Submitted by the expert from Australia

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Proposal for a new UN Regulation on uniform provisions concerning the approval of motor vehicles with regard to their Emergency Lane Keeping System (ELKS)

The text reproduced below was prepared by the expert from Australia proposing a new United Nations Regulation on uniform provisions concerning the approval of Emergency Lane Keeping System for M_1 and N_1 vehicles. The proposed Regulation intends to facilitate a consistent approach across all Contracting Parties for Emergency Lane Keeping Systems (ELKS). Currently the European Commission mandates ELKS through EU Regulation 2021/646, with this proposed Regulation closely aligning with those requirements. The modifications to the current text of the EU Regulation 2021/646 are marked in bold characters or strikethrough characters in red text[1].

I. Proposal

Uniform provisions concerning the approval of motor vehicles with regard to the Emergency Lane Keeping Systems (ELKS) for M_1 and N_1 vehicles [1]

Contents

[1] Paragraphs 2, 6, 7, 8 and 9 are based off European Regulation 2021/646 Document 32021R0646, European Commission, accessed 2 July 2024, < https://eur-lex.europa.eu/eli/reg_impl/2021/646/oj>

0. Introduction (for information)

0.1 This Regulation establishes uniform provisions for Emergency Lane Keeping Systems (ELKS) fitted to motor vehicles of the Categories M_1 and N_1.

0.2 The system shall automatically detect a potential lane departure, provide the driver with an appropriate warning and correct the vehicle's trajectory when the driver unintentionally leaves the lane.

0.3 The driver can maintain control and override the system at any time by taking a deliberate action, such as steering or other control inputs.

0.4 While this Regulation cannot account for all the traffic conditions and infrastructure features during the type-approval process, it acknowledges that the required performance may not be achieved in all circumstances. Vehicle condition, road adhesion, weather conditions, deteriorated infrastructure and traffic scenarios can all impact system performances. Real-world conditions should not trigger false warnings or steering interventions that discourage the driver's use of the system.

0.5 In the case of a failure in the system, the safe operation of the vehicle shall not be endangered.

0.6 This Regulation is an "if-fitted" regulation. It shall not prevent contracting parties from mandating the fitting of ELKS approved in accordance to this Regulation.

1. Scope

This Regulation applies to the approval of vehicles of categories M_1 and N_1 with regards to their Emergency Lane Keeping Systems (ELKS).

2. Definitions

For the purpose of this Regulation:

For the purpose of the Annexes, the following definitions shall apply:

2.1. *'vehicle type with regard to its emergency lane-keeping system'* means a category of vehicles which do not differ in such essential aspects as:

(1) vehicle features which significantly influence the performances of the emergency lane-keeping system;

(2) the type and design of the emergency lane-keeping system;

2.1. *'corrective directional control function (CDCF)'* means a control function within an electronic control system whereby, for a limited duration, changes to the steering angle of one or more wheels and/or braking of individual wheels may result from the automatic evaluation of signals initiated on-board the vehicle optionally enriched by data provided off-board the vehicle, in order to correct lane departure, e.g. to avoid crossing lane markings, leaving the road;

2.2. *'subject vehicle'* means the vehicle being tested;

2.3. *'distance to lane marking (DTLM)'* means the remaining lateral distance (perpendicular to the lane marking) between the inner side of the lane marking and most outer edge of the tyre before the subject vehicle crosses the inner side of the lane marking;

2.4. *'flat road'* means a road with a slope less than 1 % in the longitudinal direction and for the lateral direction, less than 2 % for half a lane width

either side of the centreline and less than 3 % for the outer half of the lane;

2.5. *'dry road'* means a road with a nominal peak braking coefficient of 0,9;

~~2.7. *'The System'* means the electronic control system and complex electronic control systems that provide or form part of the control transmission of the emergency lane keeping system, including the transmission links to or from other vehicle systems that act on the emergency lane keeping system;~~

~~2.8. *'units'* means the smallest divisions of system components which will be considered, since these combinations of components will be treated as single entities for purposes of identification, analysis or replacement;~~

~~2.9. *'transmission links'* means any electric, mechanic, pneumatic or hydraulic equipment used for inter-connecting distributed units for the purpose of conveying signals, operating data or energy supply;~~

~~2.10. *'electronic control system'* means a combination of units, designed to cooperate in the production of a vehicle control function by electronic data processing;~~

~~2.11. *'complex electronic vehicle control system'* means an electronic control system in which a function controlled by an electronic system or the driver may be over ridden by a higher level electronic control system/function, thus becoming part of the complex system, as well as any overriding of the system, including the transmission links to and from the overriding systems/function outside of the scope of this Regulation;~~

~~2.12. *'control strategy'* means a strategy to ensure robust and safe operation of the function(s) of an electronic control 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.), which may include the automatic deactivation of a function or temporary performance restrictions (e.g. a reduction in the maximum operating speed, etc.);~~

~~2.13. *'safety concept'* means a description of the measures designed into the system, for instance within the electronic units, so as to address system integrity and 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.~~

2.6. '*Mass of a vehicle in running order*' means the mass of an unladen vehicle with bodywork, including coolant, oils, 90 per cent of fuel, 100 per cent of other liquids, driver (75 kg) but except used waters, tools, spare wheel.

2.7 *"Lane Departure Warning System (LDWS)"* means a system to warn the driver of an unintentional drift of the vehicle out of its travel lane;

6. General requirements

6.1. An emergency lane-keeping system (ELKS) shall comprise a lane departure warning system (LDWS) and a corrective directional control function (CDCF).

6.1.1. The LDWS shall meet the requirements of **paragraphs 7.1** to **7.4** and **paragraph 7.5**.

6.1.2. The CDCF shall meet the requirements of **paragraphs 7.1** to **7.4** and **paragraph 7.6**.

6.2. ELKS lane departure warnings and interventions

Subject to specific requirements below the system shall be designed to minimise warnings and interventions for driver intended manoeuvres.

7. Specific requirements

7.1. ELKS failure warning

A warning shall be provided when there is a failure in the ELKS that prevents the requirements of this Regulation ~~of~~ being met.

7.1.1. The failure warning shall be a constant visual warning signal.

7.1.1.1. There shall not be an appreciable time interval between each ELKS self-check (an integrated function that checks for a system failure on a continuous basis at least while the system is active), and subsequently there shall not be a delay in illuminating the warning signal, in the case of an electrically detectable failure.

7.1.1.2. Upon detection of any non-electrical failure condition (e.g. sensor misalignment), the warning signal as defined in **paragraph 7.1.1** shall be activated.

7.1.2. If the vehicle is equipped with a means to deactivate the ELKS a warning shall be given when the system is deactivated according to **paragraph 7.2**. This shall be a constant visual warning signal. The failure warning signal specified in **paragraph 7.1.1.** may be used for this purpose.

7.2. ELKS deactivation

7.2.1. Manual deactivation

When a vehicle is equipped with a means to manually deactivate the ELKS function, either partially or fully, the following conditions shall apply as appropriate:

7.2.1.1. The full ELKS function shall be automatically and fully reinstated upon each activation of the vehicle master control switch **[engine start or run cycle]**

7.2.1.2. The manual deactivation of the full ELKS shall not be possible with less than two deliberate actions, e.g. press and hold on a button, or select and confirm on menu option. It shall be possible to easily suppress acoustic warnings of the LDWS, but such action shall not at the same time deactivate the LDWS or the CDCF.

7.2.1.3. The manual deactivation capability shall be tested in accordance with the relevant vehicle test(s) specified in **paragraph 7**.

7.2.2. Automatic deactivation

If the vehicle is equipped with a means to automatically deactivate the ELKS function, either partially or fully, for instance in situations such as off-road use, being towed, a trailer being hitched to the vehicle or the electronic stability control (ESC) being deactivated, the following conditions shall apply as appropriate:

7.2.2.1. ~~As~~ **In accordance with Annex 3 of this Regulation** ~~part of the safety audit~~, the vehicle manufacturer shall provide a list of situations and corresponding criteria where the ELKS function is automatically deactivated which shall be annexed to the test report.

7.2.2.2. The ELKS function shall be automatically and fully reactivated as soon as the conditions that led to the automatic deactivation are not present anymore.

7.2.3. A constant visual warning signal shall inform the driver that the ELKS function has been deactivated. The failure warning signal specified in **paragraph 7.1.1** above may be used for this purpose.

7.3. Automatic suppression

7.3.1. For driver intended manoeuvres

~~As~~ **In accordance with Annex 3 of this Regulation** ~~part of the safety audit~~, the manufacturer shall provide a documentation package which gives access to the basic design and logic of the system for detection of likely driver intended manoeuvres and automatic suppression of the ELKS. This package shall include a list of parameters detected and a basic description of the method used to decide that the system should be suppressed, including limit values where possible. For both the CDCF and LDWS, the Technical Service shall assess the documentation package to show that driver unintentional manoeuvres, within the scope of the lane keep test parameters (in particular lateral departure velocity), will not result in automatic suppression of the system.

7.3.2. Automatic suppression of the ELKS is also permitted in situations when other driver assist or automated steering functions, (i.e. Automatically commanded steering function, emergency steering function or automated lane keeping), are controlling the lateral movement of the vehicle or other safety related functions (i.e. that is capable of changing the dynamic behaviour of the vehicle such as AEBS, ESC, etc.) are intervening. These situations shall be declared by the manufacturer ~~as~~ **in accordance with Annex 3 of this Regulation** ~~part of the safety audit~~.

7.4. Provisions for the Periodic Technical Inspection

7.4.1. At a Periodic Technical Inspection, it shall be possible to confirm the correct operational status of the ELKS by a visible observation of the failure warning signal status. following a "power-ON" and any bulb check. In the case of the failure warning signal being in a common space. the common space must be observed to be functional prior to the failure warning signal status check.

7.4.2. At the time of type approval, the means to protect against simple unauthorised modification of the operation of the failure warning signal chosen by the manufacturer shall be confidentially outlined. Alternatively, this protection requirement is fulfilled when a secondary means of checking the correct operational status of the ELKS is available.

~~7.4. Provisions for periodic roadworthiness tests~~

~~7.4.1. For the purpose of periodic roadworthiness tests of vehicles, it shall be possible to verify the following features of the ELKS:~~

~~(a) Its correct operational status, by visible observation of the failure warning signal status following the activation of the vehicle master control switch and any bulb check. Where the failure warning signal is displayed in a common space (the area on which two or more information functions/symbols may be displayed, but not simultaneously), it must be checked first that~~

~~the common space must be observed to be functional prior to the failure warning signal status check;~~

~~(b) Its correct functionality and the software integrity, by the use of an electronic vehicle interface, such as the one laid down in point I.(14) of Annex III of Directive 2014/45/EU of the European Parliament and of the Council where the technical characteristics of the vehicle allow for it and the necessary data is made available. Manufacturers shall ensure to make available the technical information for the use of the electronic vehicle interface in accordance with Article 6 of Commission Implementing Regulation (EU) 2019/621.~~

~~7.4.2. At the time of type approval, the means to protect against simple unauthorised modification of the operation of the failure warning signal chosen by the manufacturer shall be confidentially outlined as part of the safety audit in Annex II. Alternatively, this protection requirement is fulfilled when a secondary means of checking the correct operational status of the ELKS is available.~~

7.5. LDWS requirements

7.5.1. Speed range

The LDWS shall be active at least within the vehicle speed range between 65 km/h and 130 km/h (or the maximum vehicle speed if it is lower than 130 km/h) and at all vehicle load conditions, unless deactivated as per **paragraph 7.2**.

7.5.2. Lane departure warning

When activated and operated within the prescribed speed range, the LDWS shall be able to warn the driver at the latest if the vehicle crosses over a visible lane marking for the lane in which it is running by more than a DTLM of – 0,3 m:

(a) for lateral departure velocities in the range of the 0,1 m/s to 0,5 m/s;

(b) on straight, flat and dry roads;

(c) for solid line and dashed lane markings in line with one of those described in Annex 3 (Visible lane marking identification) to Regulation No 130 of the United Nations Economic Commission for Europe (UNECE) – Uniform provisions concerning the approval of motor vehicles with regard to the Lane Departure Warning System ~~and other markings expected on EU roads~~;

(d) with the markings being in good condition and of a material conforming to the standard for visible markings of that contracting party;

(e) in all illumination conditions without blinding of the sensors (e.g. direct blinding due to sunlight) and with activated passing-beam (dipped-beam) headlamps if necessary;

(f) in absence of weather conditions affecting the visibility of lane markings (e.g. no fog).

It is recognised that the performance required may not be fully achieved in other conditions than those listed above. However, the system shall not unreasonably switch the control strategy in these other conditions.

The lane departure warning capability shall be tested in accordance with the relevant vehicle test(s) specified in **paragraph 8**.

7.5.3. LDWS warning indication

7.5.3.1. The lane departure warning referred to in **paragraph 7.5.2** shall be noticeable by the driver and be provided by:

(a) at least two warning means out of visual, acoustic and haptic; or

(b) one warning means out of haptic and acoustic, with spatial indication about the direction of unintended drift of the vehicle.

The warning mentioned above may be suppressed when there is a driver action which indicates an intention to depart from the lane;

7.5.3.1.1. Where a visual signal is used for the lane departure warning, it may use the failure warning signal as specified in **paragraph 7.1.1** above in a flashing mode.

7.5.3.1.2. When there is a lane keep intervention by the CDCF, this shall be considered a haptic warning according to **paragraph 7.5.3.1.**

7.5.3.2. The LDWS visual warning signal shall be activated following a vehicle master control switch **[engine start or run cycle]** 'power-ON'. This requirement does not apply to warning signals shown in a common space.

7.5.3.3. The LDWS visual warning signals shall be visible even by daylight; the satisfactory condition of the signals must be easily verifiable by the driver from the driver's seat.

7.5.3.4. The visual warning signal shall be tested in accordance with the relevant vehicle test(s) specified in **paragraph 8**.

7.6. CDCF performance requirements

7.6.1. Speed range

The CDCF shall be active at least between 70 km/h and 130 km/h (or the maximum vehicle speed if it is below 130 km/h) and at all vehicle load conditions, unless deactivated as per **paragraph 7.2**. However, in the case that the vehicle reduces its speed from above 70 km/h to below 70 km/h, the system shall be active at least until the vehicle speed reduces below 65 km/h.

7.6.2. Lane keep

In the absence of conditions leading to deactivation or suppression of the system, the CDCF shall be able to prevent lane departure by crossing of visible lane markings in the scenarios shown in the following table by more than a DTLM of – 0,3 m:

(a) for lateral departure velocities in the range of the 0,2 m/s to 0,5 m/s for vehicle speeds up 100 km/h and for lateral departure velocities in the range of 0,2 m/s to 0,3 m/s for vehicle speeds greater than 100 km/h and up to 130 km/h (or the maximum vehicle speed if it is below 130 km/h);

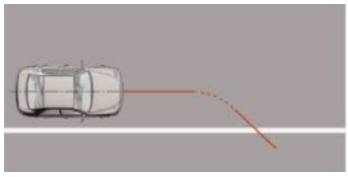
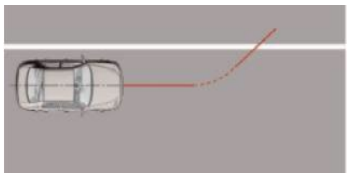
(b) on straight, flat and dry roads;

(c) for solid lane markings in line with one of those described in Annex 3 (Visible lane marking identification) to UN Regulation No 130;

(d) with the markings being in good condition and of a material conforming to the standard for visible markings of that contracting party;

(e) in all illumination conditions without blinding of the sensors (e.g. direct blinding sunlight) and with activated passing-beam (dipped-beam) headlamps if necessary;

(f) in absence of weather conditions affecting the dynamic performance of the vehicle (e.g. no storm, not below 5 °C) or the visibility of lane markings (e.g. no fog).

No.	Scenario description
1.	Solid line – departure to right side of vehicle 
2.	Solid Line – Departure to left of vehicle 

It is recognised that the performances required for the scenarios in this table may not be fully achieved in other conditions than those listed above. However, the system shall not unreasonably switch the control strategy in these other conditions. This shall be demonstrated in accordance with the ~~safety audit~~ **Annex 3 of this Regulation.**

The lane keep capability shall be tested in accordance with the relevant vehicle test(s) specified in **paragraph 9**.

7.6.3. Steering override

7.6.3.1. The steering control effort necessary to override the directional control provided by the system shall not exceed 50 N. Significant loss of steering support once overridden shall not happen suddenly.

7.6.3.2. For CDCF systems which do not act on the steering itself (e.g. differential braking type CDCF), the steering input shall not exceed 25 degrees.

7.6.3.3. The steering override control effort shall be tested in accordance with the relevant vehicle test(s) specified in **paragraph 9**.

7.6.4. CDCF warning indication

7.6.4.1. Every CDCF intervention shall immediately be indicated to the driver by a visual warning signal which is displayed for at least 1 second or as long as the intervention exists, whichever is longer. The visual signal may be the flashing of the failure warning signal specified in **paragraph 7.1.1.**

7.6.4.1.1. In the case of an intervention longer than 10 seconds, an acoustic warning signal shall be provided until the end of the intervention unless there is a driver action which indicates an intention to depart from the lane.

7.6.4.1.2. 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 this 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.

7.6.4.2. The requirements in **paragraph 7.6.4.1.1** and **7.6.4.1.2** shall be tested in accordance with the relevant vehicle test(s) specified in **paragraph 9.**

8. Test requirements for LDWS

8.1. General provisions

Vehicles fitted with LDWS shall fulfil the appropriate tests requirements of this point

8.2. Testing conditions

The tests shall be performed:

(a) On a flat and dry asphalt or concrete road type surface, which may not contain any irregularities (e.g. large dips or cracks, manhole covers or reflective studs) within a lateral distance of 3,0 m to either side of the centre of the test lane and with a longitudinal distance of 30 m ahead of the subject vehicle from the point after the test is complete.

(b) In ambient illumination conditions of at least 2 000 lux without blinding of the sensors (e.g. direct blinding sunlight) and with activated low beam head lamps if necessary.

(c) In ambient air temperatures between 5 °C and 45 °C.

(d) In the absence of weather conditions affecting the visibility of lane markings, e.g. fog.

~~At the manufacturer's discretion and with the agreement of the Technical Service the tests may be performed under conditions deviating from what is described above (e.g. at lower ambient air temperatures).~~

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.

8.2.1. Lane markings

The solid line and dashed lane markings on the road used for the tests shall be in line with one of those described in Annex 3 (Visible lane marking identification) to UN Regulation No 130. 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 (measured between the lane markings) shall be a minimum of 3,5 m for the purpose of the tests of this point. The vehicle manufacturer shall demonstrate, through the use of documentation, compliance with all other lane markings identified in Annex 3 (Visible lane marking identification) to UN Regulation No 130. Any of such documentation shall be appended to the test report.

8.2.2. Subject vehicle conditions

8.2.2.1. Test mass

The subject vehicle shall be tested in 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.

8.2.2.2. The subject vehicle shall be tested at the tyre pressures recommended by the vehicle manufacturer.

8.2.2.3. Where the LDWS is equipped with a user-adjustable warning threshold, the tests specified in **paragraph 8.3** shall be performed with the warning threshold set at its maximum lane departure setting. No alteration shall be made once the test procedure has begun.

8.2.2.4. Pre-test conditioning

If requested by the vehicle manufacturer the vehicle can be driven to calibrate the sensor system up to a maximum of 100 km on a mixture of urban and rural roads with other traffic and roadside furniture.

8.3. Test procedures

8.3.1. Visual warning signal verification test

With the vehicle stationary check that the visual warning signal(s) comply with the requirements of **paragraph 7.5.3.2.**

8.3.2. Lane departure warning test

8.3.2.1. Drive the vehicle at a speed of 70 km/h +/– 3 km/h into the centre of the test lane in a smooth manner so that the attitude of the vehicle is stable.

Maintaining the prescribed speed, gently drift the vehicle, either to the left or the right, with a lateral departure velocity of between 0,1 and 0,5 m/s so that the vehicle crosses the lane marking.

Repeat the test at a different rate of departure within the range 0,1 and 0,5 m/s. Repeat the above tests drifting in the opposite direction.

8.3.2.2. The test requirements are fulfilled if the LDWS provides the lane departure warning indication mentioned in **paragraph 7.5.3.1** above at the latest when the DLTM is – 0,3 m.

8.3.2.3. In addition, the vehicle manufacturer shall demonstrate to the satisfaction of the Technical Service that the requirements for the whole speed range and lateral departure velocity range are fulfilled. This may be achieved on the basis of appropriate documentation appended to the test report.

8.3.3. Manual deactivation test

8.3.3.1. If the vehicle is equipped with means to manually deactivate the ELKS (LDWS), turn the vehicle master control switch **[engine start or run cycle]** to the 'Power ON' position and deactivate the ELKS (LDWS). The warning signal specified in **paragraph 7.2.3** shall be activated.

Turn the master control switch **[engine start or run cycle]** to the 'Power OFF' position. Turn the vehicle master control switch **[engine start or run cycle]** to the 'Power ON' position and verify that the previously activated warning signal is not reactivated, thereby indicating that the ELKS (LDWS) has been reinstated as specified in **paragraph 7.2.1.1.**

9. Test requirements for CDCF

9.1. General provisions

Vehicles fitted with CDCF shall fulfil the appropriate tests requirements of this point.

9.2. Testing conditions

The tests shall be performed:

(a) On a flat and dry asphalt or concrete road type surface, which may not contain any irregularities (e.g. large dips or cracks, manhole covers or reflective studs) within a lateral distance of 3,0 m to either side of the centre of the test lane and with a longitudinal distance of 30 m ahead of the subject vehicle from the point after the test is complete.

(b) In ambient illumination conditions of at least 2 000 lux without blinding of the sensors (e.g. direct blinding sunlight) and with activated low beam head lamps if necessary.

(c) In ambient air temperatures between 5 °C and 45 °C.

(d) In the absence of weather conditions affecting the dynamic performance of the vehicle (e.g. no storm, not below 5 °C) or the visibility of lane markings (e.g. fog).

~~At the manufacturer's discretion and with the agreement of the Technical Service the tests may be performed under conditions deviating from what is described above (e.g. at lower ambient air temperatures).~~

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.

9.2.1. Lane markings

The solid lane marking on the road used for the tests shall be in line with one of those described in Annex 3 (Visible lane marking identification) to UN Regulation No 130. The marking shall be in good condition and of a material conforming to the standard for visible lane markings. The lane-marking used for the tests shall be recorded in the test report.

The solid lane marking shall be a minimum of 3,5 m distance from any other lane markings, for the purpose of the tests of this point. The vehicle manufacturer shall demonstrate, through the use of documentation, compliance with all other solid lane markings identified in Annex 3 (Visible lane marking identification) to UN Regulation No 130. Any of such documentation shall be appended to the test report.

9.2.2. Subject vehicle conditions

9.2.2.1. Test mass

The subject vehicle shall be tested in 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.

9.2.2.2. The subject vehicle shall be tested at the tyre pressures recommended by the vehicle manufacturer.

9.2.2.3. Where the CDCF is equipped with a user-adjustable timing threshold, the test specified in **paragraph 9.3.3** shall be performed with the timing threshold set at its latest setting for system intervention. No alteration shall be made once the test procedure has begun.

9.2.2.4. Pre-test conditioning

If requested by the vehicle manufacturer the vehicle can be driven to calibrate the sensor system up to a maximum of 100 km on a mixture of urban and rural roads with other traffic and roadside furniture.

9.3. Tests procedures

9.3.1. Warning Indication test

9.3.1.1. The subject vehicle shall be driven with an activated CDCF on a road with solid lane markings on at least one side of the lane.

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

During the test, the duration of the CDCF interventions and of the visual and acoustic warning signals shall be recorded.

In the case referred to in **paragraph 7.6.4.1.1**, the subject vehicle shall be driven such that it attempts to leave the lane and causes CDCF intervention to be maintained for a period longer than 10 seconds. 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 the acoustic warning is provided no later than 10 seconds after the beginning of the intervention.

In the case referred to in **paragraph 7.6.4.1.2.**, the subject vehicle shall be driven in such a way that it attempts to leave the lane and causes at least three interventions of the system within a rolling interval of 180 seconds.

The test requirements are fulfilled if all the following conditions are met:

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

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

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

9.3.1.2. In addition, the manufacturer shall demonstrate to the satisfaction of the Technical Service that the requirements defined in **paragraph 7.6.4.1.1** and **7.6.4.1.2** are fulfilled in the whole range of CDCF operation. This may be achieved on the basis of appropriate documentation appended to the test report.

9.3.2. Steering override test

9.3.2.1. The subject vehicle shall be driven with an activated CDCF on a road with solid lane markings on each side of the lane.

The test conditions and the subject 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 CDCF intervention. During the intervention, the driver shall apply the steering control effort necessary to override the intervention.

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

The test requirements are fulfilled if:

(a) The force applied by the driver on the steering control to override the intervention does not exceed 50 N.

(b) There is no sudden loss of significant steering support once CDCF is overridden.

(c) For ELKS that do not act on the steering itself (e.g. differential braking type CDCF), the steering input does not exceed 25 degrees.

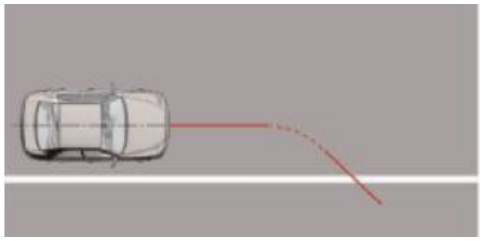
9.3.2.2. In addition, the manufacturer shall demonstrate to the satisfaction of the Technical Service that the requirements defined in **paragraph 7.6.4** are fulfilled in the whole range of CDCF operation. This may be achieved on the basis of appropriate documentation appended to the test report.

9.3.3. Lane keep test

9.3.3.1. The CDCF shall be tested for test scenarios No 1 and No 2 described in **paragraph 7.6.2.**

9.3.3.1.1. Tests for all scenarios shall be performed with lateral velocities of 0,2 m/s and 0,5 m/s.

9.3.3.1.2. A test path shall be driven which consists of an initial straight path parallel to the solid lane marking being tested, followed by a fixed radius curve to apply a known lateral velocity and yaw to the subject vehicle, followed again by a straight path without any force applied on the steering control (e.g. by removing the hands from the steering control).



9.3.3.1.3. The subject vehicle speed during the test up to the point of system intervention shall be 72 km/h +/– 1 km/h.

The curve of fixed radius driven to apply the lateral velocity required shall have a radius 1200 m or more.

The lateral velocity required shall be achieved to a tolerance of +/– 0,05 m/s.

The vehicle manufacturer shall provide information describing the radius of the curve to be driven and the location when the closed loop

path and/or speed control shall be ended so as to ensure a free drifting in order not to interfere an automatic suppression according to **paragraph 7.3.1.**

9.3.3.2. The test requirements are fulfilled if the subject vehicle does not cross the lane marking by a DTLM of more than – 0,3 m.

9.3.3.3. In addition, the vehicle manufacturer shall demonstrate to the satisfaction of the Technical Service that the requirements for the whole speed range and lateral departure velocity range are fulfilled. This may be achieved on the basis of appropriate documentation appended to the test report.

Annex 3

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

1. General

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

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

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

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

2. Definitions

For the purposes of this annex,

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

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

2.3. *"Electronic Control System"* means a combination of units, designed to cooperate in the production of the stated vehicle control function by electronic data processing. Such systems, often controlled by software, are built from discrete functional components such as sensors, electronic control units and actuators and connected by transmission

links. They may include mechanical, electro-pneumatic or electro-hydraulic elements.

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

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

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.

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.

2.8. *"Range of control"* refers to an output variable and defines the range over which the system is likely to exercise control.

2.9. *"Boundary of functional operation"* defines the boundaries of the external physical limits within which the system is able to maintain control.

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

3. Documentation

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" 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 Regulation; and,

(c) Was developed according to the development process/method declared by the manufacturer.

3.1.1. Documentation shall be made available in two parts:

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

(b) Additional material and analysis data of paragraph 3.4.4. which shall be retained by the manufacturer, but made open for inspection at the time of type approval. The manufacturer shall ensure that this material and analysis data remains available for a period of 10 years counted from the time when production of the vehicle is definitely discontinued."

3.2. Description of the functions of "The System"

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

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

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

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 (paragraph 2.7.) exercised on each such variable shall be defined.

3.2.3. Limits defining the boundaries of functional operation (paragraph 2.8.) shall be stated where appropriate to system performance.

3.3. System layout and schematics

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.

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.

3.3.3. Interconnections

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

3.3.4. Signal flow, operating data and priorities

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

3.3.5. Identification of units

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

Where functions are combined within a single unit or indeed within a single computer, but shown in multiple blocks in the block diagram for clarity and ease of explanation, only a single hardware identification marking shall be used. The manufacturer shall, by the use of this identification, affirm that the equipment supplied conforms to the corresponding document.

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 Regulation is concerned, this identification shall also be changed.

3.4. Safety concept of the manufacturer

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.

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

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.

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.

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

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.

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

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

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

(a) Inspection of the safety approach at the concept (vehicle) level with confirmation that it includes consideration of interactions with other vehicle systems. This approach shall be based on a Hazard / Risk analysis appropriate to system safety.

(b) Inspection of the safety approach at the system level. This approach shall be based on a Failure Mode and Effect Analysis (FMEA), a Fault Tree Analysis (FTA) or any similar process appropriate to system safety.

(c) Inspection of the validation plans and results. This validation shall use, for example, Hardware in the Loop (HIL) testing, vehicle on–road operational testing, or any means appropriate for validation.

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

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

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 paragraph 3.4.4. of this annex, the warning signal to be given to the driver and/or to service/technical inspection personnel.

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.

4. Verification and test

4.1. The functional operation of "The System", as laid out in the documents required in paragraph 3., shall be tested as follows:

4.1.1. Verification of the function of "The System"

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

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

4.1.2. Verification of the safety concept of paragraph 3.4.

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

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

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.

5. Reporting by Technical Service

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

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

Annex 3 - Appendix 1

Model assessment form for electronic systems

Test report No: .....

1. Identification

1.1. Vehicle make: .....

1.2. Type: .....

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

1.4. Location of that marking:.....

1.5. Manufacturer’s name and address: .....

1.6. If applicable, name and address of manufacturer’s representative: .....

1.7. Manufacturer's formal documentation package:

Documentation reference No: .....
Date of original issue: .....
Date of latest update: .....

2. Test vehicle(s)/system(s) description

2.1. General description: .....

2.2. Description of all the control functions of "The System", and methods of operation: .....

2.3. Description of the components and diagrams of the interconnections within "The System": .....

3. Manufacturer's safety concept

3.1. Description of signal flow and operating data and their priorities: .....

3.2. Manufacturer's declaration:

The manufacturer(s) ..... affirm(s) that the strategy chosen to achieve "The System", objectives will not, under non-fault conditions, prejudice the safe operation of the vehicle.

3.3. Software outline architecture and the design methods and tools used: .....

3.4. Explanation of design provisions built into "The System" under fault conditions:.....

3.5. Documented analyses of the behaviour of "The System" under individual hazard or fault conditions: .....

3.6. Description of the measures in place for environmental conditions: .....

3.7. Provisions for the periodic technical inspection of "The System": .....

3.8. Results of "The System" verification test, as per para. 4.1.1. of Annex 3 to UN Regulation No. XX: .....

3.9. Results of safety concept verification test, as per para. 4.1.2. of Annex 3 to UN Regulation No. XX: .....

3.10. Date of test: .....

3.11. This test has been carried out and the results reported in accordance with ….. to UN Regulation No. XX as last amended by the ..... series of amendments.

Technical Service[2] carrying out the test
Signed: ..... Date: .....

3.12. Type Approval Authority[5]

Signed: ..... Date: .....

3.13. Comments: .....

[2] 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.

II. Justification

1. Australia is examining the case to mandate the fitment of ELKS for vehicle categories equivalent to M_1 and N_1.

2. Research published by the Monash University Accident Research Centre (MUARC) reported that 11 per cent of casualty crashes and 42 per cent of fatal crashes involving light vehicles in Australia (between 2013 to 2019) comprised of unintentional lane departure crashes occurring on sealed roads (without snow or ice) with speed limits of ≥ 70 km/h. Unintentional lane departure crashes included single-vehicle and multi-vehicle head-on and sideswipe crashes. Unintentional lane departure crashes represented 55 per cent of all road fatalities involving light vehicles, with this number increasing to 72 per cent at highway speeds of >=100 km/h (Stuart et al. 2021).

3. The MUARC research demonstrated that ELKS is effective in reducing road trauma resulting from crashes involving unintentional lane departures. Results estimated a 9.09 per cent saving in total annul fatal crashes when 100 per cent of the light vehicle fleet is fitted with a lane keep assist system. This corresponded to a 11.9 per cent saving in total annual fatalities (Stuart et al. 2021).

4. A feasible option is to adopt the technical requirements from EU Regulation 2021/646 into a new UN Regulation.

5. This proposal will provide a consistent approach across all Contracting Parties for the performance requirements and regulation of ELKS in vehicles of category M_1 and N_1.

6. (empty)

III. References

Stuart Newstead, Linda Watson, Laurie Budd. 2021. The Potential Benefits of Lane Keep Assist Systems in Australian Light Vehicles. Melbourne: Monash University Accident Research Centre (MUARC). Accessed November 1, 2023.