

E/ECE/324 }
E/ECE/TRANS/505 } Rev.2/Add.LDWS

day month 20XX

AGREEMENT

**ADOPTION OF UNIFORM TECHNICAL PRESCRIPTIONS
S, EQUIPMENT AND PARTS WHICH CAN BE FITTED
HEELED VEHICLES AND THE CONDITIONS FOR
TION OF APPROVALS GRANTED ON THE BASIS OF
THESE PRESCRIPTIONS */**

(as amended by amendments which entered into force on 16 October 1995)

Addendum LDWS: Regulation No. LDWS+1

Date of entry into force: XXX

UNIFORM PROVISIONS CONCERNING THE APPROVAL OF MOTOR VEHICLES WITH REGARD TO THE LANE DEPARTURE WARNING SYSTEM



UNITED NATIONS

*/ Former title of the Agreement:

Agreement Concerning the Adoption of Uniform Conditions of Approval and Reciprocal Recognition of Approval for Motor Vehicle Equipment and Parts, done at Geneva on 20 March 1958.

GE.10-

Notes from the AEBS/LDWS Secretariat :

- This document is the final draft for a regulatory text on Lane Departure Warning System.
- Pending items are indicated between square brackets:
 - Paragraph 5.4.1. – warning indication
 - Paragraph 6.7.1. – manual system de-activation
- The secretary found not relevant to consider the system variant (paragraph 6.1.3.3.) as a parameter for defining the type of vehicle with regards to its LDWS (Paragraph 2.2.).

Regulation No. LDWS

UNIFORM PROVISIONS CONCERNING THE APPROVAL OF MOTOR VEHICLES
WITH REGARD TO THE LANE DEPARTURE WARNING SYSTEM

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DfT ADDED COMMENT

Annex 4: *Special requirements to be applied to the safety aspects of complex electronic*

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vehicle control systems

1. SCOPE

This Regulation applies to the lane departure warning system of vehicles of category M₂, N₂, M₃ and N₃^{1/}.

2. DEFINITIONS

For the purposes of this Regulation:

- 2.1. "Approval of a vehicle type" means the full procedure whereby a Contracting Party to the Agreement certifies that a vehicle type meets the technical requirements of this Regulation;
- 2.2. "Vehicle type with regard to its Lane Departure Warning System" means a category of vehicles which do not differ in such essential respects as:
- (a) the manufacturer's trade name or mark,
 - (b) vehicle features which significantly influence the performances of the Lane Departure Warning System,
 - (c) the type and design of the Lane Departure Warning System.
- 2.3. "Lane Departure Warning System (LDWS)" means a system to warn the driver of an unintentional drift of the vehicle out of its travel lane.

DfT ADDED COMMENT

- 2.4. "Lane" means one of the longitudinal strips into which a roadway is divided, *and intended for use by a single vehicle.*
- 2.5. "Visible lane marking" means delineators intentionally placed on the borderline of the lane that are directly visible by the driver while driving (e.g. not covered by snow, etc.).
- 2.6. "Rate of departure" means the subject vehicle's approach velocity at a right angle to the visible lane marking at the warning issue point.

DfT ADDED COMMENT

- 2.7. "*Common space*" means an area on which two or more information functions (e.g. symbols may be displayed, but not simultaneously).

3. APPLICATION FOR APPROVAL

^{1/} As defined in Annex 7 to the Consolidated Resolution on the Construction of Vehicles (R.E.3) (document TRANS/WP.29/78/Rev.1/Amend.4, as last amended by Amend.4).

- 3.1. The application for approval of a vehicle type with regard to the LDWS shall be submitted by the vehicle manufacturer or by his authorized representative.
- 3.2. It shall be accompanied by the documents mentioned below in triplicate and include the following particular:
- 3.2.1. a description of the vehicle type with regard to the items mentioned in paragraph 5., together with dimensional drawings and the documentation as referred to in paragraphs 6.1.3.2 and 6.1.3.3. The numbers and/or symbols identifying the vehicle type shall be specified.
- 3.3. A vehicle representative of the vehicle type to be approved shall be submitted to the Technical Service conducting the approval tests.
4. APPROVAL
- 4.1. If the vehicle type submitted for approval pursuant to this Regulation meets the requirements of paragraph 5., approval of that vehicle type shall be granted.
- 4.2. An approval number shall be assigned to each vehicle type approved; its first two digits (00 for the Regulation in its initial form) shall indicate the series of amendments incorporating the most recent major technical amendments made to the Regulation at the time of issue of the approval. The same Contracting Party shall not assign the same number to the same vehicle type equipped with another type of lane departure warning system, or to another vehicle type.
- 4.3. Notice of approval or of refusal or withdrawal of approval pursuant to this Regulation shall be communicated to the Parties to the Agreement applying this Regulation by means of a form conforming to the model in Annex 1 and photographs and/or plans supplied by the applicant being in a format not exceeding A4 (210 x 297 mm), or folded to that format, and on an appropriate scale.
- 4.4. There shall be affixed, conspicuously and in a readily accessible place specified on the approval form, to every vehicle conforming to a vehicle type approved under this Regulation, an international approval mark conforming to the model described in Annex 2, consisting of:
- 4.4.1 a circle surrounding the letter "E" followed by the distinguishing number of the country which has granted approval 2/;

2/ 1 for Germany, 2 for France, 3 for Italy, 4 for the Netherlands, 5 for Sweden, 6 for Belgium, 7 for Hungary, 8 for the Czech Republic, 9 for Spain, 10 for Serbia, 11 for the United Kingdom, 12 for Austria, 13 for Luxembourg, 14 for Switzerland, 15 (vacant), 16 for Norway, 17 for Finland, 18 for Denmark, 19 for Romania, 20 for Poland, 21 for Portugal, 22 for the Russian Federation, 23 for Greece, 24 for Ireland, 25 for Croatia, 26 for Slovenia, 27 for

- 4.4.2. the number of this Regulation, followed by the letter "R", a dash and the approval number to the right of the circle prescribed in paragraph 4.4.1.
- 4.5. If the vehicle conforms to a vehicle type approved under one or more other Regulations annexed to the Agreement, in the country which has granted approval under this Regulation, the symbol prescribed in paragraph 4.4.1. need not be repeated; in such a case, the Regulation and approval numbers and the additional symbols shall be placed in vertical columns to the right of the symbol prescribed in paragraph 4.4.1.
- 4.6. The approval mark shall be clearly legible and be indelible.
- 4.7. The approval mark shall be placed close to or on the vehicle data plate.
5. SPECIFICATIONS
- 5.1. General
- 5.1.1. Any vehicle fitted with a LDWS complying with the definition of paragraph 2.3 shall meet the requirements contained in paragraphs 5.1 to 5.4 of this Regulation.
- 5.1.2. The effectiveness of the LDWS shall not be adversely affected by magnetic or electrical fields. This shall be demonstrated by compliance with Regulation No. 10, 03 Series of Amendments.
- 5.2. Performance requirements

DfT ADDED COMMENT

- 5.2.1. Whenever the system is active, as specified in paragraph 5.2.3., the LDWS shall warn the driver if the vehicle crosses over a visible lane marking for the lane in

Slovakia, 28 for Belarus, 29 for Estonia, 30 (vacant), 31 for Bosnia and Herzegovina, 32 for Latvia, 33 (vacant), 34 for Bulgaria, 35 (vacant), 36 for Lithuania, 37 for Turkey, 38 (vacant), 39 for Azerbaijan, 40 for The former Yugoslav Republic of Macedonia, 41 (vacant), 42 for the European Community (Approvals are granted by its Member States using their respective ECE symbol), 43 for Japan, 44 (vacant), 45 for Australia, 46 for Ukraine, 47 for South Africa, 48 for New Zealand, 49 for Cyprus, 50 for Malta, 51 for the Republic of Korea, 52 for Malaysia, 53 for Thailand, 54 and 55 (vacant), 56 for Montenegro, 57 (vacant) and 58 for Tunisia. Subsequent numbers shall be assigned to other countries in the chronological order in which they ratify or accede to the Agreement Concerning the Adoption of Uniform Technical Prescriptions for Wheeled Vehicles, Equipment and Parts which can be Fitted and/or be Used on Wheeled Vehicles and the Conditions for Reciprocal Recognition of Approvals Granted on the Basis of these Prescriptions, and the numbers thus assigned shall be communicated by the Secretary-General of the United Nations to the Contracting Parties to the Agreement.

which it is running, on a road with a directional form that varies between straight and a curve having an inner lane marking with a minimum radius of 250 m, when there has been no *intention or system intervention* to do so. Specifically:

- 5.2.1.1. it shall provide the driver with the warning specified in paragraph 5.4.1. when tested in accordance with the provisions of paragraph 6.5. (departure warning test) and with lane markings as specified in paragraph 6.1.3.,
- 5.2.1.2. the warning mentioned in paragraph 5.2.1. may be suppressed when there is a driver action which indicates an intention to depart from the lane.
- 5.2.2 The system shall also provide the driver with the warning specified in paragraph 5.4.2. when tested in accordance with the provisions of paragraph 6.6. (failure detection test).
- 5.2.3. The LDWS shall be active at least at vehicle speeds above 60 km/h, unless manually de-activated as per paragraph 5.3.

DJT ADDED COMMENT

5.3. System Deactivation

The manufacturer may include an LDWS deactivation control, which shall be illuminated when the [driver chooses to deactivate the system]/[system has been deactivated]. If a vehicle is equipped with a means to deactivate the LDWS function, the following conditions shall apply as appropriate:

- 5.3.1 A control, whose only purpose is to deactivate the LDWS, shall be identified by the symbol [add picture below] for lane departure warning with the word "OFF" or the text "LDWS OFF".***

INSERT SYMBOL

[Alternatively, in the case where the LDWS deactivation is controlled by a multi-functional control, the driver display shall identify clearly to the driver the control position for this mode using either the symbol above. or the text "LDWS OFF".]

- 5.3.2. The LDWS function shall be automatically reinstated at the initiation of each new ignition "on" (run) cycle. This should be achievable without removing the key or other means to activate the ignition system. The system shall be tested in accordance with the provisions of paragraph 6.7.***
- 5.3.3. A constant optical warning signal shall inform the driver that the LDWS function has been deactivated. The yellow warning signal specified in paragraph 5.4.2 may be used for this purpose.***

5.4. Warning indication

DfT ADDED COMMENT

- 5.4.1. The lane departure warning referred to in paragraph 5.2.1. shall be noticeable by the driver and be provided by:
- *at least* two warning means out of optical, acoustic and haptic, or
 - one warning means out of haptic and acoustic, with spatial indication about the *direction of unintended drift of the vehicle.*

DfT ADDED COMMENT

- 5.4.1.1 *Where* an optical signal is used for *the secondary* lane departure warning, *it may use the failure warning signal as specified in paragraph 5.4.2 in a flashing mode.*

DfT ADDED COMMENT

- 5.4.2. The failure warning referred to in paragraph 5.2.2. shall be a *constant* yellow optical warning signal. *The warning signal shall be displayed, even following an ignition ‘off’ ‘on’ cycle as long as the failure or defect persists and the ignition (start) switch is in the ‘on’ (run) position.*

DfT ADDED COMMENT

- 5.4.3. *The* LDWS warning signals shall be activated either when the ignition (start) switch is turned to the "on" (run) position or when the ignition (start) switch is in a position between the "on" (run) and "start" that is designated by the manufacturer as a check position (*initial system (power-on)* check). This requirement does not apply to warning signals shown in a common space.

- 5.4.4. The optical 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.

DfT ADDED COMMENT

- 5.4.5. The failure warning signal specified in paragraph 5.4.2 may also be used to indicate that LDWS is temporarily not available, *for example due to inclement weather conditions.*

6. TEST PROCEDURE

6.1. Test conditions

- 6.1.1. The test shall be performed on a flat, dry asphalt or concrete surface.

- 6.1.2. The ambient temperature shall be between 0° C and 45° C.

6.1.3. Visible lane markings

- 6.1.3.1. The visible lane markings used in the lane departure warning tests of paragraph 6.5. shall be those of one of the Contracting Parties applying this Regulation as identified

in Annex 3 to this Regulation, with the markings being in good condition and of a material conforming to the standard for visible lane markings of that Contracting Party. The visible lane marking layout used for the testing shall be recorded.

DJT ADDED COMMENT

6.1.3.2 The vehicle manufacturer shall demonstrate, through the use of documentation, compliance with the lane markings of all the other Contracting Parties applying this Regulation as far as they are identified in Annex 3 to this Regulation *and of any cases of other regional specific adjustments so that the requirements of this regulation are fulfilled in all variants*. Any such documentation shall be appended to the test report.

Commentaire [CR1]: This needs expanding for clarification for Technical services

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

6.2. Accuracy of the measurements

6.2.1. Distances shall be measured with an accuracy of +/- 5cm.

6.2.2. Speeds shall be measured with an accuracy of +/- 3 km/h.

6.2.3. Rate of departure accuracy shall be measured with an accuracy of +/- 0.1 m/s.

6.3. Vehicle conditions

DJT ADDED COMMENT

6.3.1. Test weight

The vehicle may be tested at any condition of load, the distribution of the mass among the axles being that stated by the vehicle manufacturer without exceeding any of the maximum permissible mass for each axle. No alteration shall be made once the test procedure has begun. *The vehicle manufacturer shall demonstrate that the system works at all conditions of load.*

6.3.2. The vehicle shall be tested at the tyre pressures stated by the manufacturer for normal road use.

6.3.3 In the case where the LDWS is equipped with a user-adjustable warning threshold, the test as specified in paragraph 6.5. 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.

6.4. Optical warning signal verification test

With the vehicle stationary check that the optical warning signal(s) comply with the requirements of paragraph 5.4.3.

6.5. Lane departure warning test

6.5.1 Drive the vehicle at a speed of 65 km/h into the centre of the test lane in a smooth manner so that the attitude of the vehicle is stable.

DfT ADDED COMMENT

Maintaining the prescribed speed, gently drift the vehicle, either to the left or the right, at a rate of departure of between 0.1 and 0.8 m/s so that the vehicle crosses the *lane marking for the edge of the roadway*. Repeat the test at a different rate of departure within the range 0.1 and 0.8 m/s.

DfT ADDED COMMENT

Repeat the above tests drifting in the opposite direction *so that the vehicle crosses the lane marking for the centreline of the roadway*.

DfT ADDED COMMENT

6.5.2. The LDWS shall provide the lane departure warning indication mentioned in paragraph 5.4.1. at the latest when the outside of the tyre of the vehicle's front wheel *closest to the lane markings* crosses a line 0,3 m beyond the outside edge of the visible lane marking.

6.6. Failure detection test

6.6.1. Simulate a LDWS failure, for example by disconnecting the power source to any LDWS component or disconnecting any electrical connection between LDWS components. When simulating a LDWS failure, neither the electrical connections for the failure warning signal of paragraph 5.4.2 or the LDWS disable control of paragraph 5.3. shall be disconnected.

6.6.2. The failure warning signal mentioned in paragraph 5.4.2. shall be activated and remain activated while the vehicle is being driven and be reactivated after a subsequent ignition "off" ignition "on" cycle as long as the simulated failure exists.

6.7. Deactivation Test

DfT SUPPORT COMMENT

6.7.1 *If the vehicle is equipped with means to deactivate the LDWS, turn the ignition (start) switch to the "on" (run) position and deactivate the LDWS. The warning signal mentioned in paragraph 5.3.2. shall be activated. Turn the ignition (start) switch to the "off" position. Again, turn the ignition (start) switch to the "on" (run) position and verify that the previously activated warning signal is not re-activated, thereby indicating that the LDWS has been reinstated as specified in paragraph 5.3.1.*

7. MODIFICATION OF VEHICLE TYPE AND EXTENSION OF APPROVAL

- 7.1. Every modification of the vehicle type as defined in paragraph 2.2. shall be notified to the Administrative Department which approved the vehicle type. The department may then either:
- 7.1.1. consider that the modifications made do not have an adverse effect on the conditions of the granting of the approval and grant an extension of approval;
- 7.1.2. consider that the modifications made affect the conditions of the granting of the approval and require further tests or additional checks before granting an extension of approval.
- 7.2. Confirmation or refusal of approval, specifying the alterations, shall be communicated by the procedure specified in paragraph 4.3. to the Contracting Parties to the Agreement applying this Regulation.
- 7.3. The Competent Authority shall inform the other Contracting Parties of the extension by means of the communication form which appears in Annex 2 to this Regulation. It shall assign a serial number to each extension, to be known as the extension number.
8. CONFORMITY OF PRODUCTION
- 8.1. Procedures concerning conformity of production shall conform to the general provisions defined in Article 2 and Appendix 2 to the Agreement (E/ECE/324-E/ECE/TRANS/505/Rev.2) and meet the following requirements:
- 8.2. A vehicle approved pursuant to this Regulation shall be so manufactured as to conform to the type approved by meeting the requirements of paragraph 5.;
- 8.3. The Competent Authority which has granted the approval may at any time verify the conformity of control methods applicable to each production unit. The normal frequency of such inspections shall be once every two years.
9. PENALTIES FOR NON-CONFORMITY OF PRODUCTION
- 9.1. The approval granted in respect of a vehicle type pursuant to this Regulation may be withdrawn if the requirements laid down in paragraph 8. are not complied with.
- 9.2. If a Contracting Party withdraws an approval it had previously granted, it shall forthwith so notify the other Contracting Parties applying this Regulation by sending them a communication form conforming to the model in Annex 1 to this Regulation.
10. PRODUCTION DEFINITELY DISCONTINUED

If the holder of the approval completely ceases to manufacture a type of vehicle approved in accordance with this Regulation, he shall so inform the authority which granted the approval, which in turn shall forthwith inform the other Contracting Parties to the Agreement applying this Regulation by means of a communication form conforming to the model in Annex 1 to this Regulation.

11. NAMES AND ADDRESSES OF THE TECHNICAL SERVICES RESPONSIBLE FOR CONDUCTING APPROVAL TESTS AND OF ADMINISTRATIVE DEPARTMENTS

The Contracting Parties to the Agreement applying this Regulation shall communicate to the United Nations Secretariat the names and addresses of the Technical Services responsible for conducting approval tests and of the Administrative Departments which grant approval and to which forms certifying approval or extension or refusal or withdrawal of approval are to be sent.

Annex 1

COMMUNICATION

(Maximum format: A4 (210 x 297 mm))



issued by :

Name of administration:

.....
.....
.....

concerning: 2/

APPROVAL GRANTED
APPROVAL EXTENDED
APPROVAL REFUSED
APPROVAL WITHDRAWN
PRODUCTION DEFINITELY DISCONTINUED

of a type of vehicle with regard to the lane departure warning system (LDWS) pursuant to Regulation No. LDWS+1

Approval No.:Extension No.:

1. Trademark:
2. Type and trade name(s):
3. Name and address of manufacturer:
4. If applicable, name and address of manufacturer's representative:
.....
5. Brief description of vehicle:
6. Data to enable the identification of reference point "R" of the seating position designated for the driver in relation to the primary reference marks:
.....
7. Identification, place and relative positions of the primary reference marks:
8. Date of submission of vehicle for approval:
9. Technical Service performing the approval tests:

10. Date of report issued by that service:
11. Number of report issued by that service:
12. Approval with regard to the LDWS is granted/refused: 2/
13. Place:
14. Date:
15. Signature:
16. Annexed to this communication are the following documents, bearing the approval number indicated above:

..... dimensional drawings
17. Any remarks:

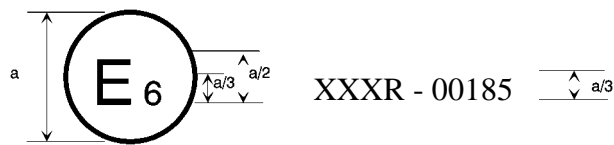
1/ Distinguishing number of the country which has granted/extended/refused/withdrawn an approval (see approval provisions in the Regulation).

2/ Delete what does not apply.

Annex 2

ARRANGEMENTS OF APPROVAL MARKS

(see paragraphs 4.4. to 4.4.2. of this Regulation)



$a = 8 \text{ mm min}$

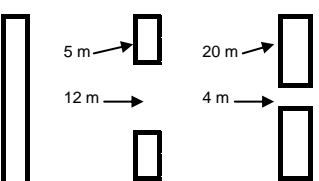



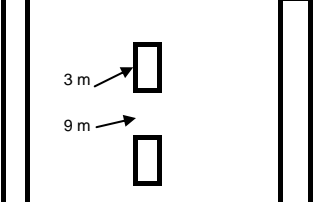
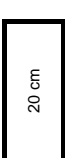

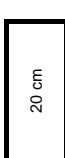
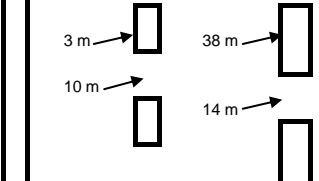

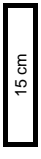

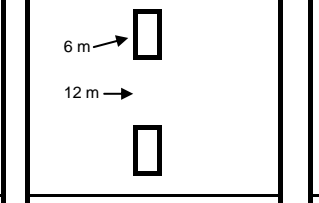


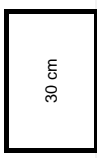
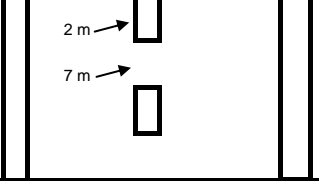



The above approval mark affixed to a vehicle shows that the vehicle type concerned has been approved in Belgium (E6) with regard to the LDWS pursuant to Regulation No. LDWS+1. The first two digits of the approval number indicate that the approval was granted in accordance with the requirements of Regulation No. LDWS+1 in its original form.

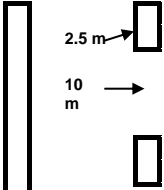



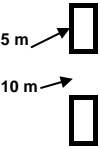



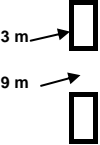



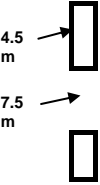



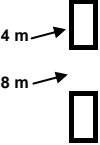


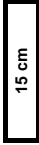
Annex 3

VISIBLE LANE MARKING IDENTIFICATION

1. For the purpose of the approval test referred to in paragraphs 6.1.3. and 6.5. of this Regulation, the test lane width shall be greater than 3.5 m.
2. The visible lane markings identified in Table 1 below are assumed to be white, unless otherwise indicated in this Annex.
3. Table of identified visible lane markings to be used for approval test in accordance with Paragraphs 6.1.3. and 6.5. of this Regulation.

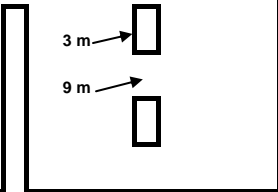



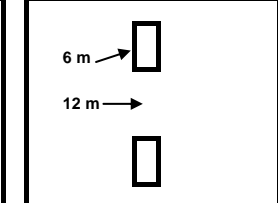

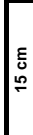

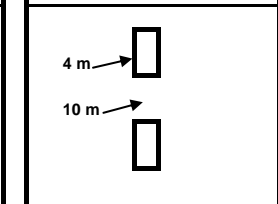

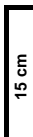

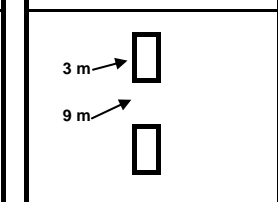
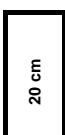
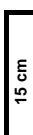

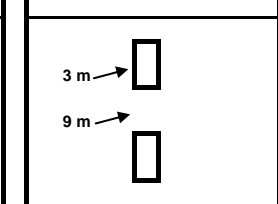
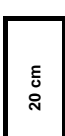
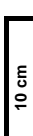

DfT COMMENTS ON DIAGRAMS

PATTERN			COUNTRY	WIDTH		
Left road marking	Centre line of roadway	Right road marking		Left road marking	Centre line of roadway	Right road marking
			SPAIN			
			SWEDEN			
			FRANCE			
			GERMANY			
			UNITED KINGDOM			

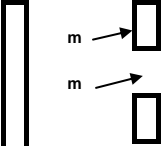
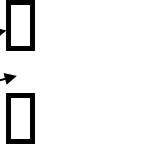
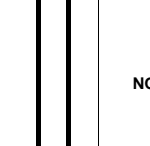



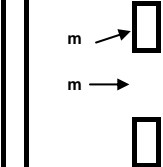
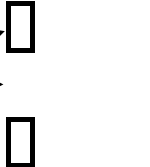
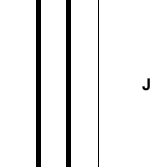
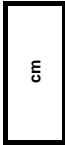


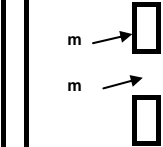
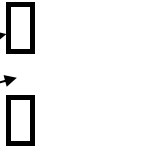
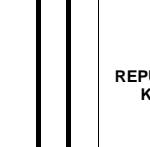
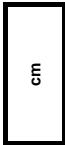

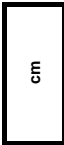
PATTERN			COUNTRY	WIDTH		
Left road marking	Centre line of roadway	Right road marking		Left road marking	Centre line of roadway	Right road marking
			BELGIUM			
			DENMARK			
			THE NETHERLANDS			
			ITALY			
			IRELAND			

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PATTERN			COUNTRY	WIDTH		
Left road marking	Centre line of roadway	Right road marking		Left road marking	Centre line of roadway	Right road marking
			GREECE			
			SWITZERLAND			
			PORTUGAL			
			NORWAY			
			FINLAND			

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PATTERN			COUNTRY	WIDTH		
Left road marking	Centre line of roadway	Right road marking		Left road marking	Centre line of roadway	Right road marking
			NORWAY			
			JAPAN			
			REPUBLIC OF KOREA			

DfT ADDED ANNEX

Annex 4

**SPECIAL REQUIREMENTS TO BE APPLIED TO THE SAFETY ASPECTS OF
COMPLEX ELECTRONIC VEHICLE 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 2.3. below) as far as this Regulation is concerned.

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

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

2. DEFINITIONS

For the purposes of this annex,

- 2.1.** *"Safety concept" is a description of the measures designed into the system, for example within the electronic units, so as to address system integrity and thereby ensure safe operation even in the event of an electrical failure. The possibility of a fall-back to partial operation or even to a back-up system for vital vehicle functions may be a part of the safety concept.*
- 2.2.** *"Electronic control system" means a combination of units, designed to co-operate in the production of the stated vehicle control function by electronic data processing. Such systems, often controlled by software, are built from discrete functional components such as sensors, electronic control units and actuators and connected by transmission links. They may include mechanical, electro-pneumatic or electrohydraulic elements. "The System", referred to herein, is the one for which type approval is being sought.*
- 2.3.** *"Complex electronic vehicle control systems" are those electronic control systems which are subject to a hierarchy of control in which a controlled function may be over-ridden by a higher level electronic control system/function. A function which is over-ridden becomes part of the complex system.*
- 2.4.** *"Higher-Level control" systems/functions are those which employ additional processing and/or sensing provisions to modify vehicle behaviour by commanding variations in the normal function(s) of the vehicle control system. This allows complex systems to automatically change their objectives with a priority which depends on the sensed circumstances.*

- 2.5. *"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.*
- 2.6. *"Transmission links" are the means used for inter-connecting distributed units for the purpose of conveying signals, operating data or an energy supply. This equipment is generally electrical but may, in some part, be mechanical, pneumatic or hydraulic.*
- 2.7. *"Range of control" refers to an output variable and defines the range over which the system is likely to exercise control.*
- 2.8. *"Boundary of functional operation" defines the boundaries of the external physical limits within which the system is able to maintain control.*
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.*
- 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 will be taken as the basic reference for the verification process set out in paragraph 4. of this annex.*
- (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.*
- 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.*
- 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.

3.3.4. Signal flow and priorities

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

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 systems which are subject to the prescriptions of this Regulation.

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

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

- (a) *Fall-back to operation using a partial system.*

(b) *Change-over to a separate back-up system.*

(c) *Removal of the high level function.*

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

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 one of those specified faults which will have a bearing on vehicle control performance or safety. This may be based on a Failure Mode and Effect Analysis (FMEA), a Fault Tree Analysis (FTA) or any similar process appropriate to system safety considerations. The chosen analytical approach(es) shall be established and maintained by the Manufacturer and shall be made open for inspection by the technical service at the time of the type approval.*

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.*

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"*

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

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

The reaction of "The System" shall, at the discretion of the type approval authority, be checked under the influence of a failure in any individual unit by applying corresponding output signals to electrical units or mechanical elements in order to simulate the effects of internal faults within the unit.

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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.
