AIS-184

AUTOMOTIVE INDUSTRY STANDARD

Driver Drowsiness and Attention Warning Systems for M, N2 and N3 category vehicles

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UNDER
CENTRAL MOTOR VEHICLE RULES – TECHNICAL STANDING COMMITTEE

SET-UP BY
MINISTRY OF ROAD TRANSPORT and HIGHWAYS
(DEPARTMENT OF ROAD TRANSPORT and HIGHWAYS)
GOVERNMENT OF INDIA

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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 website.

MoRTH has directed AISC committee to initiate new AIS on the subject of driver drowsiness and attention warning systems (DDAW), in line with European requirements.

In Europe driver drowsiness and attention warning systems is addressed in following way:

Background and evolution from Europe

1) Article 6 of Regulation (EU) 2019/2144 requires motor vehicles of categories M and N to be equipped with certain advanced vehicle systems, including driver drowsiness and attention warning ('DDAW') systems. It lays down in its Annex II basic requirements for the type-approval of motor vehicles with regard to the driver drowsiness and attention warning systems.

2) Need was identified for detailed rules necessary concerning the specific test procedures and technical requirements for the type-approval of motor vehicles with regard to driver drowsiness and attention warning systems.

3) It was noted that fatigue negatively affects driver's physical, cognitive, psychomotor and sensory processing capabilities, which are needed for safe driving. Driver fatigue is a factor in 10-25 percent of all road crashes in the Union.

4) In accordance with Article 3, point (5), of Regulation (EU) 2019/2144 the DDAW system is a system that assesses the driver's alertness through vehicle systems analysis and warns the driver if needed via the vehicle's human-machine interface.

5) DDAW systems are more effective outside the urban zones because the reduced driver alertness due to fatigue mostly occurs in long-distance driving at a constant speed. Moreover, constantly changing driving and steering pattern when driving within urban zones is difficult for assessment with the available technologies. Motor vehicles with a maximum design speed of 70 km/h or below should therefore be exempted from the obligation to be equipped with DDAW systems.

6) The DDAW systems assess the human physical state through indirect means, such as system analysis and recognition of driving or steering pattern of a driver exhibiting reduced alertness due to drowsiness, therefore it is not possible to fully test those systems through a set of defined tests or with a programmable machine, which reproduces human behaviour. Instead, the manufacturer should perform validation testing with human participants and present the results to the testing agencies together with at least one test protocol for checking the capability of the DDAW systems to produce a warning to the drowsy driver.

7) Taking into account the indirect nature of the measurement, the variability in the effects of human drowsiness and the relative immaturity of existing technologies, the performance requirements for DDAW systems should be set at a level that is realistic and attainable. At the same time, those requirements should be technology-neutral, in order to foster development of new technologies, therefore, the assessment of the performance of DDAW systems should be based on a statistical approach, taking into account either the average efficiency among the test subjects or the minimal efficiency for 95 percent of them. However, the use of the latter option should be preferred as it provides that the DDAW systems will perform equally effective to all drivers.

8) The Regulation 2021/1341 provide a reference scale to be used by manufacturers to measure driver drowsiness in the tests involving human participants. Where manufacturers choose to use an alternative measurement method, it should be duly documented and equivalence to the reference scale in this Regulation should be provided.

9) The provisions of Regulation 2021/1341 are closely linked as they deal with rules concerning the specific test procedures and technical requirements for the type-approval of motor vehicles with regard to their driver drowsiness and attention warning systems.

India perspective about Driver Drowsiness feature

1) In India, the transport vehicles' (other than special purpose vehicle) plying speed are limited to 80 km/h and considering main fatigue criteria stated in base EU Regulation of monotonous (long haul) highway application maximum design cut-off is lowered from 70 km/h to 60 km/h for M2, M3, N2, N3. N1 is exempted from DDAWS fitment requirement considering their duty cycles, applications and also meagre long haul highway application.

2) This is a new feature to be introduced in India market and collectively it is a learning curve and experience gaining phase for all stakeholders, minimum sensitivity requirement 40 percent as specified in Regulation (EU) 2021/1341 is to be taken as baseline reference to move forward. Further to accumulation of experiences and technological advancements, this standard may be suitably upgraded and revised with those learnings.

3) As this is a new technical provision included in the applicable vehicle categories, considering the learning curve and the technological advancements are still evolving, minimum sensitivity requirements of 40 percent is considered as specified in Regulation (EU) 2021/1341 to this implementation forward. Also the minimum sensitivity requirements at various speeds in context and scope of this standard may not be optimal on account of technological limitations.

Driver Drowsiness and Attention Warning Systems for M, N2 and N3 category vehicles

Driver Drowsiness and Attention Warning Systems for M, N2 and N3 category vehicles

1.0 SCOPE

This Regulation applies to motor vehicles of categories M, N2 and N3, as defined in AIS-053 / IS 14272, as amended from time to time, and with a maximum design speed as follows:

1.1 In case of vehicles of category M1 with a maximum design speed above 70 km/h.

1.2 In case of vehicles of categories M2, M3, N2 and N3 with a maximum design speed above 60 km/h.

1.3 Following special categories of vehicles are not covered under the scope of this standard, however, at the choice of manufacturer(s) they may comply with the requirements of this standard.

Off road (G category vehicles), Intra city buses, School buses, Double decker buses, Concrete mixers/ boom pump trucks, Garbage Collectors, water sprinklers, Rock breakers, vehicle with Hoists, wreckers, Hearse, Armored vehicles.

2.0 DEFINITIONS

For the purpose of this standard following definition and definitions in respective parts of this standard shall apply.

2.1 '**Driver Drowsiness and Attention Warning (DDAW)'** means a system that assesses the driver's alertness through vehicle systems analysis and warns the driver if needed;

3.0 REQUIREMENTS

3.1 Technical requirements for the DDAW system

Technical requirements for the approval of motor vehicles with regard to the driver drowsiness and attention warning systems are laid down in Part 1 of this standard.

3.2 Procedures for validation of driver drowsiness and attention warning systems

Test procedures for validation of DDAW system by the manufacturer are laid down in Part 2 of this standard.

3.3 Procedures for assessment of technical documentation and verification testing

Procedures for assessment of the technical documentation provided by the manufacturer and for verification testing by the testing agencies are laid down in Part 3 of this standard.

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

4.0 APPLICATION FOR APPROVAL

Apart from documentation to be submitted to the testing agencies as per this standard (especially Part 3), technical specifications as per Annexure 1 of this standard shall be submitted.

5.0 MODIFICATIONS AND EXTENSION OF TYPE APPROVAL

5.1 Every modification shall be notified to the Testing Agency which approved the DDAW system. The Testing Agency may then either:

5.1.1 consider that the modifications made are unlikely to have an appreciable adverse effect and that in any case the DDAW system still complies with the requirements; or

5.1.2 require a further test report from the testing agencies responsible for conducting the tests.

5.2 In case of 5.1.2 tests shall be carried out for only those parameters which are affected by the modifications.

5.3 In case of fulfilment of criteria of Para. 5.1.1 or after successful results of further verification as per para 5.1.2 the approval of compliance shall be extended for the changes carried out.

PART 1

Technical requirements for the DDAW system

1. DEFINITIONS

For the purposes of this standard, the following definitions apply:

1.1 **'Trigger behavior'** means the vehicle action for which the DDAW system monitors and provides a warning to the driver once this action happens;

1.2 '**Drowsiness threshold'** is a quantification of the level of driver drowsiness, at or before which the DDAW system shall provide a drowsiness warning to the driver.

2. GENERAL TECHNICAL REQUIREMENTS

2.1 A DDAW system shall monitor a driver's level of drowsiness and alert the driver through the vehicle human machine interface (HMI).

2.2 The DDAW system shall be designed to avoid or minimize the system error rate under real driving conditions.

2.3 **Privacy and data protection**

2.3.1 The DDAW system shall function in normal operation mode without the use of biometric information, including facial recognition, of any vehicle occupants.

2.3.2 The DDAW system shall be designed in such a way that it shall only continuously record and retain data necessary for the system to function and operate within a closed-loop system.

2.3.3 Any processing of personal data shall be carried out in accordance with data protection law

Any processing of personal data, such as information about the driver's drowsiness and attention or the driver's distraction, should be carried out in accordance with data protection prescription laid down by Government of India and amended from time to time. Event data recorders should operate on a closed-loop system, in which the data stored is overwritten, and which does not allow the vehicle or holder to be identified. In addition, the driver drowsiness and attention warning or advanced driver distraction warning should not continuously record nor retain any data other than what is necessary in relation to the purposes for which they were collected or otherwise processed within the closed-loop system.

3. SPECIFIC TECHNICAL REQUIREMENTS

3.1 DDAW system control

3.1.1 It shall not be possible for the driver to manually deactivate the DDAW system.

It may however be possible for the driver to manually deactivate the DDAW system HMI warnings. Following manual deactivation of the DDAW system HMI warnings, it shall be possible for the driver to re-activate the system HMI warnings by taking no more than the same number of actions as were required to deactivate it.

3.1.2 The DDAW system shall be automatically deactivated in the situations pre-defined by the manufacturer. Such situations include, for instance, the deactivation of the warnings by the driver (clause 3.1.1.). The DDAW system shall be automatically reactivated as soon as the conditions that led to its automatic deactivation are no longer present.

3.1.3 The DDAW system, including HMI warnings, shall be automatically reinstated to normal operation mode upon each activation of the vehicle master control switch. The vehicle manufacturer can choose to add a condition to such automatic reinstatement: upon the driver's door having been opened or the vehicle being switched off for a maximum period of 15 minutes.

3.1.4 The DDAW system shall be automatically activated above the speed of 70 km/h in case of M1 category vehicles.

3.1.4.1 The DDAW system shall be automatically activated above the speed of 60 km/h in case of vehicles of categories M2, M3, N2 and N3.

3.1.5 In case of M1 category vehicles, once activated, DDAW system shall operate normally within the speed range of 65 km/h to 130 km/h or the vehicle's maximum allowed speed, whichever is lower.

The DDAW system shall not be automatically deactivated at a speed of above 130 km/h (although the system's behavior can be adapted to the degraded situation).

3.1.5.1 In case of vehicles of categories M2, M3, N2 and N3 once activated, DDAW system shall operate normally within the speed range of 60 km/h to the vehicle's designated maximum speed as per CMVR.

3.1.6 There shall be less than 5-minute delay between the vehicle meeting the activation criteria set out in clause 3.1.4., 3.1.4.1, 3.1.5., 3.1.5.1 and the DDAW system beginning to actively monitor driver drowsiness.

3.1.7 If warning is provided during the learning phase of the DDAW system (allowing for calibration of the system parameters to best fit driver's behaviour and driving pattern), the learning phase is considered over.

The learning phase activation time shall start once all the conditions for the activation of the DDAW system referred to in clause 3.1. and 3.2. are met.

3.2 **Environmental conditions**

3.2.1 The DDAW system shall operate effectively during the day and night.

3.2.2 The DDAW system shall operate in absence of weather conditions limiting the system's operation.

3.2.3 At a minimum, the DDAW system shall work effectively on a multi-lane divided road, with or without a central divide, when lane markings are visible on both sides of the lane.

3.3 **Monitoring driver drowsiness**

3.3.1 The DDAW system shall provide a warning to the driver at a level of drowsiness which is equivalent to or above 8 on the reference sleepiness scale set out in the Appendix (Karolinska Sleepiness Scale, hereinafter referred to as 'KSS').

The DDAW system may provide a warning to the driver at a level of drowsiness which is equivalent to level 7 on KSS.

In addition, manufacturer may implement an information strategy on the HMI prior to the warning.

Detailed requirements for the validation of the DDAW system by the manufacturer are set out in Part 2.

3.3.2 The DDAW system shall analyse other vehicle systems for detection of drowsy driving indicators. Such driving indicators may include but are not limited to the following:

a) a reduction in the number of micro-corrections within driver steering, paired with an increase in the number of large and fast corrections;

b) an increase in the variability of a vehicle's lateral lane position.

It is recommended that the DDAW system analyses other vehicle systems to detect drowsy driving indicators by monitoring lane position, namely the position of the vehicle relative to the lateral lane markings, or a steering input, namely a quantification of the way the driver manipulates the steering wheel, e.g. steering wheel reversal rate, yaw rate, standard deviation of lane position, etc.

An alternative manner of measuring driver performance through vehicle systems analysis ('metrics') may be used, provided that it is an accurate and robust measure of driver drowsiness.

It is possible to use one or more secondary metrics in addition to the recommendation stated in the second subparagraph of clause 3.3.2. to aid the reliability and robustness of the system. Examples of such metrics include: additional vehicle metrics, temporal metrics (a temporal measurement directly related to the driver's operation of the vehicle), physiological metrics and vehicle control metrics.

3.4 **Human Machine Interface requirements**

3.4.1 **Warning nature**

3.4.1.1 Visual and acoustic or any other warning used by the DDAW system to alert the driver shall be presented as soon as possible after occurrence of the trigger behaviour and may cascade and intensify until acknowledgement thereof by the driver.

Can be accepted as acknowledgement by the driver: an improvement of the driving behaviour based on the input used for the DDAW system (strategy to be described in the documentation provided by the manufacturer).

Note: Minimum two modes of warnings shall be provided.

3.4.2 **Visual Warning**

3.4.2.1 The visual warning shall be located so as to be readily visible and recognisable in daylight and at night-time by the driver and distinguishable from other alerts.

3.4.2.2 The visual warning shall be a steady or flashing indication (e.g. tell-tale, pop-up message, etc.).

3.4.2.3 Any new symbols developed for the purpose of a DDAW visual warning are recommended to be constructed using similar elements to and keeping coherence with ISO 2575:2010+A7:2017 K.21 and/or ISO 2575:2010+A7:2017 K.24.

3.4.2.4 The contrast of the symbol with the background in sun light, twilight and night conditions are recommended to be in accordance with ISO 15008:2017.

3.4.2.5 The following visual alert and background colour combinations should not be used: red/green; yellow/blue; yellow/red; red/violet.

3.4.3 **Acoustic warning**

3.4.3.1 The acoustic warning shall be easily recognised by the driver.

3.4.3.2 A majority of the acoustic warning shall fall within the frequency spectrum of 200-8,000 Hz and amplitude range of 50-90 dB.

3.4.3.3 If speech alerts are utilised, the vocabulary used shall be consistent with any text used as part of the visual alert.

3.4.3.4 The audible portion of the alert shall last for at least the duration that allows the driver to understand it.

3.5 **DDAW failure warning**

3.5.1 A constant visual failure warning signal (e.g. warning reflecting the relevant Diagnostic Trouble Codes (DTC) for the system, tell-tale, pop-up message, etc.) shall be provided when there is a failure detected in the DDAW system as a result of which the DDAW system does not meet the requirements of this standard.

Temporary visual failure warning signal can be used as complimentary information to the constant optical failure warning signal

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

3.5.3 Upon detection of a non-electrical failure condition (e.g. sensor obscuration, excluding temporary obscuration such as caused by sun glare), the failure warning signal as laid down in clause 3.5.1. shall be displayed.

3.5.4 Failures that activate the warning signal mentioned in clause 3.5.1., but which are not detected under static conditions, shall be retained upon detection and continue to be displayed from start-up of the vehicle after each activation of the vehicle master control switch, for as long as the failure or defect persists.

3.6 **Provisions for periodic roadworthiness tests as and when notified under CMV Rule 62.**

3.6.1 For the purpose of periodic roadworthiness tests of vehicles, it shall be possible to verify the following features of the DDAW system:

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 is 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 a device[1] to connect to the electronic vehicle interface, such as an OBD scan tool, 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 following provisions.

1. The technical information shall be made available by the manufacturer based on the vehicle identification number of the vehicle in an open source and structured data format: (a) to the competent authorities, upon request, as a collection of offline usable machine readable data files, and (b) to the testing centres and to the competent authorities using an online solution. When using an online solution, the technical information, which has to be provided by the manufacturer at the same time as part of the repair and maintenance

information on a website, shall be made available in the same data format. Other vehicle technical information shall be made available in the data format that is used for similar information.

2. The manufacturer may deviate from the requirements defined in paragraph 1 in respect of vehicles in receipt of small series type approval as per AIS-131**.** However, the information shall be provided in an easily accessible and consistent manner that can be processed with reasonable effort.

3. In the case of vehicles in receipt of step-by-step, mixed or multi-stage type-approval the manufacturer responsible for the particular stage of the build shall be responsible for communicating the vehicle technical information relating to a particular system, component or separate technical unit for that stage to the final manufacturer. The final manufacturer shall be responsible for providing the technical information on the finished vehicle to the testing agency.

4. Paragraph 3 shall not apply to vehicles in receipt of small series approvals.

3.6.2 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 in the assessment of the technical documentation under Part 3. Alternatively, this protection requirement is fulfilled when a secondary means of checking the correct operational status of the DDAW system is available.

Appendix to Part 1

Reference sleepiness scale for DDAW system

(Karolinska Sleepiness Scale)

Rating	Verbal Description
1	Extremely alert
2	Very alert
3	Alert
4	Rather Alert
5	Neither alert nor sleepy
6	Some signs of sleepiness
7	Sleepy, no effort to keep awake
8	Sleepy, some effort to keep awake
9	Very sleepy, great effort to keep awake, fighting sleep

PART 2

Test procedures for validation of DDAW system

1. VALIDATION TESTING BY THE MANUFACTURER

1.1 General requirements

1.1.1 Manufacturers shall carry out validation testing to ensure that DDAW system is able to monitor driver drowsiness in a manner which is accurate, robust and scientifically valid.

1.1.2 The validation testing of the DDAW system shall meet the requirements set out in clause 2 to 8 of this Part. The manufacturer shall document the validation process in the documentation package to be provided by the manufacturer in accordance with Part 3.

2. TESTING REQUIREMENTS

2.1 Validation testing shall take place using human participants. Alternatively the data used for the validation shall derive from behaviour data collected with human participants.

2.2 Any validation testing that includes a human participant operating a motor vehicle in a real-world, non-simulated road environment, shall have a safety backup.

The safety backup shall intervene if the driver becomes drowsy, so that he or she can no longer safely control the motor vehicle.

If the safety backup intervenes, the participant shall not be permitted to drive any further as part of the testing.

If the safety backup is a backup driver, appropriate safety strategy (for example: double pedals) shall be required.

Once the safety backup intervenes, the safety strategy prepared for this test shall apply. For example: another non-drowsy driver takes primary control of the vehicle and the drowsy driver shall not be allowed to continue to drive.

2.3 If validation testing is performed in a simulator, the manufacturer shall document its limitations with regard to real-world open road testing for the purpose of testing the DDAW system. Such documentation will include comparison of primary input data, used for the DDAW system, from the simulator and primary input data from the vehicle in real conditions and analysis of the validity of the simulated validation’s results.

3. TEST SAMPLE

3.1 Each test participant shall generate at least 1 true positive or 1 false negative event as referred to in clauses 5.1.4. and 5.1.5. The total number, obtained by the sum of true positive events and false negative events, shall be equal to or higher than 10. The minimum sample size of participants shall be 10 participants. It is allowed to run more than one test per participant in order to acquire more data for a given participant.

The sensitivity per participant shall be calculated first for each participant, then the average sensitivity and its standard deviation shall be calculated from the values of sensitivity per participant.

It is explicitly allowed to provide results from a subgroup of participants of a larger test to include only participants fitting the description above.

3.2 All the results from participants fitting the requirements of clause 3.1. shall be accounted for the validation. Excluding results from participants with at least 1 true positive or 1 false negative is not allowed.

3.3 The participants shall correspond to the targeted demography for the vehicle (for example, participants with a valid license to drive the vehicle on which the DDAW system is installed).

3.4 None of the 10 participants of the minimum sample size shall be involved in the development of DDAW system. One of the acceptance criteria, of clause 8, shall be met with and without results from the additional participants involved in the DDAW system development.

4. ENVIRONMENTAL CONDITIONS

4.1 At a minimum, the system shall be tested in the day and night conditions from clause 4.1.1. or 4.1.2., and record at least a true positive event in each conditions (overall, not for each participant tested in the condition).

It is not necessary for each participant to test both conditions.

Systems not affected by light do not need to meet the minimum number of true positive event in each conditions indicated above.

4.1.1 For non-simulated road environment testing:

a) Day: testing shall start after sunrise and before sunset;

b) Night: testing shall start after sunset and before sunrise.

4.1.2 For simulated road environment testing:

a) Day: conditions diffuse with ambient light (ISO 15008: 2017);

b) Night: condition of low ambient illumination under which the adaptation level of the driver is mainly influenced by the portion of the road ahead covered by the vehicle’s own headlights and surrounding street lights, and display and instrument brightness (ISO 15008: 2017).

5. MEASURING DROWSINESS

5.1 Application of KSS

5.1.1 The participant's level of drowsiness shall be measured using the KSS.

5.1.1.1 Participants shall be trained on the KSS before they apply it as part of the DDAW system validation testing.

The training process shall be the same for all participants.

The training process shall be clearly documented in the evidence dossier supplied to the testing agencies in accordance with Part 3.

5.1.1.2 The standardised wording in the Appendix to Part 1 shall be used and all levels of the KSS shall be labelled.

5.1.2 Measurements shall be obtained during the testing at intervals of approximately 5 minutes, where each measurement obtained shall be assumed to cover the previous 5 minutes.

The recommended intervals does not apply before the participant provide a first self-assessment rating at level 6 or above on the KSS.

5.1.3 During the validation tests, it is recommended to mute the warning from the DDAW system, to prevent changes of the status of the participant before the next self-assessment. The time at which the warning from the DDAW is provided (muted or not) shall be recorded to clearly establish if it is a true positive event.

5.1.4 Any warning from the DDAW system shall be treated as a true positive event if the participant previous or next rating is at a KSS level of 7 or above.

Once a true positive event occurred, the data points after this event shall be considered irrelevant for this specific test. If the participant restarted the test after a rest, it shall be considered a different dataset (with the same participant).

5.1.5 If a participant rating is below the drowsiness threshold referred to in clause 3.3.1. of Part 1 and the subsequent rating is above or equal to the drowsiness threshold (e.g. a sequence of rating can be 6-8 or 7-8), either:

a) the DDAW system provides a warning and it shall be treated as a true positive and end the specific test as in clause 5.1.4.; or

b) the DDAW system does not provide a warning and it shall be treated as a false negative, unless the testing continues for at least an extra testing time interval, and the participant provide either of the following self-assessment:

- During the extra testing interval, if the participants provide a self-assessment above or equal to the drowsiness threshold again, the reading shall be treated as a false negative (e.g. sequence of rating can be 7-8-8, 7-9-9 or 7-9-8);

- During the extra testing interval, if the participants provide a self-assessment at the KSS level 7, the data point shall be treated as true negative and marked as an outlier (e.g. sequence can be 6-8-7, 7-8-7 or 7-9-7). All outliers shall be documented in the documentation package;

- Without prejudice to other situations which can be excluded, during the extra testing interval, if the participants provide a self-assessment below the KSS level of 7, the data points from this specific test shall be excluded from the overall testing data results as the drowsiness ratings of the participant are likely unreliable (e.g. sequence of rating can be 7-8-6 or 6-8-6). It is recommended to provide an additional training session to the participant after such a result.

5.2 **Alternative measurement(s)**

5.2.1 Manufacturers may use an alternative measurement(s) to validate a DDAW system under the following conditions:

a) If the alternative method directly monitors the participants' state, such as Electroencephalogram (EEG) or PERCLOS (percentage of eyelid closure).

b) If the alternative method fit the measurement described in the clause 5.1. except for the drowsiness scale used and/or the time interval used;

c) If the measurement is performed by sleep video analysis performed by at least 3 raters (sleep experts), who do not interact with the participant and each other before the rating process is finalised. The time interval of this method shall not exceed 5 minutes.

5.2.2 Where alternative measurements to KSS are used to determine the participant's level of drowsiness, the manufacturer shall provide evidence that the chosen measurement is a valid and accurate means to assess driver drowsiness, and that the drowsiness threshold used in the validation testing is equivalent to a KSS level referred to in clause 3.3.1. of Part 1.

For the sleep video analysis, expected evidence concerns the quality of the video used, the visibility of the setup for the participant, the correspondence between the rating scale and KSS, the training of the raters (in addition a minimal performance level of 'concordance rate' superior or equal to 0.70 is required), information of independence of the raters to the DDAW system development and description on how the final rating is calculated based on the input from the sleep experts.

'**Concordance rate'** is a score calculated from the rating of a sleep expert on a facial training video

$$Concordance\ rate\ = \sum_{i=1}^{n} [1 - (|A_i - B_i|)/D]/n$$

A: 'True' Drowsiness rating value of the training video

B: Evaluated drowsiness level by the sleep expert

D: Maximum of drowsiness level occurring during the training video

n: number of data point to rate during the training video

5.2.3 If the alternative measurement uses a different time interval than the one specified in clause 5.1.2, clause 5.1.5. shall apply, where the intervals of assessment are equal to or shorter than 15 minutes and above or equal to 5 minutes.

If the time interval is shorter than 5 minutes, the interpretation of clause 5.1.5. shall not apply. Instead, a false negative event occurs only if the DDAW system does not provide a warning during the 10 minutes following the last rating below the drowsiness threshold. If during 5 minutes or more the ratings are above the drowsiness threshold then it is followed by a rating below the drowsiness threshold, the data point shall be treated as an outlier. All outliers shall be documented in the documentation package;

5.2.4 If the time intervals are longer than 15 minutes, the testing agencies may consider raising the requirements from clause 8.1 (a) and clause 8.1(b) by the amount set out in clause 8.1(c) to better allow for a correct assessment of the driver's drowsiness.

5.3 **Complementary measurements**

Manufacturers may use complementary measurement(s) to KSS or the alternative measurement(s) to validate a DDAW system, which shall be duly documented in the documentation package under Part 3.

Where sleep expert video analysis are used as a complementary measurement, at a minimum two raters and an inter-rater reliability test shall be conducted, and the results shall be included in the documentation package. The facial cues and body movements/behaviours for each level of drowsiness on the KSS shall be demonstrated (usually it is a confidential document).

6. ALTERNATIVE DROWSINESS THRESHOLD

6.1 If alternative measurements to KSS are used to validate a DDAW system, the manufacturer shall state the threshold being used and provide evidence detailing the equivalency between the threshold and a KSS level of 8.

If the alternative measurement uses a scale which has fewer descriptive levels than the KSS, the equivalence between the alternative scale and the KSS shall refer to the lowest corresponding level when compared to the KSS. The only exception is for the level of the alternative scale that includes the equivalency to a KSS level of 8, in which case it shall refer to the highest corresponding level when compared to the KSS.

For example, if the alternative scale level '4' corresponds to a range between '6 and 7' on the KSS, a '4' on the alternative scale shall be considered a '6' on the KSS.

If an alternative scale level 'A' corresponds to a range between '6,5 and 8,5' on the KSS, an 'A' on the alternative scale shall be considered an '8' on the KSS.

6.2 If a complementary measurement is used in addition to KSS or to an alternative measurement to validate a DDAW system, the manufacturer shall state the threshold being used and provide evidence detailing the equivalency between the threshold and a KSS level of 8.

7. TEST RESULTS

7.1 Test data shall only be discarded by the manufacturer before any statistical analysis is conducted in any of the following cases:

a) there is an error in carrying out the testing procedure;

b) the participant's KSS ratings are deemed unreliable;

c) insufficient data is collected for a participant (e.g. length of trial was too short or participant did not generate at least 1 true positive event or 1 false negative event).

7.2 The manufacturer shall document any errors that occur during testing as part of the evidence in the documentation package, separate from the test results, along with the erroneous data and, if applicable, the reason for excluding a participants' data from the statistical analysis.

8. ACCEPTANCE CRITERIA

8.1 A DDAW system shall be deemed effective by the testing agencies if the following requirement (a) or (b) is satisfied, as modified, if necessary, by requirements (c) for tests using interval time above 15 minutes and (d) for tests performed in a simulated environment:

a) the average sensitivity is above 40 percent (sensitivity calculated from the average of the sensitivity of all participants)

b) the lower bound from the 90 percent confidence interval of the sensitivity results shall be above 20 percent. It means that 95 percent of the participants statistically have more than 20 percent average sensitivity, this is verified by satisfying the equation:

$$Average\ (Sensitivity) - 1.645 \times \frac{Standard\ Deviation\ (Sensitivity)}{\sqrt{Number\ of\ participants}} \geq 20\%$$

c) the requirement listed in sub-clause (a) is increased by 5 percent and the requirement listed in sub-clause (b) is increased by 2.5 percent if the testing method does not use an interval time equal to or shorter than the 15 minutes possible in clause 5.2.3 (upper bound possible between the recommended measurement the alternative measurement).

d) the requirement listed in sub-clause (a) is lowered by 5 percent and the requirement listed in sub-clause (b) is lowered by 2.5 percent, if the testing method is performed on an open road.

For example, the average sensitivity required for an open road test using an interval time equal to or shorter than 15 minutes will be ≥ 35 percent and the average sensitivity required for a simulation test with interval time of more than 15 minutes will be ≥ 45 percent.

Performance metric calculation: The performance metrics shall be calculated as:

Sensitivity value of a participant:

$$Sensitivity = \frac{n(TP)}{n(TP) + n(FN)} \times 100\ \%$$

Average sensitivity for all participants:

$$Average(Sensitivity) = \frac{\sum Sensitivity}{Number\ of participants}$$

Standard Deviation (Sensitivity):

$$Standard\ Deviation(Sensitivity) = \sqrt{\frac{\sum(Sensitivity - Average(Sensitivity))^2}{Number\ of participants}}$$

where:

$n(TP)$ is the total number of events in which the system and driver both correctly identify as drowsy;

$n(FN)$ is the total number of events in which the system predicts that the driver is not drowsy, but when the driver is in fact drowsy;

$n(FP)$ is the total number of events in which the system predicts that the driver is drowsy, but the driver is not drowsy;

$n(TN)$ is the total number of events in which the system and driver both correctly identify as not being drowsy;

Σ is the sum over all the participants.

Note: The distribution of the results is approximated by a Gaussian distribution.

8.2 If the DDAW system requires a learning phase, the acceptance criteria listed in clause 8.1. shall exclude results obtained during the learning phase or for 30 minutes after the condition for activation of the DDAW system are fulfilled, whichever is shorter.

PART 3

PROCEDURES FOR ASSESSMENT OF TECHNICAL DOCUMENTATION AND VERIFICATION TESTING BY THE TESTING AGENCIES

1. DOCUMENTATION PACKAGE

The manufacturer shall provide to the testing agencies a documentation package containing evidence of the effectiveness of the system. The documentation package shall cover both, the system functionality and the system validation

1.1 System functionality

a) The documentation package detailing how the system functions shall include:

b) a description of how the metrics function and monitor driving behaviour;

c) a description of the trigger behaviour being monitored by the system;

d) evidence on the relationship between drowsy driving and/or steering behaviour and the chosen trigger behaviour;

e) the system's drowsiness threshold;

f) the vehicle speed at which the system is activated;

g) an explanation of the systems activation, reactivation and deactivation functions;

h) a document detailing the functionality of the system's HMI. This includes evidence of compliance with the DDAW HMI requirements (clause 3.4. of Part 1), and justifications if the manufacturer choose not to follow the recommendations listed in the clause 3.4.2.3., 3.4.2.4. and 3.4.2.5. of Part 1.

i) a document providing at least one test protocol to be tested by the testing agencies, for which the DDAW system shall deliver a warning when performed.

The list of system inputs shall only be provided to the testing agencies for the purpose of verifying the DDAW system for the type-approval. The list of any secondary metrics will not be passed on from the testing agency.

1.2 System validation

Evidence on the effectiveness of the system document shall include:

a) the information on the number and demographics of the test participants assessed.

b) the description of the test conditions assessed;

c) evidence that the system works effectively in weather conditions not limiting the system's operation. The evidence shall indicate the known or logical limitations due to weather conditions, the technical challenge and the strategy for the system behavior in these given weather conditions (for example strong rain, snow, high temperature etc.).

d) a description of full test methodology used to assess the effectiveness of the system and the rationale behind, including any alternative or complementary measurements and alternative drowsiness threshold (referred to in clause 5.2., clause 5.3. and clause 6. of Part 2 respectively);

e) a description of the statistical analysis technique used. If a statistical analysis method that differs from that set out in clause 8.1. is used, evidence on the statistical analysis technique and level of significance used shall be provided;

f) an analysis and description of the results;

g) evidence that the system alerts a driver at the time of or before reaching the KSS level set out in clause 3.3.1. of Part 1;

h) the data of each participant for statistical anomaly assessment.

The information on demographics of the test participants referred to in sub-clause (a) shall include:

i) inclusionary or exclusionary criteria that were used when selecting participants, and

ii) a statement on the adequacy of the participants in respect of the targeted demography for the vehicle set out in clause 3.3. of Part 2.

The information on full test methodology referred to in sub-clause (d) shall include:

i) provide evidence that the complementary measurement(s) or the combination of the primary (KSS or alternative measure) and complementary measurements are a valid and accurate means to assess driver drowsiness;

ii) provide information on how the data of the primary and complementary measurements were analyzed and collated to assess the effectiveness of the DDAW system;

iii) provide evidence that the drowsiness threshold being used in the validation testing is equivalent to a KSS level referred to in clause 3.3.1 of Part 1.

1.2.1 If the validation was performed on another vehicle, the documentation shall contain information linking the validation process to the type-approval requirements for the vehicle.

e.g. Provide documents demonstrating the technical similarities or the adaptation required to enable the DDAW system to the vehicle presented for type-approval. The requirements on the participants shall also be similar (demography, involvement of professional driver).

1.2.2 If the validation was performed as part of a research to establish compliance with the technical requirements for the DDAW system, the documentation shall contain information linking the validation testing to the respective approval requirements for the motor vehicle concerned.

e.g. Provide an additional link between what is enabled in the version of the DDAW system installed in the motor vehicle and a recalculation of the equivalent sensitivity values from the data produced during the research phase.

2. ASSESSMENT BY THE TESTING AGENCIES OF THE DDAW SYSTEM DOCUMENTATION PACKAGE AND TEST REPORT

2.1 The testing agencies shall check that the manufacturer has proved on the basis of the tests performed in accordance with this standard that the DDAW meets the technical criteria laid down in Part 1 and the validation criteria laid down in Part 2. The following actions are expected:

a) check that the reported performance levels meet the required minimum thresholds referred to in clause 3.3.1. of Part 1;

b) review the test report to verify whether the underlying methodology presented in the test report meets the requirements set out in Part 2;

c) perform an assessment of the test report from the validation testing carried out by the manufacturer.

The assessment of the test report shall verify whether the underlying evidence on the tests performed correspond with the reported test results to a level of overall effect such that the performance declaration is confirmed as being adequate. This includes assessing the participant data for statistical anomalies such as the number of outliers.

The testing agencies may use means at its discretion for the assessment of the test report. Such means may include a review of the full raw data sets from a selection of test drives chosen by the testing agencies (including any data that was excluded from the analysis) and re-running

parts of the validation testing based on collected data (may only be possible for limited validation methods, such as sleep video analysis).

2.2 The testing agencies shall, taking into account the information on the system functionality provided under clause 1.1, assess the capability of the test protocol, proposed by the manufacturer, to detect a drowsy driving event. The testing agencies shall also perform the test based on the proposed protocol.

2.2.1 The test shall be accounted as passed as soon as the DDAW system provides a warning for a drowsy driver.

2.2.2 If the test fails to provide a warning for a drowsy driver, the testing agencies may repeat it up to two times.

2.2.3 The root cause of any failed test run shall be analysed by the testing agencies and the analysis shall be annexed to the test report. If the root cause cannot be linked to a deviation in the test setup, the testing agencies may test any variation of parameter within parameter's range defined in the test protocol provided by the manufacturer.

2.2.4 A reference to the code of the respective test protocol, which has been run by the testing agencies, shall be included in the 'Remarks' section of the Type-Approval Certificate in order to allow competent authorities, when performing for instance market surveillance activities, to request the test protocol from the testing agencies that carried out the test.

ANNEXURE 1
(See 4.0)
TECHNICAL INFORMATION TO BE SUBMITTED BY VEHICLE MANUFACTURER FOR TYPE APPROVAL

1.	Name and address of vehicle manufacturer	
2	Vehicle model and its variant(s)	
3	Vehicle overall dimensions, (length, width and height), mm	
4	At least one test protocol for checking capability of DDAW	
5.	'KSS' training evidence	
6.	Whether alternative method used (Yes/no)	
6.1	If Yes equivalence with 'KSS'	
6.2	Which type of alternative method used (EEG / PERCLOS)	
6.3	Human Machine Interface provisions	

ANNEXURE 2

(See Introduction)

COMPOSITION OF AISC PANEL ON DRIVER DROWSINESS AND ATTENTION WARNING SYSTEM*

Convener	
Mr. Pratyush Khare	SIAM (Tata Motors Ltd.)
Members	**Representing**
Mr. A. A. Badusha	The Automotive Research Association of India
Mr. Manoj Desai	The Automotive Research Association of India
Mr. Vishal P. Rawal	The Automotive Research Association of India
Mr. Chappagadda Bala Subrahmanyam	The Automotive Research Association of India
Ms. Shubhangi Dalvi	Central Institute of Road Transport
Mr. Ravi M	Global Automotive Research Centre
Mr. Hariharan R	Global Automotive Research Centre
Dr. Madhusudan Joshi	International Centre for Automotive Technology
Ms. Vijayanta Ahuja	International Centre for Automotive Technology
Ms. Sonia Nain	International Centre for Automotive Technology
Mr. Ved Prakash Gautam	SIAM (Ashok Leyland Ltd.)
Mr. V. Faustino	SIAM (Ashok Leyland Ltd.)
Mr. D. Karthikeyan	SIAM (Daimler India Commercial Veh. Pvt. Ltd.)
Mr. Rama Manikandan	SIAM (Daimler India Commercial Veh. Pvt. Ltd.)
Mr. Jagan Vasanth	SIAM (Daimler India Comm.Veh. Pvt. Ltd.)
Mr. Girish S. Kodolikar	SIAM (Force Motors Ltd.)
Mr. Subrat Kumar Dash	SIAM (Hero MotoCorp Ltd.)
Mr. Sakthivelan S.	SIAM (Mahindra & Mahindra Ltd.)
Mr. Sudhir Sathe	SIAM (Mahindra & Mahindra Ltd.)
Mr. Shailesh Kulkarni	SIAM (Mahindra & Mahindra Ltd.)
Ms. Pushpanjali Pathak	SIAM (Mahindra & Mahindra Ltd.)
Mr. Gururaj Ravi	SIAM (Maruti Suzuki India Ltd.)
Mr. Arun Kumar	SIAM (Maruti Suzuki India Ltd.)

Mr. Awasthi Prashank	SIAM (Maruti Suzuki India Ltd.)
Mr. Tarun Nagar	SIAM (Mercedes Benz India Pvt. Ltd.)
Mr. Rajendra Khile	SIAM (Renault Nissan India Pvt. Ltd.)
Mr. S. Vivekraj	SIAM (Renault Nissan India Pvt. Ltd.)
Mr. Jebin Jowhar	SIAM (Renault Nissan India Pvt. Ltd.)
Mr. Selvam M	SIAM (Renault Nissan India Pvt. Ltd.)
Mr. Makarand Brahme	SIAM (Skoda Auto Volkswagen India Pvt. Ltd.)
Mr. Mohit Gupta	SIAM (SML Isuzu Ltd.)
Mr. P. S. Gowrishankar	SIAM (Tata Motors Ltd.)
Mr. B. Sudarshan	SIAM (Tata Motors Ltd.)
Ms. Namrata Deb	SIAM (Tata Motors Ltd.)
Mr. Vinay Maurya	SIAM (Tata Motors Ltd.)
Mr. Raju M	SIAM (Toyota Kirloskar Motor Pvt. Ltd.)
Mr. Vijeth Gatty	SIAM (Toyota Kirloskar Motor Pvt. Ltd.)
Mr. Dinesh G. M	SIAM (Toyota Kirloskar Motor Pvt. Ltd.)
Mr. Pavan V	SIAM (Toyota Kirloskar Motor Pvt. Ltd.)
Mr. Nithin Roy	SIAM (Volvo Trucks)
Mr. Ramakant Pandey	SIAM (VE Commercial Vehicles)
Mr. Sanjay Tank	ACMA
Mr. Rai Shashank	ACMA (Bosch Ltd.)
Mr. Noel Alexander Peters	ACMA (Denso International India Pvt. Ltd.)
Mr. Anadi Sinha	ACMA (Minda Group)
Mr. Ashutosh Telang	ACMA (Minda Group)
Mr. Kishor Golesar	Nippon Audiotronix Ltd
Mr. Sarat Chandra	G Mobis
Mr. Sandeep Saxena	Drivebuddy AI
Mr. Nisarg Pandya	Drivebuddy AI
Mr. Akshay Dhruv	Emerging Technologies AI solutions
Mr. Sanidhya Patel	Emerging Technologies Ai Tech
Mr. Prakash Govindappa	Veoneer

Mr. Deepak Narayanaswamy	Veoneer
Mr. Sharad Mehta	High Tech Robotics
Mr. Nishant Kejriwal	High Tech Robotics

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

ANNEXURE 3

(See Introduction)

COMMITTEE COMPOSITION *

Automotive Industry Standards Committee

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

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