Finalized Draft

AUTOMOTIVE INDUSTRY STANDARD

FIRE DETECTION AND ALARM SYSTEM (FDAS) & FIRE DETECTION AND SUPPRESSION SYSTEMS (FDSS) FOR BUSES OF TYPE III (AIS-052) - REQUIREMENTS

ARAI

Date of hosting on website: 8th February 2016
Last date for comments: 8th March 2016
## CHECK LIST FOR PREPARING AUTOMOTIVE INDUSTRY STANDARD

### Draft AIS-135: Fire Detection and Alarm System (FDAS) & Fire Detection and Suppression Systems (FDSS) for Buses of type III (AIS-052) - Requirements

<table>
<thead>
<tr>
<th>SR. NO.</th>
<th>PARTICULARS</th>
<th>REMARKS</th>
</tr>
</thead>
</table>
| 1.      | Indicate details of the base reference standard.  
          (e.g. ECE / EEC Directive/GTR etc.) | GRSG-108-51e  
          ECE R 107-06 |
| 2.      | Add an explanatory note indicating differences between the above standard and the draft, if any. | Nil |
| 3.      | Specify details of technical specifications to be submitted at the time of type approval relevant to the requirements of this standard covered. | Refer Annexures I / II / III |
| 4.      | Are the details of Worst Case Criteria covered? | Covered in the standard |
| 5.      | Are the performance requirements covered? | Yes |
| 6.      | Is there a need to specify dimensional requirements? | Nil |
| 7.      | If yes, are they covered? | |
| 8.      | Is there a need to specify COP requirements?  
          If yes, are they covered? | |
| 9.      | Is there a need to specify type approval, and routine test separately, as in the case of some of the Indian Standards?  
          If yes, are they covered? | This needs type approval of vehicles with FDSS or FDAS if fitted. |
| 10.     | If the standard is for a part/component or sub-system;  
          i) AIS-037 or ISI marking scheme be implemented for this part?  
          ii) Are there any requirements to be covered for this part when fitted on the vehicle?  
          If yes, has a separate standard been prepared? | Not required |
<table>
<thead>
<tr>
<th></th>
<th>Question</th>
<th>Answer</th>
</tr>
</thead>
<tbody>
<tr>
<td>11.</td>
<td>If the standard is intended for replacing or revising an already notified standard, are transitory provisions for recertification of already certified parts/vehicles by comparing the previous test result, certain additional test, etc. required? If yes, are they included?</td>
<td>This is a new standard</td>
</tr>
<tr>
<td>12.</td>
<td>Include details of any other international or foreign national standards which could be considered as alternate standard.</td>
<td>Nil</td>
</tr>
<tr>
<td>13.</td>
<td>Are the details of accuracy and least counts of test equipment/meters required to be specified? If yes, have they been included?</td>
<td>Covered</td>
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<tr>
<td>14.</td>
<td>What are the test equipments for establishing compliance?</td>
<td>Test agencies are working on the same</td>
</tr>
<tr>
<td>15.</td>
<td>If possible, identify such facilities available in India.</td>
<td>Component makers have similar facilities</td>
</tr>
<tr>
<td>16.</td>
<td>Are there any points on which special comments or information is to be invited from members? If yes, are they identified?</td>
<td>Nil</td>
</tr>
<tr>
<td>17.</td>
<td>Does the scope of standard clearly identify vehicle categories?</td>
<td>Yes applies to Type III category of vehicles</td>
</tr>
<tr>
<td>18.</td>
<td>Has the clarity of definitions been examined?</td>
<td>Yes, aligned with GRSG-108-51e ECE R107-06</td>
</tr>
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</table>
Status chart of the Standard to be used by the purchaser for updating the record

<table>
<thead>
<tr>
<th>Sr. No.</th>
<th>Corrigenda</th>
<th>Amendment</th>
<th>Revision</th>
<th>Date</th>
<th>Remark</th>
<th>Misc.</th>
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</thead>
</table>

General remarks:
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, will publish this standard.

In 49th meeting of AISC, it was decided to formulate an AIS standard on the subject “Fire Detection & Suppression System (FDSS) for Buses” to standardize the specifications and test procedures for FDSS systems as technology neutral covering only performance parameters and not supplier specific specifications.

Considering that:

➢ There is a sense of urgency as evidenced by the formulation of Fire Detection & Suppression system requirements and specified in Urban Bus Specification II for implementing the required fire safety technologies;
➢ There are no mandatory regulations exist internationally for Fire Detection and/or Suppression systems;
➢ The on-going UNECE-GRSG discussions on regulating such systems here evolved a near-mature document for implementing fire safety rules on buses in Europe (Refer to GRSG- 108-51e)
➢ a significant majority of the bus fire accidents on Indian roads originate from the engine bay of the vehicle.

This Committee has decided to create rules in progression adapted from this document as follows:

Part I: Regulations for Detection & Alarm Systems for Fires originating from engine compartment of Type III buses

Part II: Regulations for Detection & Suppression of Fires originating from engine compartment of Type III buses

Till such time as part I and subsequently part II are made mandatory for the vehicles scoped therein, institutional and private procurers of such buses would have the option to specify FDAS or FDSS complying to this standard as part of their procurement requirements.
It is to be recorded that the discussions in UNECE on the scope, technical content & implementation times are still ongoing and the closing decisions would be reflected in the final version of the UNECE regulation. Such changes in the UNECE document will be monitored and suitably updated in this standard.

Composition of the Panel that has finalized this standard is given in Annex-IX.
Fire Detection and Fire Suppression Systems in Buses of Type III

1. SCOPE

1.1 This standard specifies the requirements for detection and suppression systems for fires that may originate from engine compartment located anywhere on buses.

1.2 This standard applies to:

1.2.1 Part I: Fire Detection & Alarm Systems:

1.2.1.1 Approval of Fire Detection and Alarm Systems (FDAS) which are intended to be optionally fitted to buses as defined in AIS-052 (Rev.1)

1.2.2 Part II: Fire Detection & Suppression Systems:

1.2.2.1 Approval of Fire detection and suppression systems (FDSS) which are intended to be mandatorily fitted to Type-III category buses having seating capacity more than 22 passengers as defined in AIS-052 (Rev.1).

1.2.2.2 The fitment of Fire Detection & Suppression Systems on buses other than those referred in clause 1.2.2.1 above is optional. However, if fitted, such systems shall comply with the relevant portions of this standard.

2. REFERENCES

2.1 AIS 052 Rev. 1 Code of Practice for Bus Body Design and Approval

2.2 ECE R 107-06 (Rev.6/Corr.1, 8th December 2014) – Uniform provisions concerning the approval of category: M2 or M3 vehicles with regard to their general construction.

2.3 IS 2175 Specification for Heat Sensitive Fire Detectors for use in Automatic Fire Alarm System

PART I

REQUIREMENTS OF TYPE III BUSES WITH REGARD TO FIRE DETECTION & ALARM SYSTEM (FDAS)

1. DEFINITIONS

For the purpose of Part I of this standard,

1.1 Automatic Fire Detection and Alarm System - A system comprising of components and sub-systems required for automatically detecting a fire and initiating an automatic alarm.

1.2 ‘Engine compartment’ means the compartment in which the engine is installed and / or in which a combustion heater may be installed.

1.3 Fault Signal - A distinctive audible and visual signal indicating occurrence of a fault within the FDAS / FDSS system (for example, break in electric circuit, short circuit or fault in power supply, mechanical damage in detector or elsewhere in system).

1.4 Alarm Signal - A signal is an audio and visual signal initiated by a fire alarm-initiating device, such as a manual fire alarm box, automatic fire detector, water flow switch, or other device in which activation is indicative of the presence of a fire or fire signature.

1.5 "Fire detection system type" for the purpose of type approval as a component means a category of systems which does not essentially differ in the following aspects:
   a  Detection system;
   b  detector;
   c  triggering device at end of detector;
   d  ECU;

1.6 Heat Detector - A heat detector is a sensor that senses either abnormally high temperature or rate of temperature rise, or both.

2. APPLICATION FOR CMVR APPROVAL

2.1.1 Application for CMVR type approval for a vehicle type in respect of the fire detection & alarm system (FDAS).

2.1.1 The application for approval of:
   (a) A vehicle type or;
   (b) A separate technical unit type or;
(c) A vehicle type fitted with bodywork type already approved as a separate technical unit or;
(d) A component type with regard to its constructional features shall be submitted by the manufacturer or by his duly accredited representative.

2.1.2 It shall be accompanied by the documents containing the information specified in Annex I & III as applicable.

2.1.2.1 Detailed description of the vehicle type with regard to the arrangement and design of the control or of the unit on which the fire detection and alarm system acts.

2.1.3 A vehicle representative of the type to be approved shall be submitted to the test agency.

2.1.4 A vehicle not comprising all the components proper to the type may be accepted provided that it can be shown by the applicant to the satisfaction of the test agency that the absence of the components omitted has no effect on the results of the verifications, so far as the requirements of this standard are concerned.

2.1.5 In case of application for approval of a type of vehicle, the manufacturer shall also provide the following documents:

2.1.5.1 Information regarding the installed fire detection & alarm system (FDAS):

2.1.5.1.1 In case of a fire detection & alarm system (FDAS) approved as a component, a copy of the analysis on regarding the installation of the FDAS (see Annex IV) or

2.1.5.1.2 In case of a fire detection & alarm system (FDAS) installed in a specific engine compartment, an analysis on regarding the installation of the FDAS (see Annex VI)

3. MODIFICATION AND EXTENSION OF APPROVAL OF A VEHICLE OR BODYWORK TYPE

3.1 Every modification of the vehicle, bodywork type or fire detection & alarm system shall be notified to the test agency which approved the type. That test agency may then determine that: (see Annex VIII)

Either that the modifications made are unlikely to have an appreciable adverse effect and that, in any case, the vehicle, bodywork or fire detection system still complies with the requirements; Or require a further test of compliance from the manufacturer.
4. GENERAL REQUIREMENTS

4.1 Vehicles shall be equipped with fire detection & alarm system detecting fires in the engine compartment based on sensors that senses either abnormally high temperature or rate of temperature rise, or both.

4.2 Upon detection in engine compartment, the system referred in clause no 4.1, shall provide the driver with both an acoustic and a visual signal, and activate the hazard warning signal. The placement of the visual alarm shall be such that it is visible unobstructed while viewed from the driver seat.

4.3 The detection & alarm system shall be operational irrespective of whether engine has been started and the vehicle's attitude.

4.4 The installation of the fire detection & alarm system shall comply with the following requirements;

4.4.1 The fire detection & alarm system shall be installed according to the system manufacturer's installation manual.

4.4.2 An analysis shall be conducted prior to the installation in order to determine the location of fire detectors and alarm system. Potential fire hazards within the engine compartment shall be identified such that the fire detectors shall be positioned to cover the fire hazard. The system shall also be ensured to work properly regardless of the vehicle’s altitude, road conditions etc.,

4.4.3 Fire hazards to be taken into account in the analysis shall at least consist of the following: Components whose surface may reach temperatures above the auto-ignition temperature for fluids, gases or substances that are present within the compartment and electrical components and cables with a current or voltage high enough for an ignition to occur as well as hoses and containers with flammable liquid or gas (in particular if those are pressurized). The analysis shall be fully documented.
PART II

APPROVAL OF TYPE III BUSES WITH REGARD TO
FIRE DETECTION & SUPPRESSION SYSTEM (FDSS)

1. DEFINITIONS

For the purpose of Part II of this standard,

1.1 Fire detection and suppression system is a FDAS (Fire detection & alarm system) with additional facility to automatically trigger fire extinguishing system capable of extinguishing fire in engine compartment.

1.2 "Approval of a vehicle, or a separate technical unit or a component" means the approval of a vehicle type, or of bodywork or of a component type with regard to the constructional features specified in this Standard;"

1.3 "Fire suppression system type" for the purpose of type approval as a component means a category of systems which does not essentially differ in the following aspects:
   (a) fire suppression system manufacturer;
   (b) extinguishing agent;
   (c) type of discharge point(s) used (e.g. type of nozzle, extinguishing agent generator or extinguishing agent discharge tube);
   (d) type of propellant gas, if applicable."

2. APPLICATION FOR CMVR APPROVAL

2.1 The application for approval of:
   (a) A vehicle type or;
   (b) A separate technical unit type or;
   (c) A vehicle type fitted with bodywork type already approved as a separate technical unit or;
   (d) A component type with regard to its constructional features shall be submitted by the manufacturer or by his duly accredited representative.

2.2 It shall be accompanied by the documents containing the information specified in Annex II and III.

2.3 Detailed description of the vehicle type with regard to the arrangement and design of the control or of the unit on which the fire detection & suppression system acts.

2.4 A vehicle or fire detection & suppression system representative of the type to be approved shall be submitted to the test agency.
2.5 A vehicle not comprising all the components proper to the type may be accepted provided that it can be shown by the applicant to the satisfaction of the test agency that the absence of the components omitted has no effect on the results of the verifications, so far as the requirements of this standard are concerned.

2.6 In case of application for approval of a type of vehicle, the manufacturer shall also provide the following documents, if applicable:

2.6.1 Information regarding the installed fire detection & suppression system:

2.6.1.1 In case of a fire detection & suppression system (FDSS) approved as a component, a copy of the analysis on regarding the installation of the FDSS (see Annex V) or

2.6.1.2 In case of a fire detection & suppression system (FDSS) installed in a specific engine compartment, an analysis on regarding the installation of the FDSS (see Annex VII)

3. MODIFICATION AND EXTENSION OF APPROVAL OF A VEHICLE OR BODYWORK TYPE

3.1 Every modification of the vehicle, bodywork type or fire detection & suppression system shall be notified to the test agency which approved the type. That test agency may then determine that: (see Annex VIII)

Either that the modifications made are unlikely to have an appreciable adverse effect and that, in any case, the vehicle, bodywork or fire suppression system still complies with the requirements; Or require a further test of compliance from the manufacturer.

4. GENERAL REQUIREMENTS

4.1 In the case of vehicles having an internal combustion engine or a combustion heater located either to the front or rear, the engine compartment shall be equipped with a fire alarm system providing the driver with both an acoustic and a visual signal, and activating the hazard warning signal, in the event of sensing either abnormally high temperature or rate of temperature rise, or both in the engine compartment and in each compartment where a combustion heater is located.
4.2 In addition to the fire alarm system, vehicles shall be equipped with a fire suppression system in the engine compartment and each compartment where a combustion heater is located.

4.3 The fire alarm system and the fire suppression system shall be automatically activated through a fire detection system. The detection alarm system shall be designed so as to detect a temperature in the engine compartment, and in each compartment where a combustion heater is located in excess of the temperature occurring during normal operation. There shall not be any false alarm.

4.4 The fire alarm system and the fire suppression system shall be operational irrespective of whether engine has been started and the vehicle's attitude.

4.5 The installation of the fire detection & suppression system shall comply with the following requirements:

4.5.1 The fire detection & suppression system shall be installed according to the system manufacturer's installation manual.

4.5.2 An analysis shall be conducted prior to the installation in order to determine the location and direction of suppression agent discharge point(s) (e.g. nozzles, extinguishing agent generators or extinguishing agent discharge tube or other distribution points). Potential fire hazards within the engine compartment and each compartment where a combustion heater is located, shall be identified and discharge point(s) located such that the suppression agent will be distributed to cover the fire hazard when the system activates. The spray pattern and direction of discharge points as well as the throwing distance shall be ensured to cover identified fire hazards. The system shall also be ensured to work properly regardless of the vehicle’s altitude, road conditions etc.,

Fire hazards to be taken into account in the analysis shall at least consist of the following: Components whose surface may reach temperatures above the auto-ignition temperature for fluids, gases or substances that are present within the compartment and electrical components and cables with a current or voltage high enough for an ignition to occur as well as hoses and containers with flammable liquid or gas (in particular if those are pressurized). The analysis shall be fully documented.

4.5.3 The suppression system shall be scaled from the tested system, based on the total gross volume of the engine and auxiliary heater compartments where the system is to be installed. When measuring the engine compartment and the auxiliary heater compartment, the gross volume of these compartments shall be
measured, i.e. the volume of the engine and its components shall not be subtracted.

The scaling of the system includes the mass of the suppression agent, all discharge points and the mass of the propellant gas container, if applicable. The system pressure shall remain the same as in the tested system. If the system includes a discharge tube for the extinguishing agent, the length of the tube shall be scaled without nozzles. It is acceptable if the suppression system has more extinguishing agent and/or more discharge points and/or a longer discharge tube for the extinguishing agent and/or more propellant gas than required according to the scaling models found below.

If the gross volume of the engine and auxiliary heater compartments exceed 4 m³, the suppression system shall be scaled up using the following scaling factor calculated in equation (1) below. If the gross volume is less than 4 m³, it is allowed to scale down the suppression system using the scaling factor given in equation (2) below. Sx denotes the scaling factor and x denotes the total gross volume including the engine and combustion heater compartments [m³].

\[
\begin{align*}
S_x &= 0.1 \cdot x + 0.6 \quad \text{(1)} \\
S_x &= 0.15 \cdot x + 0.4 \quad \text{(2)}
\end{align*}
\]

The scaled number of nozzles or other discharge points, if the suppression system has more than one discharge point may be rounded to the closest whole number.
ANNEX I
(See 2.1.2)
INFORMATION TO BE SUBMITTED FOR TYPE APPROVAL OF
TYPE III CATEGORY BUSES WITH REGARD TO FIRE DETECTION
AND ALARM SYSTEM

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<thead>
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<th>S. No</th>
<th>Parameter</th>
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<td>1</td>
<td>Name of the Model(s)</td>
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<tr>
<td>2</td>
<td>Variant(s)</td>
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<td>3</td>
<td>Vehicle category (s)</td>
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<td>4</td>
<td>Name and address of vehicle manufacturer</td>
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<td>5</td>
<td>Type of fire detector(s) used</td>
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<td>6</td>
<td>Name and address of manufacturer of the Fire detectors</td>
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<tr>
<td>7</td>
<td>Description of the device or sketch showing location, relevant dimensions of fire detectors</td>
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</table>
| 8     | Devices provided additionally
      | Acoustic or visual |
      | If visual, duration and type of optical signal |
ANNEX II
(See 2.2)
INFORMATION TO BE SUBMITTED FOR TYPE APPROVAL OF
TYPE III CATEGORY BUSES WITH REGARD TO FIRE DETECTION
AND SUPPRESSION SYSTEM

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<td>3</td>
<td>Vehicle category(s)</td>
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<td>4</td>
<td>Name and address of vehicle manufacturer</td>
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<td>5</td>
<td>Make and type of the fire suppression system</td>
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<td>FDAS / FDSS for a specific engine compartment</td>
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<td>Extinguishing agent (make and type):</td>
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<td>9</td>
<td>Mass of extinguishing agent:</td>
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<td>10</td>
<td>Type of discharge point(s):</td>
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<td>11</td>
<td>Length of discharge tube</td>
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<tr>
<td>12</td>
<td>Number of discharge points(s):</td>
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<td>13</td>
<td>Type of propellant gas, if applicable:</td>
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<td>14</td>
<td>Pressure of propellant gas</td>
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<td>15</td>
<td>Minimum operating temperature</td>
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<td>16</td>
<td>Dimensions of pipes and fittings</td>
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<tr>
<td>17</td>
<td>Detailed description, layout drawings and installation manual of the fire suppression system and its components</td>
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</table>


### ANNEX III
(See 2.2)

INFORMATION TO BE SUBMITTED FOR COMPONENT LEVEL APPROVAL OF FIRE DETECTION & ALARM SYSTEM AND FIRE DETECTION & SUPPRESSION SYSTEM

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<td>3</td>
<td>Name and address of manufacturer:</td>
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<td>4</td>
<td>Type of fire detector(s) used</td>
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<tr>
<td>5</td>
<td>Name and address of manufacturer of the Fire detectors</td>
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<tr>
<td>6</td>
<td>Description of the device or sketch showing location, relevant dimensions of fire detectors</td>
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<td>7</td>
<td>Devices provided additionally</td>
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<td>Acoustic or visual</td>
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<td>If visual, duration and type of optical signal</td>
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<td>Extinguishing agent (make and type):</td>
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<td>Mass of extinguishing agent:</td>
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<td>Length of discharge tube</td>
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<td>Number of discharge points(s):</td>
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<td>13</td>
<td>Type of propellant gas, if applicable:</td>
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<td>Pressure of propellant gas</td>
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<td>Minimum operating temperature</td>
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<td>17</td>
<td>Detailed description, layout drawings and installation manual of the fire suppression system and its components</td>
<td></td>
</tr>
</tbody>
</table>
ANNEX IV
(See 2.1.5.1.1)
REQUIREMENTS FOR FIRE DETECTION & ALARM SYSTEM (FDAS) APPROVED AS A COMPONENT

1. Specifications

1.1 Fire detection system & alarm system (FDAS) conforming to this standard shall comply with the requirements of high fire load, low fire load and high fire load with fan described in Appendix 1 but excluding fire suppression requirements.

1.2 The test apparatus, test fires and general test conditions are described in Appendix 1.

2. High fire load

2.1 The high fire load test shall be conducted in accordance with Appendix 2.

2.2 The detector/s will be mounted in the engine compartment in such a manner that there will be line of sight to at least one detector from any point surrounding the engine, in order to ensure optimal coverage of threats of fire liable to break out in the engine compartment.

2.3 The installation of the detectors will prevent mechanical damage that is liable to disrupt the operation thereof.

2.4 The command and control system will be mounted outside of the engine compartment, if possible.

2.5 The manual means of activation and warning will be positioned in the vicinity of the driver’s dashboard.

2.6 The fire shall be detected and warning signal shall be activated within 20 seconds after ignition.

2.7 The test is considered passed either after success at first attempt or at two of three attempts in a case when first of these attempts fails.

3. Low fire load

3.1 The low fire load test shall be conducted in accordance with Appendix 3.

3.2 The detector/s will be mounted in the engine compartment in such a manner that there will be line of sight to at least one detector from any
point surrounding the engine, in order to ensure optimal coverage of threats of fire liable to break out in the engine compartment.

3.3 The installation of the detectors will prevent mechanical damage that is liable to disrupt the operation thereof.

3.4 The command and control system will be mounted outside of the engine compartment, if possible.

3.5 The manual means of activation and warning will be positioned in the vicinity of the driver’s dashboard.

3.6 The fire shall be detected and warning signal shall be activated within 20 seconds after ignition.

3.7 The test is considered passed if success was achieved at the first attempt or at two of three attempts in a case when first of these attempts fails.

4. High fire load with fan

4.1 The high fire load test with fan shall be conducted in accordance with Appendix 4.

4.2 The detector/s will be mounted in the engine compartment in such a manner that there will be line of sight to at least one detector from any point surrounding the engine, in order to ensure optimal coverage of threats of fire liable to break out in the engine compartment.

4.3 The installation of the detectors will prevent mechanical damage that is liable to disrupt the operation thereof.

4.4 The command and control system will be mounted outside of the engine compartment, if possible.

4.5 The manual means of activation and warning will be positioned in the vicinity of the driver’s dashboard.

4.6 The fire shall be detected and warning signal shall be activated within 20 seconds after ignition.

4.7 The test is considered passed if success was achieved at the first attempt or at two of three attempts in a case when first of these attempts fails.
ANNEX V

(See 2.6.1.1)

REQUIREMENTS FOR FIRE DETECTION & SUPPRESSION SYSTEM (FDSS) APPROVED AS A COMPONENT

1. Specifications

1.1 Fire detection & suppression system (FDSS) conforming to this standard shall comply with the requirements of high fire load, low fire load, high fire load with fan and re-ignition described in Appendix 1.

1.2 The test apparatus, test fires and general test conditions are described in Appendix 1.

2. High fire load

2.1 The high fire load test shall be conducted in accordance with Appendix 2.

2.2 The detector/s will be mounted in the engine compartment in such a manner that there will be line of sight to at least one detector from any point surrounding the engine, in order to ensure optimal coverage of threats of fire liable to break out in the engine compartment.

2.3 The installation of the detectors will prevent mechanical damage that is liable to disrupt the operation thereof.

2.4 The command and control system will be mounted outside of the engine compartment, if possible.

2.5 The manual means of activation and warning will be positioned in the vicinity of the driver’s dashboard, in such a manner that the driver will be able to see, hear and activate them, and such will be connected to the command and control system of the extinguishing system.

2.6 The fire shall be detected and warning signal shall be activated within 20 seconds after ignition.

2.7 The test shall be conducted with the extinguishing agent and the propellant gas vessel or the suppression agent generator cooled to the minimum operating temperature (“0” degrees) for the fire suppression system, as declared by the manufacturer.

2.8 The fires shall be fully extinguished, either, in the minute after activation or upon end of the discharge of the suppression system.
2.9 The test is considered passed either after success at first attempt or at two of three attempts in a case when first of these attempts fails.

3. **Low fire load**

3.1 The low fire load test shall be conducted in accordance with Appendix 3.

3.2 The detector/s will be mounted in the engine compartment in such a manner that there will be line of sight to at least one detector from any point surrounding the engine, in order to ensure optimal coverage of threats of fire liable to break out in the engine compartment.

3.3 The installation of the detectors will prevent mechanical damage that is liable to disrupt the operation thereof.

3.4 The command and control system will be mounted outside of the engine compartment, if possible.

3.5 The manual means of activation and warning will be positioned in the vicinity of the driver’s dashboard, in such a manner that the driver will be able to see, hear and activate them, and such will be connected to the command and control system of the extinguishing system.

3.6 The fire shall be detected and warning signal shall be activated within 20 seconds after ignition.

3.7 The test shall be conducted with the extinguishing agent and the propellant gas vessel or the suppression agent generator cooled to the minimum operating temperature ("0" degrees) for the fire suppression system, as declared by the manufacturer.

3.8 The fires shall be fully extinguished either in the minute after activation or upon end of the discharge of the suppression system.

3.9 The test is considered passed if success was achieved at the first attempt or at two of three attempts in a case when first of these attempts fails.

4. **High fire load with fan**

4.1 The high fire load test with fan shall be conducted in accordance with Appendix 4.

4.2 The detector/s will be mounted in the engine compartment in such a manner that there will be line of sight to at least one detector from any
point surrounding the engine, in order to ensure optimal coverage of threats of fire liable to break out in the engine compartment.

4.3 The installation of the detectors will prevent mechanical damage that is liable to disrupt the operation thereof.

4.4 The command and control system will be mounted outside of the engine compartment, if possible.

4.5 The manual means of activation and warning will be positioned in the vicinity of the driver’s dashboard, in such a manner that the driver will be able to see, hear and activate them, and such will be connected to the command and control system of the extinguishing system.

4.6 The fire shall be detected and warning signal shall be activated within 20 seconds after ignition.

4.7 The test shall be conducted with the extinguishing agent and the propellant gas vessel or the suppression agent generator cooled to the minimum operating temperature (“0” degrees) for the fire suppression system, as declared by the manufacturer.

4.8 The fires shall be fully extinguished either in the minute after activation or upon end of the discharge of the suppression system.

4.9 The test is considered passed if success was achieved at the first attempt or at two of three attempts in a case when first of these attempts fails.

5. Re-ignition test

5.1 The re-ignition test shall be conducted in accordance with Appendix 5.

5.2 The fire shall be fully extinguished and no re-ignition shall occur 45 seconds after the extinguishing of the fire.

5.3 The test is considered passed either if success was achieved at the first attempt or at two of three attempts in a case when first of these attempts fails.
ANNEX VI
(See 2.1.5.1.2)
REQUIREMENTS FOR FIRE DETECTION & ALARM SYSTEM (FDAS) INSTALLED IN A SPECIFIC ENGINE COMPARTMENT

1. Specifications

1.1. A specific engine compartment means engine compartments which do not differ in the following essential aspects:

(a) Engine compartments position in the vehicle;

(b) Maximum gross volume;

(c) General layout of components in the compartment (i.e. position of fire hazards determined).

For compartments where a combustion heater is placed aspects (b) and (c) apply.

1.2. The fire detection & alarm system (FDAS) conforming to this standard shall comply with the requirements of high fire load, low fire load, high fire load with fan (to be applied if a fan is fitted in the engine compartment and/or combustion heater compartment) described in Appendix 1.

1.3. The test apparatus, test fires and general test conditions are described in Appendix 1.

In order to facilitate the positioning of the fire trays within the engine and combustion heater compartment additional supports may be used and the height of the prescribed test fire may be lowered to a minimum of 40 mm.

The test conditions in Appendices 2 to 5 may be adapted for the specific engine compartment and combustion heater compartment. The adaptation shall provide an equivalent level of safety. The principles for the adaptation shall be verified by the Test Agency responsible for the tests. The principle of adaption shall be documented and added to the test report.

2. High fire load

2.1. The high fire load test shall be conducted in accordance with Appendix 2.

2.2. The fire shall be detected and warning signal shall be activated within 20 seconds after ignition.

2.3. The test is considered passed either after success at the first attempt or after success at the second and third attempts in case of failure at the first attempt.
3. Low fire load

3.1 The low fire load test shall be conducted in accordance with Appendix 3.

3.2 The fire shall be detected and warning signal shall be activated within 20 seconds after ignition.

3.3 The test is considered passed either after success at the first attempt or after success at the second and third attempts in case of failure at the first attempt.

4. High fire load with fan (if a fan is fitted in the engine and/or combustion heater compartment)

4.1 The high fire load test with fan shall be conducted in accordance with Appendix 4.

4.2 The fire shall be detected and warning signal shall be activated within 20 seconds after ignition.

4.3 The test is considered passed either after success at the first attempt or after success at the second and third attempts in case of failure at the first attempt.
ANNEX VII
(See 2.6.1.2)
REQUIREMENTS FOR FIRE DETECTION & SUPPRESSION SYSTEM (FDSS) INSTALLED IN A SPECIFIC ENGINE COMPARTMENT

1. Specifications

1.1. A specific engine compartment means engine compartments which do not differ in the following essential aspects:

(a) Engine compartments position in the vehicle;

(b) Maximum gross volume;

(c) General layout of components in the compartment (i.e. position of fire hazards determined).

For compartments where a combustion heater is placed aspects (b) and (c) apply.

1.2. The fire detection & suppression system (FDSS) conforming to this standard shall comply with the requirements of high fire load, low fire load, high fire load with fan (to be applied if a fan is fitted in the engine compartment and/or combustion heater compartment) and re-ignition described in Appendix 1.

1.3. The test apparatus, test fires and general test conditions are described in Appendix 1.

In order to facilitate the positioning of the fire trays within the engine and combustion heater compartment additional supports may be used and the height of the prescribed test fire may be lowered to a minimum of 40 mm.

The test conditions in Appendices 2 to 5 may be adapted for the specific engine compartment and combustion heater compartment. The adaptation shall be based on the provisions given in Part II, Clause nos. 4.5.1, 4.5.2 and 4.5.3, determining the fire hazards within the compartment and the scaling of the fire suppression system. The adaptation shall provide an equivalent level of safety. The principles for the adaptation shall be verified by the Test Agency responsible for the tests. The principle of adaption shall be documented and added to the test report.

2. High fire load

2.1 The high fire load test shall be conducted in accordance with Appendix 2.

2.2 The test shall be conducted with the extinguishing agent and the propellant gas vessel or the suppression agent generator cooled to the minimum operating
temperature ("0" degrees) for the fire suppression system, as declared by the manufacturer.

2.3 The fire shall be detected and warning signal shall be activated within 20 seconds after ignition.

2.4 The fires shall be fully extinguished, either, in the minute after activation or upon end of the discharge of the suppression system.

2.5 The test is considered passed either after success at the first attempt or after success at the second and third attempts in case of failure at the first attempt.

3.   Low fire load

3.1 The low fire load test shall be conducted in accordance with Appendix 3.

3.2 The fire shall be detected and warning signal shall be activated 20 seconds after ignition.

3.3 The fires shall be fully extinguished either in the minute after activation or upon end of the discharge of the suppression system.

3.4 The test is considered passed either after success at the first attempt or after success at the second and third attempts in case of failure at the first attempt.

4.  High fire load with fan (if a fan is fitted in the engine and/or combustion heater compartment)

4.1 The high fire load test with fan shall be conducted in accordance with Appendix 4.

4.2 The fire shall be detected and warning signal shall be activated within 20 seconds after ignition.

4.3 The fires shall be fully extinguished either in the minute after activation or upon end of the discharge of the suppression system.

4.4 The test is considered passed either after success at the first attempt or after success at the second and third attempts in case of failure at the first attempt.

5.  Re-ignition test

5.1 The re-ignition test shall be conducted in accordance with Appendix 5.

5.2 The fire shall be fully extinguished and no re-ignition shall occur 45 seconds after the extinguishing of the fire.

5.3 The test is considered passed either after success at the first attempt or after success at the second and third attempts in case of failure at the first attempt.
ANNEX VIII

GUIDELINES FOR DECIDING WHETHER TESTING IS NEEDED
(See 3.0 of Parts I & II)

1. In general, when changes in technical specifications of vehicle do not affect the FDAS / FDSS performance adversely, and is still within the stipulated limits, the type approval certificate can be extended. The changes in parameters that affect the FDAS / FDSS performance are listed in clause no. 2.

2. In the case of following changes, with respect to the vehicles tested, in the details submitted as per Annexures I & II, tests are necessary for establishing compliance:

<table>
<thead>
<tr>
<th></th>
<th>Change in volume of engine compartment</th>
<th>To be tested if volume of engine compartment is increased which increases the number of nozzles derived from clause no. 4.5.3</th>
</tr>
</thead>
<tbody>
<tr>
<td>2</td>
<td>Type of extinguishing agents</td>
<td>To be tested in case of any change</td>
</tr>
<tr>
<td>3</td>
<td>Change in capacity of extinguishing agent</td>
<td>To be tested in case of decrease in capacity</td>
</tr>
<tr>
<td>4</td>
<td>Dimensions of pipes &amp; fittings of FDSS &amp; FDAS</td>
<td>To be tested in case of any change</td>
</tr>
<tr>
<td>5</td>
<td>Pressurized cartridge system</td>
<td>To be tested in case of decrease in pressure of the system</td>
</tr>
</tbody>
</table>

3. Changes other than the above are generally considered as not affecting compliance. However it does not limit test agencies and vehicle manufacturer to investigate possibility of any other criteria, for which tests may be conducted for extension as per mutual agreement between test agencies & vehicle manufacturer.
Appendix 1

Test apparatus, test fires and general test specifications

1. Test apparatus

1.1. The test apparatus is to be made of steel plate. The thickness of the steel plate shall be in accordance with Table 1. Figure 1 shows the test apparatus from the front side, Figure 2 from the rear side and Figure 3 from top. The front side of the test apparatus simulates the rear side of a real engine compartment. Test apparatus shall have its own fire suppression systems which can extinguish the test fire in case the FDAS test and also in case the FDSS under test fails to suppress the test fire.

Figure 1
Coordinate system for the position of objects in test apparatus (view from front side)

![Coordinate system](image1)

Figure 2
Test apparatus seen from the rear

![Test apparatus seen from the rear](image2)
1.2. Object locations

1.2.1. All objects in the test apparatus are positioned according to coordinates (x, y, z) as shown in Table 2. Origin is the position marked (O) in Figure 1. The value of the coordinates is the distance in meter from origin (see Figure 1, i.e. left-front-bottom corner.)
1.3. Framework

1.3.1. The framework of the test apparatus shall be constructed according to Figure 4. The sizes of the beams are 50 mm × 50 mm and 100 mm × 50 mm respectively. The framework shall be 300 mm above the ground.

![Figure 4](image)

Framework for the test apparatus

1.4. Apertures

1.4.1. In addition to the opening for the fan, the test apparatus includes six apertures. The dimensions and positions of the apertures are given according to the coordinates in Table 3. The positions are given by referring to two diagonally opposite corners (all apertures are rectangular in shape). The apertures are shown in Figure 4.

Table 3
Coordinates of apertures in the test apparatus

<table>
<thead>
<tr>
<th>Aperature</th>
<th>Coordinates $[x; y; z]$</th>
<th>Area of aperture</th>
</tr>
</thead>
<tbody>
<tr>
<td>A1</td>
<td>[0.03; 0.00; 1.08] - [1.18; 0.00; 1.13]</td>
<td>0.06 m²</td>
</tr>
<tr>
<td>A2</td>
<td>[1.22; 0.00; 1.08] - [2.57; 0.00; 1.13]</td>
<td>0.06 m²</td>
</tr>
<tr>
<td>B</td>
<td>[2.40; 0.50; 0.70] - [2.40; 1.50; 0.90]</td>
<td>0.16 m²</td>
</tr>
<tr>
<td>C</td>
<td>[0.85; 1.50; 0.03] - [1.24; 1.50; 0.36]</td>
<td>0.13 m²</td>
</tr>
<tr>
<td>D1</td>
<td>[2.00; 0.05; 0.00] - [2.35; 0.73; 0.00]</td>
<td>0.27 m²</td>
</tr>
<tr>
<td>D2</td>
<td>[2.00; 0.73; 0.00] - [2.35; 1.20; 0.00]</td>
<td>0.26 m²</td>
</tr>
</tbody>
</table>

Total area of aperture: 0.94 m²
1.5. Fan

1.5.1. An axial fan with a diameter of 710 mm shall be mounted on the left side of the fan cylinder. The diameter of the cylinder shall be equal to the diameter of the fan. The fan shall produce a certain rate of air flow through the cylinder according to the test scenarios in Appendices 2 to 5. A frequency converter may be used to adjust the fan speed.

1.6. Mock-up components

1.6.1. The dimensions of the engine mock-up are 1,000 mm × 650 mm × 500 mm. The dimensions of the muffler mock-up are Ø400 mm × 800 mm. The exhaust manifold mock-up shall have the inner dimensions of Ø80 mm × 900 mm. The mock-up components shall be hollowed. The exhaust manifold mock-up shall be connected to the muffler mock-up through a pipe with a diameter of 76 mm. A pipe from the muffler mock-up should also be used to carry the exhaust gases from the pre-warming system out from the test apparatus.

1.7. Thermocouples

1.7.1. Seven thermocouples (Tc) shall be mounted on the exhaust manifold mock-up, drilled 2 mm into the tube from the outside. Thermocouples Tc1 to Tc4 shall be located on top of the mock-up at the distances from the mock-up inlet according to Table 4. Thermocouples Tc5 to Tc7 shall be located around the mock-up at the same distance from the inlet as Tc2. The location of the thermocouples is illustrated in Figures 5 and 6.

Table 4
Distance to thermocouple from inlet of exhaust manifold mock-up

<table>
<thead>
<tr>
<th>Thermocouple</th>
<th>Distance from inlet</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tc1</td>
<td>250 mm</td>
</tr>
<tr>
<td>Tc2</td>
<td>300 mm</td>
</tr>
<tr>
<td>Tc3</td>
<td>350 mm</td>
</tr>
<tr>
<td>Tc4</td>
<td>600 mm</td>
</tr>
<tr>
<td>Tc5</td>
<td>300 mm</td>
</tr>
<tr>
<td>Tc6</td>
<td>300 mm</td>
</tr>
<tr>
<td>Tc7</td>
<td>300 mm</td>
</tr>
</tbody>
</table>
1.8. Propane burner

1.8.1. The propane burner used to pre-warm the exhaust system shall be chosen as to fulfill the requirements on achieved temperatures specified in paragraph 3.4.6.

1.9. Obstructions

1.9.1. Obstruction 1 has the dimensions of 900 mm × 840 mm × 230 mm, as shown in Figure 7. Obstructions 2 and 3 consist of horizontal and vertical obstruction tubes as shown in Figure 8. The horizontal obstruction tubes are closed and hollow, with a diameter of 80 mm and a length of 480 mm. The vertical tubes are hollow and open in the bottom, with a diameter of 80 mm and a length of 230 mm. The open distance between every tube is 20 mm. Obstruction 4 is a box measuring 1,250 mm × 300 mm × 390 mm as shown in Figure 9.
Figure 7
Obstruction 1

Figure 8
Obstruction 2 and 3

Figure 9
Obstruction 4
1.10. Pool Fire trays

1.10.1. The square pool fire trays with fibreboards and the rectangular pool fire trays shall be positioned in its orientation according to the test scenarios in Appendices 2 to 4. Figure 10 shows the dimensions for test fire #2. The test fire shall be positioned perpendicular to the long edge of the test apparatus.

Figure 10
Distances for test fire #2

2. Test fires

2.1. The test fires in Table 5 are to be used in the different test scenarios described in Appendices 2 to 5. Diesel oil (commercial fuel oil or light diesel oil), heptane (C7H16) and engine oil 15W-40 with a flash point COC of 230 °C and viscosity at 40 °C of 107 mm²/s shall be used as test fuels.

Table 5
Test fires
2.2. Three different types of pool fire trays are applied in Table 5: square, rectangular and circular. Detailed descriptions of these trays are given in Table 6.

Table 6
Specification of pool fire trays

<table>
<thead>
<tr>
<th>Dimensions</th>
<th>Rim height</th>
<th>Nominal thickness</th>
<th>Used for test fire</th>
</tr>
</thead>
<tbody>
<tr>
<td>300 mm × 300 mm</td>
<td>70 mm</td>
<td>1.5 mm</td>
<td>#1, #2</td>
</tr>
<tr>
<td>200 mm × 300 mm</td>
<td>70 mm</td>
<td>2 mm</td>
<td>#3</td>
</tr>
<tr>
<td>Ø 150 mm</td>
<td>100 mm</td>
<td>1.5 mm</td>
<td>#4</td>
</tr>
</tbody>
</table>

2.3. The amount of water, diesel and heptane used in the tests should be in accordance with Table 7.

Table 7
Amount of fuel used in pool fire trays

<table>
<thead>
<tr>
<th>Dimensions</th>
<th>Water</th>
<th>Diesel</th>
<th>Heptane</th>
<th>Used for test fire</th>
</tr>
</thead>
<tbody>
<tr>
<td>300 mm × 300 mm</td>
<td>1.01</td>
<td>0.51</td>
<td>0.21</td>
<td>#1, #2</td>
</tr>
<tr>
<td>200 mm × 300 mm</td>
<td>0.51</td>
<td>0.51</td>
<td>0.21</td>
<td>#3</td>
</tr>
<tr>
<td>Ø 150 mm</td>
<td>0.21</td>
<td>0.21</td>
<td>0.11</td>
<td>#4</td>
</tr>
</tbody>
</table>

2.4. Test fire #2 consists of a heptane pool and two diesel soaked fibreboards with a dry density of 3.5 kg/m³. The dimensions of the fibreboards shall be 12 mm × 295 mm × 190 mm. The fibreboards shall consist of at least 90 per cent raw material from wood. The moisture content in the boards before they are soaked in diesel oil shall not exceed 7 per cent. The fibreboards shall be completely immersed in diesel oil for at least 10 minutes prior to the test and mounted vertically in the pool fire tray not more than 10 minutes before the start of the test.

2.5. Test fire #5 and #6 consist of diesel oil spray fires while Test fire #7 consists of a dripping oil fire (by hot surface ignition).

The spray nozzle for test fire #5 shall be a Lechler 460.368.30 or an equivalent. The spray nozzle for test fire #6 shall be a Lechler 212.245.11 or an equivalent. The spray nozzle for test fire #7 shall be a Danfoss 0.60X80H or an equivalent.

3. Installation of fire suppression system

3.1. To obtain the minimum discharge rate condition, an extinguishing system is to be assembled using its maximum piping limitations with respect to the number of fittings and size and length of pipe, if relevant. The cylinder is to be used with its rated capacity and the cylinder or gas cartridge pressurized with propellant gas to the normal operating pressure, if relevant.
3.2. The fire suppression system shall be installed by the system manufacturer or supplier. Figure 11 shows the area where extinguishing agent discharge points such as of nozzles, extinguishing agent generators or extinguishing agent discharge tubes may be located. The discharge points shall be positioned inside the test apparatus, at two different areas:

(a) In the ceiling and at the rear wall. Discharge points positioned in the ceiling shall be positioned at a minimum of 750 mm above the floor level ($z \geq 0.75$) and outside of Obstruction 1. Nozzles positioned at the rear wall shall be positioned within 350 mm from the rear wall ($y \geq 1.15$) and minimum 450 mm from the floor level ($z \geq 0.45$). Figures 17 and 18 show the area where the nozzles may be located.

(b) Inside the small box (referred to as Obstruction 4) in the rear side of the test apparatus. Nozzles should be located in the ceiling of the box with a minimum of 290 mm from the floor ($z \geq 0.29$).

Figure 11
Nozzle positioning seen from the rear side of test apparatus

3.3. The system set-up and configuration shall be observed and documented prior to the test (e.g. amount of suppression agent and propellant gas, system pressure, number, type and location of discharge points, length of pipes and number of fittings). Temperature shall be measured during the re-ignition tests at locations specified in Appendix 1.
3.4. Practical conduct of a test

3.4.1. The pool fire trays are to be filled with diesel and heptane on a base of water according to Table 7. If fibreboards are to be used as a fire source, the fibreboards shall be soaked in diesel oil, prior to the test, according to instructions in paragraph 2.4.

3.4.2. A pre-burn time based on the information in Appendices 2 to 5 is required. The pre-burn time is measured beginning from the time the first fire is ignited. All pool fires in the test scenarios shall be ignited within the allowed ignition-time, according to Appendices 2 to 5, using a suitable ignition source. The low fire load scenario in Appendix 3 may be performed either with one test fire at a time or the test fires combined with the suppression system showing its ability to extinguish all test fires, separately or merged.

3.4.3. A fan is used in some of the test scenarios to obtain a specific air flow rate into the test apparatus. The fan shall be engaged 30 seconds before the suppression system is activated. The fan shall remain active until the test is complete, i.e. until it is determined whether the test is passed or failed.

3.4.4. A diesel spray is used in some of the test scenarios. The diesel spray shall be activated 10 seconds prior to activation of the suppression system. The diesel spray shall remain active until the test is completed, i.e. until it is clarified if the test is passed or failed.

3.4.5. After the stipulated pre-burn time, the suppression system shall be manually or automatically activated.

3.4.6. In test for re-ignition, the exhaust manifold mock-up tube is pre-heated prior to the test with a burner. Pressurized air may be added to the flame for better combustion. The tube shall be heated from the inner side until the temperature of $T_{c2}$ is above 600 °C and $T_{c1}$ is above 570 °C and the temperatures of $T_{c5}$, $T_{c6}$ and $T_{c7}$ not are less than 520 °C. When the predefined temperatures are reached the pre-heating procedure stops. After 30 seconds the engine oil start dripping and the suppression system activates 15 seconds later. The engine oil shall ignite before activation of the suppression system. The oil should continue to drip on to the tube until it is clarified if the test is passed or failed.

4. Tolerances

4.1. A tolerance of ±5 per cent of the stipulated values shall apply (for time values: ±5 seconds).
Appendix 2

High fire load scenario

Table 1
Test fires in high fire load scenario

<table>
<thead>
<tr>
<th>Test fire (see Table 3 in Appendix 1)</th>
<th>Description</th>
<th>Coordinates [x:y:z] (see Figure 1 in Appendix 1)</th>
</tr>
</thead>
<tbody>
<tr>
<td>#6</td>
<td>Spray fire (4.5 bar, 0.19 kg/min)</td>
<td>[1.47; 0.73; 0.46]</td>
</tr>
<tr>
<td>#3</td>
<td>Pool fire 200 mm × 300 mm</td>
<td>[0.97; 0.85; 0.70]</td>
</tr>
<tr>
<td>#4</td>
<td>Pool fire 150 mm</td>
<td>[0.97; 1.28; 0.00]</td>
</tr>
<tr>
<td>#5</td>
<td>Pool fire 200 mm × 300 mm</td>
<td>[1.54; 0.67; 0.36]</td>
</tr>
<tr>
<td>#2</td>
<td>Pool fire 300 mm × 300 mm and 2 Fibreboards</td>
<td>[1.54; 0.77; 0.36]</td>
</tr>
<tr>
<td>#3</td>
<td>Pool fire 200 mm × 300 mm</td>
<td>[1.54; 0.13; 0.00]</td>
</tr>
</tbody>
</table>

Note: The fan is not used

Table 2
Test procedure for high fire load scenario

<table>
<thead>
<tr>
<th>Time</th>
<th>Action</th>
</tr>
</thead>
<tbody>
<tr>
<td>00:00</td>
<td>Start igniting</td>
</tr>
<tr>
<td>00:20</td>
<td>Alarm should have activated</td>
</tr>
<tr>
<td>01:20</td>
<td>Ignition complete</td>
</tr>
<tr>
<td>01:50</td>
<td>Start of Diesel spray</td>
</tr>
<tr>
<td>02:00</td>
<td>Manual activation of suppression system</td>
</tr>
<tr>
<td>02:30</td>
<td>FDSS should have suppressed the Fire</td>
</tr>
</tbody>
</table>

Figure 1
Test fire positioning, view from the front side
Figure 2
Test fire positioning, view from the rear side
Appendix 3

Low fire load scenario

Table 1
Test fires in low fire load scenario

<table>
<thead>
<tr>
<th>Test fire (see Table 3 in Appendix 1)</th>
<th>Description</th>
<th>Coordinates [x; y; z] (see Figure 1 in Appendix 1)</th>
</tr>
</thead>
<tbody>
<tr>
<td>#4</td>
<td>Pool fire O 150 mm</td>
<td>[0.02; 0.08; 0.00]</td>
</tr>
<tr>
<td>#3</td>
<td>Pool fire 200 mm x 300 mm</td>
<td>[0.37; 0.57; 0.00]</td>
</tr>
<tr>
<td>#4</td>
<td>Pool fire O 150 mm</td>
<td>[0.45; 1.20; 0.00]</td>
</tr>
<tr>
<td>#4</td>
<td>Pool fire O 150 mm</td>
<td>[0.97; 1.28; 0.00]</td>
</tr>
<tr>
<td>#4</td>
<td>Pool fire O 150 mm</td>
<td>[1.54; 0.57; 0.00]</td>
</tr>
</tbody>
</table>

*Note: The fan is producing an air flow of 1.5 m³/s.*

Table 2
Test procedure for low fire load scenario

<table>
<thead>
<tr>
<th>Time</th>
<th>Action</th>
</tr>
</thead>
<tbody>
<tr>
<td>00:00</td>
<td>Start igniting</td>
</tr>
<tr>
<td>00:20</td>
<td>Alarm should have activated</td>
</tr>
<tr>
<td>01:00</td>
<td>Ignition complete</td>
</tr>
<tr>
<td>01:30</td>
<td>Start the Fan</td>
</tr>
<tr>
<td>02:00</td>
<td>Manual activation of suppression system</td>
</tr>
<tr>
<td>02:30</td>
<td>FDSS should have suppressed the Fire</td>
</tr>
</tbody>
</table>

Figure 1
Test fire positioning, view from the front side
Figure 2
Test fire positioning, view from the rear side
Appendix 4

High fire load scenario with fan

Table 1
Test fires in high fire load scenario with fan

<table>
<thead>
<tr>
<th>Test fire (see Table 5 in Appendix 1)</th>
<th>Description</th>
<th>Coordinates [x; y; z] (see Figure 1 in Appendix 1)</th>
</tr>
</thead>
<tbody>
<tr>
<td>#5</td>
<td>Spray fire (4.5 bar, 0.73 kg/min)</td>
<td>[0.37; 0.70; 0.46]</td>
</tr>
<tr>
<td>#1</td>
<td>Pool fire 300 mm x 300 mm</td>
<td>[0.37; 0.47; 0.36]</td>
</tr>
<tr>
<td>#2</td>
<td>Pool fire 300 mm x 300 mm and 2 fibreboards</td>
<td>[0.37; 0.77; 0.56]</td>
</tr>
<tr>
<td>#1</td>
<td>Pool fire 300 mm x 300 mm</td>
<td>[0.37; 0.13; 0.00]</td>
</tr>
<tr>
<td>#1</td>
<td>Pool fire 300 mm x 300 mm</td>
<td>[1.54; 0.13; 0.00]</td>
</tr>
</tbody>
</table>

Note: The fan is producing an air flow of 1.5 m³/s.

Table 2
Test procedure for high fire load scenario with fan

<table>
<thead>
<tr>
<th>Time</th>
<th>Action</th>
</tr>
</thead>
<tbody>
<tr>
<td>00:00</td>
<td>Start igniting</td>
</tr>
<tr>
<td>00:20</td>
<td>Alarm should have activated</td>
</tr>
<tr>
<td>01:00</td>
<td>Ignition complete</td>
</tr>
<tr>
<td>01:30</td>
<td>Start the Fan</td>
</tr>
<tr>
<td>01:45</td>
<td>Start of diesel spray</td>
</tr>
<tr>
<td>02:00</td>
<td>Manual activation of suppression system</td>
</tr>
<tr>
<td>02:30</td>
<td>FDSS should have suppressed the Fire</td>
</tr>
</tbody>
</table>

Figure 1
Test fire positioning, view from the front side
Appendix 5

Re-ignition scenario

Table 1
Test fires in re-ignition scenario

<table>
<thead>
<tr>
<th>Test fire (see Table 5 in Appendix 1)</th>
<th>Description</th>
<th>Coordinates ( {x; y; z} ) (see Figure 1 in Appendix 1)</th>
</tr>
</thead>
<tbody>
<tr>
<td>#7</td>
<td>Dripping oil fire (2 bar, 0.01 kg/min)</td>
<td>[0.82; 0.28; 1.22]</td>
</tr>
</tbody>
</table>

*Note: The fan is not used.*

Table 2
Test procedure for re-ignition scenario

<table>
<thead>
<tr>
<th>Time</th>
<th>Action</th>
</tr>
</thead>
<tbody>
<tr>
<td>Prior to test</td>
<td>Pre-heat tube</td>
</tr>
<tr>
<td>00:00</td>
<td>Predefined temperatures are reached</td>
</tr>
<tr>
<td>00:30</td>
<td>Start oil dripping</td>
</tr>
<tr>
<td>00:45</td>
<td>FDSS should have activated suppression system &amp; suppressed the fire</td>
</tr>
</tbody>
</table>

Figure 1
Test fire positioning, view from the front side
# ANNEX IX

## PANEL COMPOSITION *

<table>
<thead>
<tr>
<th>Chairman</th>
<th>Membership</th>
</tr>
</thead>
<tbody>
<tr>
<td>Shri Arun S</td>
<td>SIAM (Hero Moto Corp Ltd.)</td>
</tr>
</tbody>
</table>

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