturer shall demonstrate to the satisfaction of the Technical Service that the requirements for the whole speed range are fulfilled. This may be achieved on the basis of appropriate documentation appended to the test report.
F-3.2.4.2	The test requirements are fulfilled if:
	During both tests the optical warning signal was given at the latest 15 s after the steering control has been released and remains until ACSF is deactivated.
	During the lower speed test, the acoustic warning signal was given at the latest 30 s after the steering control has been released and remains until ACSF is deactivated.
	During the lower speed test, the ACSF is deactivated at the latest 30 s after the acoustic warning signal has started, with an acoustic emergency signal of at least 5 s, which is different from the previous acoustic warning signal."
F-3.2.5	Lane Crossing Warning Test for M1, N1 and for M2, M3, N2 and N3, if not equipped with a Lane Departure Warning System (LDWS) fulfilling the technical requirements of AIS 188 for LDWS.
F-3.2.5.1	The vehicle shall be driven with activated ACSF with a vehicle test speed between V_{smin} and 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) on a curved track with lane markings at each side
	The technical service defines a test speed and a radius which would provoke a lane crossing. The test speed and radius shall be defined such that the necessary lateral acceleration to follow the curve is in between ay_{smax} + 0.1 m/s² and ay_{smax}

	+ 0.4 m/s².
F-3.2.5.2	The test requirements are fulfilled if:
	The optical warning signal and additionally the acoustic or haptic warning signal was given at the latest when the outside edge of the tyre tread of the vehicle's front wheel has crossed the outside edge of the lane marking."
	The system continues to provide assistance as required in Clause 4.6.2.2.3."
F-3.3	Tests for ESF
	The vehicle shall be driven with an activated ESF on a road with lane markings on each side and positioned within those lane markings.
	The test conditions and the vehicle speeds shall be within the operating range of the system as declared by the manufacturer.
	Specific details of the mandatory tests described below shall be discussed and agreed between the vehicle manufacturer and the Technical Service to adapt the required testing to the declared use case(s) for which the ESF is designed to operate.
	In addition, the manufacturer shall demonstrate to the satisfaction of the Technical Service that the requirements defined in Clause 4.1.6.2.1 to 4.1.6.2.6 are fulfilled in the whole range of the ESF operation (specified by the vehicle manufacturer in the system information data). This may be achieved on the basis of appropriate documentation appended to the test report.
F-3.3.1	Test for ESF Type a i/ii: (unintentional lateral manoeuvre)
	A target vehicle driving in the adjacent lane shall approach the vehicle under test and one of the vehicles shall minimize their lateral separation distance until an ESF intervention is started.
	The tests requirements are fulfilled if:
	(a) The warnings specified in Clause 4.1.6.2.6 of this Standard are provided no later than the ESF intervention starts, and
	(b) The ESF intervention does not lead the vehicle to leave its original lane.
F-3.3.2	Test for ESF Type a iii: (intentional lateral manoeuvre)
	The vehicle under test starts a lane change while another vehicle is driving in the adjacent lane such that no intervention of the ESF system would lead to a collision.
	The test requirements are fulfilled if:
	(a) An ESF intervention is started, and
	(b) The warnings specified in Clause 4.1.6.2.6 of this Standard are provided no later than the ESF intervention starts, and
	(c) The ESF intervention does not lead the vehicle to leave its original lane.
F-3.3.3	Test for ESF Type b:
	The vehicle under test shall approach an object positioned within its trajectory. The object shall be of such size and positioned in a way that the vehicle can pass

	the object without crossing the lane markings.
	The tests requirements are fulfilled if:
	(a) The ESF intervention avoids or mitigates the collision, and
	(b) The warnings specified in Clause 4.1.6.2.6 of this Standard are provided no later than the ESF intervention starts, and
	(c) The ESF intervention does not lead the vehicle to leave its lane
F-3.3.4	Tests for systems able to operate in the absence of lane markings
	In case any system works in absence of lane markings the corresponding tests from paragraphs 3.3.1 to 3.3.3 need to be repeated on a test track without lane markings.
	These test requirements are fulfilled if
	(a) An ESF intervention is started; and
	(b) The warnings specified in Clause 4.1.6.2.6 of this Standard are provided no later than the ESF intervention starts; and
	(c) The lateral offset during the manoeuvre is 0.75 m, as specified in Clause 4.1.6.2.2, at maximum; and
	(d) The vehicle has not left the road due to the ESF intervention
F-3.3.5	False reaction test for ESF Type b
	The vehicle under test shall approach a plastic sheet having a color contrast to the road surface, a thickness less than 3 mm, a width of 0.8 m and a length of 2 m positioned between the lane markings in the trajectory of the vehicle. The plastic sheet shall be positioned in a way that the vehicle could pass the sheet without crossing the lane markings.
	The test requirements are fulfilled, if the ESF does not start any intervention.
F-3.4	Reserved for ACSF of Category B2
F-3.5	Tests for ACSF of Category C Systems
	If not specified otherwise all vehicle test speeds shall be based on V_{app} = 130 km/h.
	If not specified otherwise, the approaching vehicle shall be a type-approved high-volume series production vehicle.
	The vehicle manufacturer shall demonstrate to the satisfaction of the Technical Service that the requirements are fulfilled for the whole speed range. This may be achieved on the basis of appropriate documentation appended to the test report.
F-3.5.1	Lane change functional test
F-3.5.1.1	The test vehicle shall be driven in a lane of a straight test track, which has at least two lanes in the same direction of travel, with road markings on each side of the lanes. The vehicle speed shall be: V_{smin} + 10 km/h.
	The ACSF of Category C shall be activated (standby mode) and, unless the system is already enabled according to clause 4.6.4.8.3, another vehicle shall

	approach from the rear in order to enable the system as specified in Clause 4.6.4.8.3 above.
	The approaching vehicle shall then pass the vehicle under test entirely.
	A lane change into the adjacent lane shall then be initiated by the driver.
	The lateral acceleration and the lateral jerk shall be recorded during the test.
F-3.5.1.2	The requirements of the test are fulfilled if:
	(a) The lateral movement towards the marking does not start earlier than 1 second after the lane change procedure was initiated,
	(b) The lateral movement to approach the lane marking and the lateral movement necessary to complete the lane change manoeuvre are completed as one continuous movement,
	(c) The recorded lateral acceleration does not exceed 1 m/s^2,
	(d) The moving average over half a second of the lateral jerk does not exceed 5 m/s^3,
	(e) The measured time between the start of the lane change procedure and the start of the lane change manoeuvre is not less than 3.0 seconds and not more than
	(i) 5.0 seconds in the case of an automatic initiation,
	(ii) 7.0 seconds in the case of an initiation by a second deliberate action
	whatever is appropriate.
	(f) For systems with an initiation of the lane change manoeuvre by a second deliberate action,
	(i) The measured time between the start of the lane change procedure and the second deliberate action is not more than 5.0 seconds, and
	(ii) The measured time between the second deliberate action and the start of the lane change manoeuvre is not more than 3.0 seconds
	(g) The system provides an information to the driver to indicate that the lane change procedure is on-going,
	(h) The lane change manoeuver is completed in less than 5 seconds for M1, N1 vehicle categories and less than 10 s for M2, M3, N2, N3 vehicle categories
	(i) ACSF of Category B1 automatically resumes after the lane change manoeuvre is completed, and
	(j) The direction indicator is deactivated not before the end of the lane change manoeuvre and no later than 0.5 seconds after ACSF of Category B1 has resumed in case the lateral movement is initiated automatically and the direction indicator control was not fully engaged (latched position) during the lane change manoeuvre.
F-3.5.1.3	The test according to Clause 3.5.1.1 shall be repeated with a lane change in the opposite direction.
F-3.5.2	Minimum activation speed test V_{smin}

F-3.5.2.1	Minimum activation speed test V_{smin} based on V_{app} = 130 km/h.
	The test vehicle shall be driven within a lane of a straight track which has at least two lanes in the same direction of travel and road markings on each side of the lane.
	The vehicle speed shall be: V_{smin} – 10 km/h.
	The ACSF of Category C shall be activated (standby mode) and, unless the system is already enabled according to clause 4.6.4.8.3, another vehicle shall approach from the rear in order to enable the system as specified in Clause 4.6.4.8.3 above.
	The approaching vehicle shall then pass the vehicle under test entirely.
	A lane change procedure shall then be initiated by the driver
	The requirements of the test are fulfilled if the lane change manoeuvre is not performed.
F-3.5.2.2	Minimum activation speed test V_{smin} based on country specific general maximum speed limit below 130 km/h.
	In case V_{smin} is calculated, based on a country specific general maximum speed limit instead of V_{app} =130 km/h as specified in Clause 4.6.4.8.1, the tests described below shall be performed. For this purpose it is allowed to simulate the country of operation in agreement between the vehicle manufacturer and the Technical Service.
F-3.5.2.2.1	The test vehicle shall be driven within a lane of a straight track which has at least two lanes in the same direction of travel and road markings on each side of the lane.
	The vehicle speed shall be: V_{smin} – 10 km/h.
	The ACSF of Category C shall be activated (standby mode) and, unless the system is already enabled according to clause 4.6.4.8.3, another vehicle shall approach from the rear in order to enable the system as specified in Clause4.6.4.8.3 above.
	The approaching vehicle shall then pass the vehicle under test entirely.
	A lane change procedure shall then be initiated by the driver
	The requirements of the test are fulfilled if the lane change manoeuvre is not performed.
F-3.5.2.2.2	The test vehicle shall be driven within a lane of a straight track which has at least two lanes in the same direction of travel and road markings on each side of the lane
	The vehicle speed shall be: V_{smin} + 10 km/h
	The ACSF of Category C shall be activated (standby mode) and, unless the system is already enabled according to clause 4.6.4.8.3, another vehicle shall approach from the rear in order to enable the system as specified in Clause4.6.4.8.3 above.
	The approaching vehicle shall then pass the vehicle under test entirely.

	A lane change procedure shall then be initiated by the driver.
	The requirements of the test are fulfilled if the lane change manoeuvre is performed.
F-3.5.2.2.3	The manufacturer shall demonstrate to the satisfaction of the Technical Service that the vehicle is able to detect the country of operation and that the general maximum speed limit of this country is known.
F-3.5.3	Overriding test
F-3.5.3.1	The test vehicle shall be driven in a lane of a straight test track, which has at least two lanes in the same direction of travel, with road markings on each side of the lanes.
	The vehicle speed shall be: V_{smin} + 10 km/h.
	The ACSF of Category C shall be activated (standby mode) and, unless the system is already enabled according to clause 4.6.4.8.3, another vehicle shall approach from the rear in order to enable the system as specified in Clause 4.6.4.8.3 above.
	The approaching vehicle shall then pass the vehicle under test entirely
	A lane change into the adjacent lane shall then be initiated by the driver
	The steering control shall be firmly controlled by the driver to maintain the vehicle in the straight direction.
	The force applied by the driver on the steering control during the overriding manoeuver shall be recorded.
F-3.5.3.2	The test requirements are fulfilled if the measured overriding force does not exceed 50 N, as specified in Clause 4.6.4.3 above.
F-3.5.3.3	The test according to Clause 3.5.3.1 shall be repeated with a lane change in the opposite direction
F-3.5.4	Lane Change Procedure suppression test
F-3.5.4.1	The test vehicle shall be driven in a lane of a straight test track, which has at least two lanes in the same direction of travel, with road markings on each side of the lanes
	The vehicle speed shall be: V_{smin} + 10 km/h.
	The ACSF of Category C shall be activated (standby mode) and, unless the system is already enabled according to clause 4.6.4.8.3, another vehicle shall approach from the rear in order to enable the system as specified in Clause 4.6.4.8.3 above
	The approaching vehicle shall then pass the vehicle under test entirely
	A Lane Change Procedure shall then be initiated by the driver.
	The test shall be repeated for each of the following conditions, which shall occur before the lane change manoeuvre has started:
	(a) The system is overridden by the driver;
	(b) The system is switched off by the driver;

	(c) The vehicle speed is reduced to: V_{smin}-10 km/h;
	(d) The driver has removed his hands from the steering control and the hands-off warning has been initiated;
	(e) The direction indicator lamps are manually deactivated by the driver;
	(f) The lane change manoeuvre has not commenced within 5.0 seconds following the initiation of the lane change procedure. (e.g. another vehicle is driving in the adjacent lane in a critical situation as described in Clause 4.6.4.7.)
F-3.5.4.2	The requirements of the test are fulfilled if the lane change procedure is suppressed, for each of the test cases above.
F-3.5.5	Sensor performance test
F-3.5.5.1	The test vehicle shall be driven in a lane of a straight test track, which has at least two lanes in the same direction of travel, with road markings on each side of the lanes.
	The vehicle speed shall be: V_{smin} + 10 km/h.
	The ACSF of Category C shall be activated (standby mode).
	Another vehicle shall approach from the rear on the adjacent lane, with a speed of 120 km/h.
	The approaching vehicle shall be a type approved high volume series production motorcycle of category L3 with an engine capacity not exceeding 600 cm^3 without front fairing or windshield and shall aim to drive in the middle of the lane
	The distance between the rear end of the test vehicle and the front end of the approaching vehicle shall be measured (e.g. with a Differential Global Positioning System), and the value when the system detects the approaching vehicle shall be recorded.
F-3.5.5.2	The requirements of the test are fulfilled if the system detects the approaching vehicle no later than at the distance declared by the vehicle manufacturer (S_{rear}), as specified in 4.6.4.8.1 above.
F-3.5.6	Sensor blindness test
F-3.5.6.1	The test vehicle shall be driven in a lane of a straight test track, which has at least two lanes in the same direction of travel, with road markings on each side of the lanes.
	The vehicle speed shall be: V_{smin} + 10 km/h.
	The ACSF of Category C shall be activated (standby mode) and, unless the system is already enabled according to paragraph 4.6.4.8.3, another vehicle shall approach from the rear in order to enable the system as specified in Clause 4.6.4.8.3 above.
	The approaching vehicle shall then pass the vehicle under test entirely.
	The rear sensor(s) shall be made blind, with means agreed between the vehicle manufacturer and the Technical Service, which shall be recorded in the test report. This operation may be carried out at standstill, provided no new engine

	start /run cycle is performed.
	The vehicle shall be driven to a speed of V_{smin} + 10 km/h, and a lane change procedure shall be initiated by the driver.
F-3.5.6.2	The requirements of the test are fulfilled if the system:
	(a) Detects the sensor blindness
	(b) Provides a warning to the driver as defined in para. 4.6.4.8.4, and
	(c) Is prevented from performing the lane change manoeuvre.
	In addition to the above mentioned test, the manufacturer shall demonstrate to the satisfaction of the Technical Service that the requirements defined in Clause 4.6.4.8.4 are also fulfilled under different driving scenarios. This may be achieved on the basis of appropriate documentation appended to the test report.
F-3.5.7	Engine start/run cycle test
	The test is divided in 3 consecutive phases as specified below.
	The vehicle speed shall be: V_{smin} + 10 km/h.
F-3.5.7.1	Phase 1 – Default-off test
F-3.5.7.1.1	Following a new engine start /run cycle performed by the driver, the test vehicle shall be driven in a lane of a straight test track, which has at least two lanes in the same direction of travel, with road markings on each side of the lanes.
	The ACSF of Category C shall not be activated (off mode) and another vehicle shall approach from the rear and the approaching vehicle shall pass the vehicle entirely.
	A lane change procedure shall then be initiated by the driver with the appropriate deliberate action(s)."
F-3.5.7.1.2	The requirements of the test phase 1 are fulfilled if the lane change manoeuvre is not initiated.
F-3.5.7.2	Phase 2
	The objective of the test is to check that the lane change manoeuvre is prevented if the system has not detected any moving object at a distance equal or greater than the distance S_{rear} (as specified in Clause 4.6.4.8.3).
F-3.5.7.2.1	Following a new engine start / run cycle performed by the driver, the test vehicle shall be driven in a lane of a straight test track, which has at least two lanes in the same direction of travel, with road markings on each side of the lanes.
	The ACSF of Category C shall be manually activated (standby mode).
	A lane change procedure shall then be initiated by the driver with the appropriate deliberate action(s).
F-3.5.7.2.2	The requirements of the test phase 2 are fulfilled if the lane change manoeuvre has not started (as the pre-condition specified in 4.6.4.8.3 is not fulfilled).
F-3.5.7.3	Phase 3 – Lane change enabling conditions test
	The objective of the test is to check that the lane change manoeuvre is only possible once the system has detected a moving object at a distance equal or

	greater than the distance S_{rear} (as specified in Clause 4.6.4.8.3).
F-3.5.7.3.1	Following the completion of the test phase 2, another vehicle shall approach from the rear on the adjacent lane in order to enable the system as specified in Clause 4.6.4.8.3.
	The distance between the rear end of the test vehicle and the front end of the approaching vehicle shall be measured (e.g. with a differential GPS), and the value when the system detects the approaching vehicle be recorded.
	After the rear coming vehicle has entirely passed the vehicle under test, a lane change procedure and Manoeuvre shall be initiated by the driver with the appropriate deliberate action(s).
F-3.5.7.3.2	The requirements of the test phase 3 are fulfilled if:
	(a) The lane change manoeuver is executed;
	(b) The approaching vehicle is detected no later than at the distance declared by the vehicle manufacturer (S_{rear}).
F-3.6	Test for RMF
	The vehicle shall be driven with an activated RMF on a road with all relevant lane markings in a good visible shape.
	The test conditions and the vehicle speeds shall be within the operating range of the system as declared by the manufacturer.
	Specific details of the mandatory tests described below shall be discussed and agreed between the vehicle manufacturer and the Technical Service to adapt the required testing to the declared use case(s) for which the RMF is designed to operate.
	In addition, the manufacturer shall demonstrate to the satisfaction of the Technical Service that the requirements defined in clause 4.1.6.3 are fulfilled in the whole operating range of the RMF (specified by the vehicle manufacturer in the system information data). This may be achieved on the basis of appropriate documentation appended to the test report.
F-3.6.1	Tests for an RMF, with the purpose of bringing the vehicle to a safe stop inside its own lane of travel:
	The vehicle shall be driven in a way that an intervention is initiated.
	The test requirements are fulfilled if:
	(a) The ongoing intervention is indicated to the driver by an optical warning signal and additionally an acoustic and/or haptic warning signal as defined in clause 4.1.6.3.2.
	(b) The signal to activate the hazard warning lights is generated with the start of the intervention.
	(c) The deceleration demand does not exceed $4 m/s^2$ as described in clause 4.1.6.3.6.
	(d) Once RMF has brought the vehicle to a safe stop, the vehicle does not move away without manual input.

F-3.6.2	Tests for an RMF, with the purpose of bringing the vehicle to a safe stop outside its own lane of travel:
F-3.6.2.1	Scenario A:
	A Lane Change Manoeuvre is possible according to the provisions of clause 4.1.6.3.9.8.2.
	The vehicle shall be driven in a way that an RMF intervention is initiated while a target stop area outside the current lane of travel is available. In case there is another vehicle in the target lane this shall be positioned in a way not preventing a lane change of the RMF vehicle to the target lane.
	The test requirements are fulfilled if;
	(a) The ongoing intervention is indicated to the driver by at least an optical and acoustic and/or haptic warning signal as defined in clause 4.1.6.3.2.
	(b) The signal to activate the hazard warning lights is generated with the start of the intervention.
	(c) The lane change manoeuvre is indicated in advance to other road users.
	(d) The RMF vehicle changes the lane(s) following the provisions of clause 4.1.6.3.9.8 and its subclauses.
F-3.6.2.2	Scenario B
	A Lane Change Manoeuvre is not possible according to the provisions of clause 4.1.6.3.9.8.2.
	The vehicle shall be driven in a way that an RMF intervention is initiated while a target stop area outside the current lane of travel is available. At the start of the RMF intervention there shall be another vehicle in the target lane positioned in a way preventing a lane change manoeuvre of the RMF vehicle to the target lane.
	The test requirements are fulfilled if;
	(a) The ongoing intervention is indicated to the driver by at least an optical and acoustic and/or haptic warning signal as defined in clause 4.1.6.3.2.
	(b) The signal to activate the hazard warning lights is generated with the start of the intervention.
	(c) The lane change manoeuvre is indicated in advance to other road users.
	(d) The RMF vehicle does not start a lane change manoeuvre as long as the vehicle in the target lane is still positioned in a way preventing a lane change manoeuvre." "

ANNEX G SPECIAL PROVISIONS FOR THE POWERING OF TRAILER STEERING SYSTEMS FROM THE TOWING VEHICLE	
G-1.0	General
	The requirements of this Annex shall apply to towing vehicles and trailers where electrical energy is supplied from the towing vehicle to facilitate operation of the steering system installed on the trailer.
G-2.0	Requirements for towing vehicles
G-2.1	Energy Supply
G-2.1.1	The vehicle manufacturer shall define the capacity of the energy source that will enable the current defined in Clause 2.3. below to be available for the trailer during normal operation of the vehicle.
G-2.1.2	The driver's manual shall include information to advise the driver on the electrical energy available for the trailer steering system and that the electrical interface shall not be connected when the current requirement marked on the trailer exceeds that which can be supplied by the towing vehicle.
G-2.1.3	The power supply provided by the connector referenced in Clause 2.5. below shall be used for the powering of the trailer steering system. However, in all cases the provisions of Clause 3.3 below shall apply.
G-2.2	The nominal operating voltage is 24V
G-2.3	The maximum current supply available at the connector referenced in Clause 2.5.2. below shall be defined by the towing vehicle manufacturer.
G-2.4	Protection of the electrical system
G-2.4.1	The electrical system of the towing vehicle shall be protected from an overload or short circuit in the supply to the trailer steering system.
G-2.5	Wiring and Connectors
G-2.5.1	The cables used to supply the trailer electrical energy shall have a conductor cross-sectional area compatible with the continuous current defined in Clause 2.3. above.
G-2.5.2	Until a uniform standard has been defined the connector used to connect to the trailer shall fulfil the following:
	(a) The pins shall have a current carrying capacity compatible with the maximum continuous current defined in Clause 2.3. above;
	(b) Until uniform standards have been agreed the environmental protection of the connector shall be appropriate to the application and included in the Annex 6 assessment; and
	(c) The connector shall not be interchangeable with an existing electrical connector currently used on the towing vehicle i.e. ISO 7638, ISO 12098, etc.
G-2.6	Marking
G-2.6.1	The towing vehicle shall be marked to indicate the maximum current available for

	the trailer as defined in Clause 2.3. above.
	The marking shall be indelible and positioned so that it is visible when connecting the electrical interface referenced in Clause 2.5.2. above
G-3.0	Requirements for trailers
G-3.1	The maximum current requirement of the trailer steering system shall be defined by the vehicle manufacturer.
G-3.2	The nominal operating voltage is 24V.
G-3.3	The electrical energy available from the towing vehicle shall only be used as follows:
	(a) Exclusively for use by the trailer steering system;
	Or
	(b) For the trailer steering system and to power auxiliary systems on the trailer provided the steering system has priority and is protected from an overload external to the steering system. This protection shall be a function of the trailer steering system.
G-3.4	Wiring and Connectors
G-3.4.1	The cables used to supply the trailer steering system with electrical energy shall have a conductor cross sectional area compatible with the energy requirements of the steering system installed on the trailer.
G-3.4.2	Until a uniform standard has been defined the connector used to connect to the trailer shall fulfil the following:
	(a) The pins shall have a current carrying capacity compatible with the maximum current defined by the vehicle manufacturer in Clause 3.1. above;
	(b) Until uniform standards have been agreed the environmental protection of the connector shall be appropriate to the application and included in the Annex 6 assessment;
	(c) The connector shall not be interchangeable with an existing electrical connector currently used on the towing vehicle, i.e. ISO 7638, ISO 12098, etc.
G-3.5	Failure warning:
	Failures within the electric control transmission of the steering system shall be directly displayed to the driver.
G-3.6	Demonstration of the operation of the steering system
G-3.6.1	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 Standard.
G-3.6.2	Failure Conditions:
G-3.6.2.1	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 Clause 6.3. of the Standard for the intact system.
G-3.6.2.2	Under transient conditions
	The transient behavior 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:
	(a) By applying the test procedure and requirements defined within Clause 6.3.1. of the Standard. *
	(b) By applying the test procedure and requirements defined within Clause 6.3.3. of the Standard. *
	* The technical service may accepted the test results supplied by the trailer manufacturer to demonstrate compliance with the transient tests.
G-3.6.3	If the trailer steering system utilizes hydraulic transmission to operate the steering, the requirements of Annex 5 shall apply.
G-3.7	Marking
G-3.8.1	Trailers equipped with a connector for the supply of electrical energy to the trailer steering system shall be marked to include the following information
	(a) The maximum current requirement for the trailer steering system as defined in Clause 3.1. above
	(b) The functionality of the trailer steering system including the impact on maneuverability 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 referenced in Clause 3.3.2. above.

ANNEX- H

(See Introduction)

COMPOSITION OF AISC PANEL ON AUTOMOTIVE VEHICLES — STEERING EFFORT — METHOD OF EVALUATION

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Mr. Samson Border	ZF Steering Gear India Ltd.
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Mr. Sandeep More	SIAM (Tata Motors Ltd.)
Mr. Swapnil Salunkhe	SIAM (Tata Motors Ltd.)
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Mr. Sarang Deshpande	ACMA (Hella India Pvt Ltd.)
Dr. R. M. Thirupati	ACMA (Rane Mysore)
Mr. Vinita Shaw	ACMA (Sandhar Group)
Mr. Manish Menon	ACMA (Uno Minda Group)
Mr. Srikanth	ACMA (Uno Minda Group)
Mr. Surender Bhatti	ACMA (Uno Minda Group)
Mr. Sahin Deshmukh	ACMA (ZF Group)
Mr. D Senthil	ACMA (ZF Group)
* At the time of approval of this Automotive Industry Standard (AIS)	

ANNEXURE I
(See Introduction)

COMMITTEE COMPOSITION *
Automotive Industry Standards Committee

Chairperson	
Dr. Reji Mathai	Director, The Automotive Research Association of India, Pune
Members	**Representing**
Representative from	Ministry of Road Transport and Highways
Representative from	Ministry of Heavy Industries
Representative from	Office of the Development Commissioner, MSME, Ministry of Micro, Small and Medium Enterprises, New Delhi
Shri Shrikant R. Marathe	Former Chairman, AISC
Shri P. V. Srikanth	Bureau of Indian Standards
Director	Central Institute of Road Transport
Director	Global Automotive Research Centre
Director	International Centre for Automotive Technology
Director	Indian Institute of Petroleum, Dehra Dun
Director	Vehicles Research and Development Establishment
Director	Indian Rubber Manufacturers Research Association
Representatives from	Society of Indian Automobile Manufacturers
Representative from	Tractor Manufacturers Association
Representative from	Automotive Components Manufacturers Association of India
Representative from	Indian Construction Equipment Manufactures' Association (ICEMA)
Member Secretary	
Shri Vikram Tandon	The Automotive Research Association of India, Pune

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