AIS-162

AUTOMOTIVE INDUSTRY STANDARD

Type Approval of Motor Vehicles of categories M2, M3, N2 and N3 with regard to the Advanced Emergency Braking Systems (AEBS)

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UNDER
CENTRAL MOTOR VEHICLE RULES – TECHNICAL STANDING COMMITTEE

SET-UP BY
MINISTRY OF ROAD TRANSPORT and HIGHWAYS
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INTRODUCTION

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

The intention of this Standard is to establish uniform provisions for Advanced Emergency Braking Systems (AEBS) fitted to motor vehicles of the categories M2, M3, N2 and N3 primarily used under monotonous highway driving conditions.

While, in general, those vehicle categories will benefit from the fitment of an AEBS, there are sub-groups where the benefit is rather uncertain because they are primarily used in other conditions than highway conditions (e.g. buses with standing passengers, category G vehicles, construction vehicles, etc.). Regardless from the benefit, there are other sub-groups where the installation of AEBS would be technically difficult or not feasible (e.g. position of the sensor on vehicles of category G, construction vehicles mainly used in off-road areas and gravel tracks, special purpose vehicles and vehicles with front mounted equipment, etc.). In some cases, there may be a possibility of false emergency braking events because of vehicle design constraints.

The system shall automatically detect a potential forward collision, provide the driver with a warning and activate the vehicle braking system to decelerate the vehicle with the purpose of avoiding or mitigating the severity of a collision in the event that the driver does not respond sufficiently quickly to the warning.

The system shall only operate in driving situations where braking will avoid or mitigate the severity of an accident and shall take no action in normal driving situations.

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

The system shall provide as a minimum an acoustic or haptic warning, which may also be a sharp deceleration, so that an inattentive driver is made aware of a critical situation.

During any action taken by the system (the warning and emergency braking phases), the driver can, at any time through a conscious action, e.g. by a steering action or an accelerator kick-down, take control and override the system.

The Standard cannot include all the traffic conditions and infrastructure features in the type-approval process. Actual conditions and features in the real world should not result in false warnings or false braking to the extent that they encourage the driver to ignore warnings or endanger other traffic participants**.**

While preparation of this standard considerable assistance is derived from UNR 131(Rev. 1), Amendment 1.

The AISC panel and the Automotive Industry Standards Committee (AISC) responsible for preparation of this standard are given in Annex 5 and Annex 6 respectively.

Type Approval of Motor Vehicles of categories M2, M3, N2 and N3 with regard to the Advanced Emergency Braking Systems (AEBS)

1.0 SCOPE AND PURPOSE

This standard applies to the approval of vehicles of category M2, N2, M3 and N3 with regard to an on-board system to avoid or mitigate the severity of a rear-end in lane collision with preceding vehicle.

Note: The requirements of this standard may be optional for the following as per choice of the manufacturer:

Type I buses, off-road vehicles and construction vehicles.

Vehicles where installation of AEBS would be technically difficult or not feasible (e.g. position of the sensor on vehicles of category G, construction vehicles mainly used in off-road areas and gravel tracks, special purpose vehicles and vehicles with front mounted equipment, etc.)

2.0 DEFINITIONS

2.1 "**Advanced Emergency Braking System (AEBS)**" means a system which can automatically detect a potential forward collision and activate the vehicle braking system to decelerate the vehicle with the purpose of avoiding or mitigating a collision.

2.2 "**Vehicle type with regard to its Advanced Emergency Braking 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 Advanced Emergency Braking System;
(c) The type and design of the Advanced Emergency Braking System.

2.3 "**Subject vehicle**" means the vehicle being tested.

2.4 "**Target**" means a high-volume series production compact passenger car of category M1 AA Saloon[1] or-in the case of a soft target an object representative of such a vehicle in terms of its detection characteristics applicable to the sensor system of the AEBS under test.

2.5 "**Moving target**" means a target travelling at a constant speed in the same direction and in the center of the same lane of travel as the subject vehicle.

[1] As defined in IS 14272: 2011

2.6 "**Stationary target**" means a target at standstill facing the same direction and positioned on the center of the same test lane of travel as the subject vehicle.

2.7 "**Soft target**" means a target that will suffer minimum damage and cause minimum damage to the subject vehicle in the event of a collision.

2.8 "**Collision warning phase**" means the phase directly preceding the emergency braking phase, during which the AEBS warns the driver of a potential forward collision.

2.9 "**Emergency braking phase**" means the phase starting when the AEBS emits a braking demand for at least 3 m/s^2 deceleration to the service braking system of the vehicle.

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

2.11 "**Self-check**" means an integrated function that checks for a system failure on a semi-continuous basis at least while the system is active.

2.12 "**Time to collision (TTC)**" means the value of time obtained by dividing the distance between the subject vehicle and the target by the relative speed of the subject vehicle and the target, at an instant in time.

3.0 APPLICATION FOR APPROVAL

3.1 The application for approval of a vehicle type with regard to the Advanced Emergency Braking System shall be submitted by the vehicle manufacturer or by his authorized representative.

3.2 It shall be accompanied by the documents mentioned below;

3.2.1 A description of the vehicle type with regard to the items mentioned in paragraph 2.2, together with a documentation package which gives access to the basic design of the AEBS and the means by which it is linked to other vehicle systems or by which it directly controls output variables.

3.3 A vehicle representative of the vehicle type to be approved shall be submitted to the test agency conducting the approval tests.

4.0 APPROVAL

4.1 If the vehicle type submitted for approval pursuant to this standard meets the requirements of paragraph 5 below, approval of that vehicle shall be granted.

Note: For vehicles sold in drive away chassis / partially built configuration, vehicle manufacturer shall take approval of one completely built vehicle and shall provide installation guidelines to the body builders.

5.0 SPECIFICATIONS

5.1 General requirement

5.1.1 Any vehicle fitted with an AEBS complying with the definition of paragraph 2.1 above shall meet the performance requirements contained in paragraphs 5.1 to 5.6.2 of this standard and shall be equipped with anti-lock braking systems in accordance with the performance requirements of IS 11852: 2013 as amended from time to time.

5.1.2 The effectiveness of AEBS with respect to EMI/EMC shall be demonstrated by fulfilling the technical requirements of AIS-004 (Part 3), as amended from time to time.

5.1.3 Conformity with the safety aspects of complex electronic control systems shall be shown by meeting the requirements of Annex 4.

5.2 Performance requirements

5.2.1 The system shall provide the driver with appropriate warning(s) as below:

5.2.1.1 A collision warning when the AEBS has detected the possibility of a collision with a preceding vehicle of category M, N, C or T in the same lane which is travelling at a slower speed, has slowed to a halt or is stationary having not being identified as moving. The warning shall be as specified in paragraph 5.5.1 below.

5.2.1.2 A failure warning when there is a failure in the AEBS that prevents the requirements of this standard of being met. The warning shall be as specified in paragraph 5.5.4 below.

5.2.1.2.1 There shall not be an appreciable time interval between each AEBS self-check, and subsequently there shall not be an appreciable delay in illuminating the warning signal, in the case of an electrically detectable failure.

5.2.1.2.2 Failures due to temporary sensor blocking, for instance due to a mounted snow-plough, shall be detected within a driving time of maximum 300 seconds.

5.2.1.3 A deactivation warning, if the vehicle is equipped with a means to manually deactivate the AEBS, shall be given when the system is deactivated. This shall be as specified in paragraph 5.4.2 below.

5.2.2 Subsequent to the warning(s) of paragraph 5.2.1.1 above, and subject to the provisions of paragraphs 5.3.1 to 5.3.3 below, there shall be an emergency braking phase having the purpose of significantly decreasing the speed of the subject vehicle. This shall be tested in accordance with paragraphs 6.4 and 6.5 of this standard.

5.2.3 The system shall be active at least within the vehicle speed range of 25 km/h up to the maximum design speed of the vehicle, and at all

vehicle load conditions, unless manually deactivated as per paragraph 5.4 below.

5.2.4 The system shall be designed to minimize the generation of collision warning signals and to avoid autonomous braking in situations where the driver would not recognize an impending forward collision. This shall be demonstrated in accordance with paragraph 6.8 of this standard.

5.3 **Interruption by the driver**

5.3.1 The AEBS may provide the means for the driver to interrupt the collision warning phase. However, when a vehicle braking system is used to provide a haptic warning, the system shall provide the driver with a means to interrupt the warning braking.

5.3.2 The AEBS shall provide the means for the driver to interrupt the emergency braking phase.

5.3.3 In both cases above, this interruption may be initiated by any positive action (e.g. kick-down, operating the direction indicator control or steering action) that indicates that the driver is aware of the emergency situation. The vehicle manufacturer shall provide a list of these positive actions to the test agency at the time of type approval and it shall be annexed to the test report.

5.4 When a vehicle is equipped with a means to deactivate the AEBS function, the following conditions shall apply as appropriate:

5.4.1 The AEBS function shall be automatically reinstated at the initiation of each new ignition cycle.

5.4.2 A constant optical warning signal shall inform the driver that the AEBS function has been deactivated. The yellow warning signal specified in paragraph 5.5.4 below may be used for this purpose.

5.5 **Warning indication**

5.5.1 The collision warning referred to in paragraph 5.2.1.1 above shall be provided by at least two modes selected from acoustic, haptic or optical.

The timing of the warning signals shall be such that they provide the possibility for the driver to react to the risk of collision and take control of the situation and shall also avoid nuisance for the driver by too early or too frequent warnings. This shall be tested in accordance with the provisions of paragraphs 6.4.2 and 6.5.2 of this Standard.

5.5.2 A description of the warning indication and the sequence in which the collision warning signals are presented to the driver shall be provided by the vehicle manufacturer at the time of type-approval and recorded in the test report.

5.5.3 Where an optical means is used as part of the collision warning, the optical signal may be the flashing of the failure warning signal specified in paragraph 5.5.4 below.

5.5.4 The failure warning referred to in paragraph 5.2.1.2 above shall be a constant yellow optical warning signal.

5.5.5 Each AEBS optical warning signal 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)). This requirement does not apply to warning signals shown in a common space.

5.5.6 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.

5.5.7 When the driver is provided with an optical warning signal to indicate that the AEBS is temporarily not available, for example due to inclement weather conditions, the signal shall be constant and yellow in colour. The failure warning signal specified in paragraph 5.5.4 above may be used for this purpose.

5.6 **Provisions for the periodic technical inspection**

5.6.1 At a periodic technical inspection, it shall be possible to confirm the correct operational status of the AEBS 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.

5.6.2 At the time of type approval, the means to protect against simple unauthorized 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 AEBS is available.

6.0 TEST PROCEDURE

6.1 Test conditions

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

6.1.2 The ambient temperature shall be between 0 °C and 45 °C or as agreed between manufacturer and test agency.

6.1.3 The horizontal visibility range shall allow the target to be observed throughout the test.

6.1.4 The tests shall be performed when there is no wind liable to affect the results.

6.2 Vehicle conditions

6.2.1 Test weight

During the test, the vehicle shall be loaded to its gross vehicle weight (GVW). If this is deemed justified, the test agency may additionally select a different load condition.

No alteration shall be made once the test procedure has begun.

6.3 Test targets

6.3.1 The target used for the tests shall be a regular high-volume series production compact passenger car of category M1 AA Saloon, or alternatively a "soft target"[3] representative of such a vehicle in terms of its identification characteristics applicable to the sensor system of the AEBS under test[2].

6.3.2 Details that enable the target(s) to be specifically identified and reproduced shall be recorded in the vehicle type approval documentation.

6.4 Warning and activation test with a stationary target

6.4.1 The subject vehicle shall approach the stationary target in a straight line for at least two seconds prior to the functional part of the test with a subject vehicle to target centerline offset of not more than 0.5 m.

The functional part of the test shall start when the subject vehicle is travelling at a speed of 80 percent of max. speed condition or 64 km/h whichever is lower in line with IS 11852 2013 engine connected for and is at a distance of at least 120 m from the target.

From the start of the functional part until the point of collision there shall be no adjustment to any control of the subject vehicle by the driver other than slight adjustments to the steering control to counteract any drifting.

[2] The identification characteristics of the soft target shall be agreed upon between the test agency and the vehicle manufacturer as being equivalent to a compact passenger car of category M1 AA Saloon.

6.4.2 The timing for the collision warning modes referred to in paragraph 5.5.1 above shall comply with the following:

6.4.2.1 At least one warning mode shall be provided no later than specified in Table I, Column B, of Annex 3.

In the case of the vehicles referred to in Table I, row 1, of Annex 3, the warning shall be haptic or acoustic.

In the case of the vehicles referred to in Table I, row 2, of Annex 3, the warning shall be haptic, acoustic or optical

6.4.2.2 At least two warning modes shall be provided no later than specified in Table I, Column C, of Annex 3.

6.4.2.3 Any speed reduction during the warning phase shall not exceed either 15 km/h or 30 per cent of the total subject vehicle speed reduction, whichever is higher.

6.4.3 The collision warning phase shall be followed by the emergency braking phase.

6.4.4 The total speed reduction of the subject vehicle at the time of the impact with the stationary target shall be not less than the value specified in Table I, column D of Annex 3.

6.4.5 The emergency braking phase shall not start before a TTC equal to or less than 3.0 seconds.

6.5 **Warning and activation test with a moving target**

6.5.1 The subject vehicle and the moving target shall travel in a straight line, in the same direction, for at least two seconds prior to the functional part of the test, with a subject vehicle to target centerline offset of not more than 0.5 m.

The functional part of the test shall start with the subject vehicle travelling at a speed of 80 percent of max. speed condition or 64 km/h whichever is lower in line with IS 11852 2013 engine connected for, the moving target at speed of the value specified in Table I, column H of Annex 3, and a separation distance of at least 120 m between them.

From the start of the functional part of the test until the subject vehicle comes to a speed equal to that of the target there shall be no adjustment to any subject vehicle control by the driver other than slight steering adjustments to counteract any drifting.

6.5.2 The timing for the collision warning modes referred to in paragraph 5.5.1 above shall comply with the following:

6.5.2.1 At least one haptic or acoustic warning mode shall be provided no later than specified in Table I Column E of Annex 3.

6.5.2.2 At least two warning modes shall be provided no later than specified in Table I Column F of Annex 3.

6.5.2.3 Any speed reduction during the warning phase shall not exceed either 15 km/h or 30 per cent of the total subject vehicle speed reduction, whichever is higher.

6.5.3 The emergency braking phase shall result in the subject vehicle not impacting the moving target.

6.5.4 The emergency braking phase shall not start before a TTC equal to or less than 3.0 seconds.

6.6 **Failure detection test**

6.6.1 Simulate an electrical failure, for example by disconnecting the power source to any AEBS component or disconnecting any electrical connection between AEBS components. When simulating an AEBS failure, neither the electrical connections for the driver warning signal of paragraph 5.5.4 above nor the optional manual AEBS deactivation control of paragraph 5.4 shall be disconnected.

6.6.2 The failure warning signal mentioned in paragraph 5.5.4 above shall be activated and remain activated not later than 10 seconds after the vehicle has been driven at a speed greater than 15 km/h and be reactivated immediately after a subsequent ignition "off" ignition "on" cycle with the vehicle stationary as long as the simulated failure exists.

6.7 **Deactivation test**

6.7.1 For vehicles equipped with means to deactivate the AEBS, turn the ignition (start) switch to the "on" (run) position and deactivate the AEBS. The warning signal mentioned in paragraph 5.4.2 above 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 reactivated, thereby indicating that the AEBS has been reinstated as specified in paragraph 5.4.1 above. If the ignition system is activated by means of a "key", the above requirement shall be fulfilled without removing the key.

6.8 **False reaction test**

6.8.1 Two stationary vehicles, of category M1 AA Saloon / compact Passenger car, shall be positioned:

(a) So as to face in the same direction of travel as the subject vehicle,

(b) With a distance of 4.5 m between them[3],

(c) With the rear of each vehicle aligned with the other.

[3] The point of reference of each stationary vehicle for establishing the distance between the two stationary vehicles shall be determined in accordance with latest version of ISO 612.

6.8.2 The subject vehicle shall travel for a distance of at least 60 m, at a constant speed of 50 ± 2 km/h to pass centrally between the two stationary vehicles.

During the test there shall be no adjustment of any subject vehicle control other than slight steering adjustments to counteract any drifting.

6.8.3 The AEBS shall not provide a collision warning and shall not initiate the emergency braking phase.

7.0 MODIFICATIONS AND EXTENSION OF APPROVAL OF A TYPE OF VEHICLE WITH AEBS SYSTEM

7.1 Every modification of a AEBS system shall be notified to the Testing Agency which approved the vehicle with AEBS system. The Testing Agency 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; Consider that the modifications made are unlikely to have an appreciable adverse effect and that in any case the vehicle with AEBS system still complies with the requirements; or

7.1.2 require a further test report from the testing agency responsible for conducting the tests.

7.2 In case of 7.1.2 tests shall be carried out for only those parameters which are affected by the modifications.

7.3 In case of fulfilment of criteria of Para. 7.1.1 or after successful results of further verification as per para 7.1.2 the approval of compliance shall be extended for the changes carried out.

7.4 Detailed extension criteria are mentioned below as ready reference, however with mutual agreement between test agency and vehicles manufacturer these may be elaborated further:

For selecting the worst case vehicle for testing, worst case criteria of Brake system mentioned in IS 11852 2019 Annex K – Table 1 shall be applicable except Sl No. i)-d, f, g, h, j ; ii)- c,e ;iv)-a,b,c,d ; v)-c; vi)-d, h. Additional clauses which are to be considered are mentioned below.

Alternatively, extension can be sought based on AEBS tested vehicle, if it meets the basic extension criteria of Brake system mentioned in IS 11852 2019 Annex K – Table 1 excluding SI No. i)-d, f,g,h,j ; ii)-c,e ;iv)-a,b,c,d ; v)-c; vi)-d,h. Additional clauses which are to be considered are mentioned below.

	Parameters	Change	Extension / Worst case Criteria	Tests to be Conducted
	Vehicle Category	Change from one vehicle category to another	Extension can be given across vehicle Category i.e. from M1 to N1, M2 to N2, M3 to N3 and vice-versa, provided it meets the other clauses for extension	No Tests. If remaining extension criteria specified here and other criteria of same frontal area, GVW variation of max. 10%, etc. are complied with, extension can be given across vehicle Category after mutual agreement between the testing agency and manufacturer.
	Vehicle Speed	Increase in speed in excess of 8 percent	No extension	All tests pertaining to AIS-162 clause 6.4 and 6.5
	Camera (If applicable)	Manufacturer	No extension	All tests pertaining to AIS-162 clause 6.4, 6.5, 6.6, 6.7 and 6.8
		Type	No extension	
		Construction	Extension can be provided if there is no change in performance	No Tests
		Sensor	No extension	All tests pertaining to AIS-162 clause 6.4, 6.5, 6.6, 6.7 and 6.8

		Field of View	Extension can be provided if there is no reduction in minimum field of view	All tests pertaining to AIS-162 clause 6.4, 6.5 and 6.8 if there is reduction in minimum field of view. the test vehicle to be tested after masking the camera as per the worst-case field of view, to get extension on other vehicles.
		Mounting Location from ground	Extension can be provided, if the change in mounting height is such that minimum field of view is not changed	
		Mounting Angle	Extension can be provided if there is no reduction in minimum field of view	
	Radar	Manufacturer	No extension	All tests pertaining to AIS 162 clause 6.4, 6.5, 6.6, 6.7 and 6.8
		Type	No extension	
		Frequency	No extension	All tests pertaining to AIS-162 clause 6.4, 6.5 and 6.8 if there is reduction in minimum field of view
		Accuracy, Range	Lowest accuracy is worst case	
		Mounting Location from ground	Extension can be provided if the change in location is such that minimum field of view is not changed	
	Cabin related components - Windshield/Mirror/ front protrusion, grill, cover, etc.	Any reduction or obstruction in field of view of camera and radar	Lowest field of view is worst case.	All tests pertaining to AIS-162 clause 6.4, 6.5 and 6.8 if there is reduction in minimum field of view

	AEBS ECU/Controller	Manufacturer	No extension	All tests pertaining to AIS-162 clause 6.4, 6.5, 6.6, 6.7 and 6.8
		Software/Critical Hardware affecting AEBS performance	Vehicle level Test to be repeated	

8.0 TECHNICAL INFORMATION TO BE SUBMITTED BY VEHICLE MANUFACTURER

8.1 Information on technical specifications to be submitted by the vehicle manufacturer shall be as per Annex 1

ANNEX 1

TECHNICAL INFORMATION TO BE SUBMITTED BY VEHICLE MANUFACTURER

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 the type of AEBS: .....
7.	Brief description of AEBS system:.....
8.	Whether the system comply with AIS-004 (Part 3) :.....
9.	Type of forward collision warning used (i.e. Audio, optical, Haptic)……. .....
10.	Brief description of FVCWS system ……..

ANNEX 2

(Reserved)

ANNEX 3
WARNING AND ACTIVATION TEST REQUIREMENTS – PASS / FAIL VALUES

Table I

A	B	C	D	E	F	G	H	Row
	Stationary target			Moving target				
	Timing of warning modes		Speed reduction (ref. paragraph 6.4.4.)	Timing of warning modes		Speed reduction (ref. paragraph 6.5.3.)	Target speed (ref. paragraph 6.5.1.)	
	At least 1 (ref. paragraph 6.4.2.1.)	At least 2 (ref. paragraph 6.4.2.2.)		At least 1 (ref. paragraph 6.5.2.1.)	At least 2 (ref. paragraph 6.5.2.2.)			
M3[1], N2 > 8 t and N3	Not later than 1.4 s. before the start of emergency braking phase	Not later than 0.8 s. before the start of emergency braking phase	Not less than 20 km/h	Not later than 1.4 s. before the start of emergency braking phase	Not later than 0.8 s. before the start of emergency braking phase	No impact	16 ± 2 km/h	1
N2 ≦ 8 t[2, 4] and M2[2,4]	Not later than 0.8 s before the start of the emergency braking phase	Before the start of the emergency braking phase [3]	Not less than 10 km/h	Not later than 0.8 s before the start of the emergency braking phase	Before the start of the emergency braking phase [3]	No impact	51 ± 2 km/h	2

[1] Vehicles of category M3 with hydraulic braking system are subject to the requirements of row 2.

[2] Vehicles with pneumatic braking systems are subject to the requirements of row 1.

[3] Values shall be specified by the vehicle manufacturer at the time of Type approval.

[4] Manufacturers of vehicles covered by row 2 may elect to gain vehicle Type Approval to the values specified in row 1; in this instance compliance shall be demonstrated with all the values contained in row 1.

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 (definition 2.3. below) as far as this Standard is concerned.

This annex may also be called, by special paragraphs in this Standard, 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 test agency, 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 Standard.

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 fallback 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 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.

"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 behavior 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, hydraulic or optical.

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 2 parts:

(a) The formal documentation package for the approval, containing the material listed in paragraph 3 of this annex (with the exception of that of paragraph 3.4.4. below) which shall be supplied to the Test agency 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 below, 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 (see paragraph 2.7. of this annex) exercised on each such variable shall be defined.

3.2.3 Limits defining the boundaries of functional operation (see paragraph 2.8. of this annex) 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 an optical-fiber diagram for optical 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 Standard 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 Standard 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 standard.

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 realization 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 functions.

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 realize the vehicle control system objective, the principles of the change-over mechanism, the logic and level of redundancy and any built-in back-up checking features shall be explained and the resulting limits of back-up effectiveness defined.

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 test agency 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 above, 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 above, 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 Standard.

4.1.2 Verification of the safety concept of paragraph 3.4 above.

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.

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.

ANNEX 5
(See Introduction)
COMPOSITION OF AISC PANEL ON ADVANCED EMERGENCY BRAKING SYSTEMS (AEBS)*

Panel convener	**Representing**
Mr. Sachin Deshmukh	ACMA (ZF India Pvt. Ltd.)
Members	
Mr. A. A. Badusha	The Automotive Research Association of India
Mr. Vishal P. Rawal	The Automotive Research Association of India
Mr. Konaki Ramu	The Automotive Research Association of India
Ms. Shubhangi Dalvi	Central Institute of Road Transport
Mr. D. H. Pendharkar	Central Institute of Road Transport
Mr. V M Dhanasekkar	Global Automotive Research Centre
Mr. Kubenthiran	Global Automotive Research Centre
Mr. Ravi M	Global Automotive Research Centre
Mr. Mayank Sharma	International Centre for Automotive Technology
Mr. Gurkaran Singh	International Centre for Automotive Technology
Mr. N. Muthukumar	SIAM (Ashok Leyland Ltd.)
Mr. V. Faustino	SIAM (Ashok Leyland Ltd.)
Mr. Ved Prakash Gautam	SIAM (Ashok Leyland Ltd.)
Mr. Rama Manikandan	SIAM (Daimler India Commercial Veh. Pvt. Ltd.)
Mr. D. Karthikeyan	SIAM (Daimler India Commercial Veh. Pvt. Ltd.)
Mr. Chaitanya Wagh	SIAM (FCA Engineering India Pvt. Ltd.)
Mr. Girish S. Kodolikar	SIAM (Force Motors Ltd.)
Mr. Kulkarni Varadendra	SIAM (Mahindra & Mahindra Ltd)
Mr. Shailesh Kulkarni	SIAM (Mahindra & Mahindra Ltd.)
Mr. Devinder Tangri	SIAM (Mahindra & Mahindra Ltd.)
Ms. Pushpanjali Pathak	SIAM (Mahindra & Mahindra Ltd.)
Mr. Sudhir Sathe	SIAM (Mahindra & Mahindra Ltd.)
Mr. Dhotre Abhijit	SIAM (Mahindra & Mahindra Ltd)
Mr. Arun Kumar	SIAM (Maruti Suzuki India Ltd.)
Mr. Sumit Kumar	SIAM (Maruti Suzuki India Ltd.)
Mr. Jebin Jowhar	SIAM (Renault Nissan India Pvt. Ltd)
Mr. Mohit Gupta	SIAM (SML Isuzu Ltd.)
Mr. Pushpinder Singh	SIAM (SML Isuzu Ltd.)

Mr. Abhinav Sharma	SIAM (SML Isuzu Ltd.)
Mr. P. S. Gowrishankar	SIAM (Tata Motors Ltd.)
Mr. Mahesh Shridhare	SIAM (Tata Motors Ltd.)
Mr. Ranjit K Ballal	SIAM (Tata Motors Ltd.)
Mr. Uday Salunkhe	SIAM (Tata Motors Ltd.)
Mr. Pridhvi Raju Vatsavayi	SIAM (Tata Motors Ltd.)
Mr. B. Sudarshan	SIAM (Tata Motors Ltd.)
Mr. Mahendra Wadje	SIAM (Tata Motors Ltd.)
Mr. Uday Harite	ACMA
Mr. Noel Alexander Peters	ACMA (Denso International India Pvt. Ltd.)
Ms. Alka Sharma	ACMA (Denso International India Pvt. Ltd.)
Mr. Durairaj Prabhakaran	ACMA (WABCO India Ltd.)
Ms. Sudha Ramani	ACMA (Brakes India Ltd.)
Mr. Raykar Nagendra	ACMA (Bosch Ltd.)
Mr. Rai Shashank	ACMA (Bosch Ltd.)
Mr. Sanjay Khatri	ACMA (Bosch Ltd.)
Mr. Paritosh Dagli	Sixth Sensor
Mr. Abhishek Jadhav	Knorr Bremse

***** At the time of approval of this Automotive Industry Standard (AIS)

ANNEX 6
(See Introduction)
COMMITTEE COMPOSITION *

Automotive Industry Standards Committee

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

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