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Draft Amendment 1

to

AIS-135 Fire Detection and Alarm System (FDAS) & Fire Detection and Suppression Systems (FDSS) for Buses

1. **Page III, INTRODUCTION**

After first paragraph of introduction, insert following text

Under the guidance of the Ministry of Road Transport and Highways (MORTH) and project proposal based on experiments carried out by DRDO ***(CFEES)*** for introduction of protection of occupants from fire, panel under Automotive Industry Standards Committee (AISC), has prepared this amendment to notified standard AIS-135.

Presently fire detection, alarm and suppression systems are notified for fires originating from engine compartment vide AIS-135. Provisions regarding protection of occupants from fire under this amendment are aimed at proving an additional evacuation time to the occupants and thus will further enhance the safety in fire incidents in buses through FPS and FAS.

A significant majority of fatal and non-fatal injuries to passengers in bus fire accidents on Indian roads are due to heat and **/ or** smoke in passenger compartment irrespective of origin of fire in the vehicle. The fatal and non-fatal injuries to passengers in bus fire accidents on Indian roads can be prevented if, irrespective of origin of fire in the vehicle, the heat and smoke in occupant compartment is controlled and thus providing an evacuation window to the occupants. ***In amendment 1 smoke and heat detectors are specified. However, other better detectors (e.g. CO or UV detectors) are also allowed. Also over and above of protection specified in standard additional protection may be provided at the choice of manufacturer.***

2. **Page 1/35, clause 1.0**

Substitute following text Scope for existing text of Scope

"1.0 SCOPE

1.1 This standard specifies the guidelines for detection and suppression systems for fires that may originate from engine compartment of buses and protection system from heat and smoke in occupant compartment.

1.2 This standard applies to

1.2.1 Part I – Fire Detection and Alarm Systems (FDAS)

Approval of Fire Detection and Alarm Systems (FDAS) which are fitted in engine compartment of Buses.

1.2.2 Part II – Fire Detection and Suppression Systems (FDSS)

Approval of Fire Detection and Suppression Systems (FDSS) which are fitted in engine compartment of Buses.

1.2.3 Part III – Occupant compartment Fire Alarm Systems (FAS) for school bus and buses of Type III category as per AIS-052 (Rev. 1) as amended from time to time.

Approval of systems which are fitted in Buses to detect the presence of fire, smoke and /or heat in occupant compartment and provide alarm.

1.2.4 Part IV – Occupant compartment Fire Protection Systems (FPS) for school bus and buses of Type III category as per AIS-052(Rev. 1) as amended from time to time.

Approval of systems which are fitted in Buses to protect the occupants from fire, heat and smoke to provide sufficient time for their safe evacuation.

1.3 Buses fitted with FDAS, FDSS, FAS and FPS shall comply with the requirements of this standard.

1.4 The requirements of this standard shall not be applicable for Electric Powertrain Vehicles (EVs)."

3. Page 1/35, clause 2.0

Add following clauses 2.7 to 2.9 after clause 2.6

2.7 UL – 268 UL Standard for Safety Smoke Detectors for Fire Alarm Systems
2.8 EN 54/22 Fire detection and fire alarm systems. Resettable line-type heat detectors
2.9 EN 54/20 Fire detection and fire alarm systems. Aspirating Smoke detectors
2.10 IS 15519:2004 Water Mist Fire Protection Systems—System Design, Installation and Commissioning—Code of Practice.

4. Page 5/35, Part II

Add following Parts III and IV after Part II

"PART III
Requirements of Fire Alarm Systems (FAS)
for bus occupant compartment

1.0. DEFINITIONS

For the purpose of Part III of this standard,

1.1 **Fire Alarm System (FAS)** - A system comprising of components and sub-systems required for automatically detecting fire, heat and /or smoke in occupant compartment and initiating an automatic alarm.

1.2. **Occupant Compartment** - for the purpose of this standard occupant compartment means the compartment / space inside a vehicle designed for occupant occupancy including driver's seating area.

1.3. **Fault Signal** - A distinctive audible and visual signal indicating occurrence of a fault within the FAS (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** - An audio and visual signal initiated by a smoke ***or CO or Heat*** alarm-initiating device, such as a fire alarm box, automatic fire detector, or other device in which activation is indicative of the presence of a smoke ***or gas or heat*** as 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) ECU ***(ECU/Control Panel may be common for FDAS/ FDSS/ FAS/ FPS).***

1.6. **Smoke**- The airborne solid and liquid particulates along with gases evolved due to pyrolysis or combustion of materials, together with the quantity of air that is entrained or otherwise mixed into the mass.

1.7. **Heat Detector** - A heat detector is a sensor that senses either abnormally high temperature or rate of temperature rise, or both, coupled with smoke detector.

1.8. **Smoke Detector** - A smoke detector is a sensor that senses the presence of significant amount of smoke as fire signature.

1.9. **Class A Fire** – A fire in occupant compartment involving all possible ordinary solid combustibles present there.

1.10. **False Alarm**: A false alarm, is the deceptive or erroneous signal of an emergency, causing unnecessary panic and/or involvement of specialized resources when they are not needed.

1.11 ***Carbon Monoxide*** *- Carbon monoxide (CO) is an invisible, odorless gas. It is a common by-product of incomplete combustion, produced when fossil fuels (like oil, gas or coal) burn.*

1.12 ***Carbon Monoxide Detector*** *- A carbon monoxide detector or CO detector is a device that detects the presence of the carbon monoxide gas as fire signature.*

2.0. APPLICATION FOR CMVR APPROVAL

2.1. Application for CMVR type approval for a vehicle type in respect of the Fire Alarm Systems (FAS) in Occupant Compartment of buses.

2.1.1. The application for approval of:

(a) A vehicle type or;
(b) A vehicle type fitted with bodywork type approved as a technical unit.
(c) 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 IA & IIIA 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 alarm system acts.

2.1.3 A vehicle representative of the type to be approved shall be submitted to the approval 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 approval 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 information about installed FAS:

2.1.5.1 A copy of the analysis regarding the installation of the FAS (see Annex IVA) in case FAS is approved as a component, or

2.1.5.2 An analysis on regarding the installation of the FAS (see Annex VIA) in case FAS is installed in a specific occupant compartment.

3.0 MODIFICATION AND EXTENSION OF APPROVAL OF A VEHICLE OR BODYWORK TYPE

3.1 Every modification of the vehicle, bodywork type or fire 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.

4.0. GENERAL REQUIREMENTS

4.1 Vehicles shall be equipped with fire alarm system detecting fires in the occupant compartment based on sensors that get provide a signal of presence of fire either through smoke or abnormally high temperature / rate of temperature rise, or both ***or light (infrared, visible, ultraviolet) emitted by flames during combustion*****.** The ***smoke or CO*** detectors ***when*** forming part of FAS shall have dust compensation feature and conform to relevant IS/UL/FM / Global Standard / ***LPCB/VdS/EN 54***.

4.2 Upon detection of fire in occupant compartment, the system referred in clause no 4.1, shall provide the driver and passengers 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 occupant compartment fire alarm system shall be operational irrespective of whether engine has been started and the vehicle's altitude.

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

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

4.4.2 An fire risk 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 occupant compartment shall be identified such that the fire detectors shall be positioned to appropriately cover the fire hazard. The system shall also be ensured to work properly regardless of the vehicle's altitude, road conditions etc.

4.5. Minimum sound level of audio-visual alarm shall be 90 dB(A) to make it audible to the passenger seated on rear seats of the bus. Optionally hooter system as approved under AIS-052(Rev. 1) can be used with minimum sound level of 90 dB(A). ***Hooter may be common with FDAS/FDSS.***

4.6 Further, to the FAS required in the occupant compartment by this standard, the additional heat sensors to monitor temperature near fuel tank and/or near wheel braking system may be installed as enhanced fire safety measures.

PART IV

Approval of Bus Occupant Compartment Fire Protection System (FPS)

1.0. DEFINITIONS

For the purpose of Part IV of this standard,

1.1 Fire Protection System (FPS): Fire Protection System is a low pressure water mist system comprising of necessary elements to manually trigger release of water mist, with specific characteristics, capable of suppressing the designed class A fire in occupant compartment as well as controlling the temperature inside the occupant compartment, when origin of fire is not occupant compartment, to provide atleast three minutes of evacuation window to the occupants.

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 Protection System" for the purpose of type approval as a component means a category of bus systems which does not essentially differ in the following aspects:

(a) Compartment(s) for passengers including drivers' cabin;
(b) Maximum gross volume upto $80m^3$;
(c) General layout of components in the compartment (i.e. position of fire hazards determined and limited to maximum no of seats for a given volume).
(d) Marking of exit routes, combustion heater and engine on the layout

(e) Number and type of ~~extinguishing~~ ***fire suppression*** agent discharge point(s) (e.g. nozzle/ mist generator atomizer) used ;

(f) Stored dry air as propellant gas or alternative mechanism, including pump ***(if fitted)***, to generate desired water pressure at discharge point."

1.4. 'Occupant Compartment' means the compartment / space inside a vehicle designed for passenger occupancy including driver's cabin, if any.

1.5. Water Mist System –A distribution system connected to a water cylinder as atomizing media through suitable number of nozzles capable of delivering water mist that meets the performance requirements as per this standard.

1.6. Propulsion System – a system when activated shall be able to provide water in the piping network at constant nozzle operating pressure for specific time either using air propulsion system including high pressure air cylinder, pressure regulating valve and solenoid valve or any such similar arrangement.

1.7. Pressure Relief Valve - A device designed to prevent pressure levels in excess of the design pressure of the system and/or, the system components.

1.8. Low Pressure System. A water mist system where the water distribution piping is exposed to pressures of 12.1 bar (175 psi) or less.

2.0. APPLICATION FOR CMVR APPROVAL

2.1 The application for approval of:

(a) A vehicle type with fire risk analysis or;

(b) A separate technical unit type or;

(c) A vehicle type fitted with bodywork type already approved as a separate technical unit as per this part of the standard with type approval of all its components type with regard to its constructional features working at higher than atmospheric pressure 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 IIA and IIIA.

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 protection system acts.

2.4 A vehicle or fire protection 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 type approval of a bus, the manufacturer shall also provide the following information regarding the occupant compartment fire protection system, if applicable:

2.6.1 A copy of the analysis on regarding the installation of the FPS in case of a fire protection system (FPS) approved as a component (see Annex VA) or

2.6.2 An analysis on regarding the installation of the FPS in case of a fire protection system (FPS) installed in a specific occupant compartment, (see Annex VIIA)

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

3.1 Every modification of the vehicle, bodywork type or fire protection 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.

4.0. GENERAL REQUIREMENTS

4.1 The requirements of this Part of the standard have been formalized based on the evaluation of the efficacy of water mist system in occupant compartment of standard size bus, in case of

a. Seat surface fire inside the occupant compartment where the suppression is achieved through experiments.
b. External fire affecting occupant compartment of buses, where cooling and scavenging is achieved, in simulation studies, to ensure an evacuation window of at least three minutes to the occupants.

4.2 In the buses irrespective of having engine located either to the front or rear, the occupant compartment shall be equipped with a fixed fire protection system for life safety of occupants. Thus providing the driver an option to use fire fighting system to flood the compartment with water mist to control the temperature and smoke inside the occupant compartment for a defined period of time. This time window shall be used for evacuation of passengers to safety. The hazard warning signal include acoustic and a visual signal indicting presence of fire/smoke or event of sensing either abnormally high temperature or rate of temperature rise, or both, in the occupant compartment or in each sub-compartments, as the case may be.

4.3 In addition to the fire alarm system, vehicles shall be equipped with a fire protection system in the occupant compartment as well as in each sub-compartments within the occupant compartment.

4.4 The fire alarm system and the fire protection system shall be operational irrespective of whether engine is running or not and the vehicle's altitude. This is to ensure availability of FPS in the case of external fire which is expected to be the most likely cause of transfer of heat and smoke to occupant compartment. The external fire sources i.e. not originated in occupant compartment, are fires such as in engine, fuel tank or in braking system with or without involvement of collision.

4.5 Before finalizing the design and installation details of the FPS, an assessment of fire risk within the occupant area shall be completed.

4.5.1 For standard bus designs, the primary risk of heat and smoke to occupants from within the compartment emanates from ignition of class 'A' materials present in the form of solid combustibles (wood, fiber boards, seat cushions/foams, curtains, upholstery etc.) and the total quantity is expected to be proportional to the number of seats. Excessive loading of combustible material inside the occupant compartment may have adverse impact on expected performance of FPS. The risk analysis shall be documented with approximate quantities of the each source as per clause 4.5.2 below.

4.5.2 The analysis shall take into account at-least the following:

a. amount of each Class A fire source spread over the compartment,
b. identification ***of*** surfaces where temperatures may reach above 80°C (due to the auto-ignition temperature for fluids, gases or substances in contact with the surfaces 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 pressurized gas).

4.5.3 Further analysis shall also be conducted prior to the installation of FPS in order to determine the location and direction of suppression agent discharge point(s) (e.g. nozzles, type or water mist discharge tube or other distribution points). Potential fire hazards within the occupant compartment and each sub-compartment where a fire risk is present shall be identified as per clause 4.5.2 and discharge point(s) located such that the water mist is 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.

4.5.4 A low pressure system comprising of atomizer/nozzles, piping network, water cylinder mounted with pressure relief valve ***if fitted***, and connected to water propulsion system to generate fine mist of desired size and concentration for specified time is to be installed in the occupant compartment.

4.5.5 The design of FPS comprising of water mist system is recommended to be based on 0.65 LPM/m^3 mist injection rate and accordingly the technical features with respect to different volume of occupant compartment ***have been arrived*** ~~shall be~~ as per the table given below. The "seating capacity" is used as ***an indication*** of standard fire load. The ~~and categorization while~~ highest volume in "gross volume range" of the occupant compartment is used as a basis for system design for FPS implementation. When measuring the gross volume of occupant compartment, the range shall be arrived without subtracting the volume of installed components / seats etc. from it. ***Selection of number of nozzle and water quantity shall be based on gross volume of the bus using following table as a reference.***

S. No.	Seating Capacity (Maximum)	Gross Volume Range (m^3)	No of Nozzles (Minimum)	Water Quantity (Liters)
1.	20	Less than 20	9	55
2.	30	20 to 30	13	80
3.	40	30 to 40	18	110
4.	50	40 to 50	22	130

5.	60	50 to 60	26	155
6.	70	60 to 70	30	185
7.	80	70 to 80	35	210

4.5.6 ~~The design features of the system are based on worst case scenario of maximum volume in the given gross volume range. And lowest water flow rate accordingly key design parameters i.e. the minimum number of discharge points /nozzles and mass of water as suppression agent are provided. The volume and pressure of the propellent gas shall be sufficient to achieve at least 7 bar constant nozzle operating pressure at farthest point. to meet~~

~~Nozzle Flow Rate at 7 bar pressure~~	~~:~~	~~[1.75 ± 0.25 LPM]~~
~~Cone Angle~~	~~:~~	~~90° or higher, solid cone~~
~~Droplet Size, Sauter Mean Diameter (D_{32})~~	~~:~~	~~[50 micron or lower]~~

4.5.6 The design features of the any FPS system shall be based on maximum volume in the applicable gross volume range. Accordingly, design parameters i.e. the minimum number of discharge points / nozzles and quantity of stored water as suppression agent are provided in 4.5.5 above. The pressure of the propellent gas shall be operated to achieve 8.0±1.0 bar nozzle operating pressure at all discharge points. The nozzles used shall meet the following characteristics at 7.0 bar i.e. minimum design operating pressure of FPS.

Nozzle Flow Rate	***:***	***1.75 ± 0.5 Litres per minute***
Cone Angle	***:***	***90° or higher, solid cone***
Polydisperse Droplet Sizes		
D_{32} (Sauter Mean Diameter)	***:***	***180 micrometre or lower***
Dv90 (Droplet size for 90% of the volume faction)	***:***	***300 micrometre or lower***

4.5.7 The discharge of water as extinguishing agent shall be along the length of the bus, in three headers, in such a way that mist is targeted to the seats on left side, right side with the nozzle spacing upto 1500 mm as well as on the mid-section of the ceiling for cooling of smoke layer, as per clause 5.0 for installation of water mist system. The total discharge time of the system shall not be less than THREE minutes. It is acceptable if the suppression system has more quantity of ~~extinguishing~~ ***fire suppression*** 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 table given in clause 4.5.5.

4.5.8 The manual activation of system through control panel, having independent power backup or auxiliary power back-up ***or through vehicle bypass power supply for mandatory emergency functions*** as the case may be, will be positioned in the vicinity of the driver's dashboard, in such a manner that the driver based on one or more of the following inputs, shall be able remotely activate the FPS through electrically operated solenoid valve on confirmation of unmanageable fire in occupant compartment after receiving an audio-visual

signal from Fire Alarm System or self-observation / input from others about presence of an external fire that may affect the lives of bus occupants.

4.5.9 For ensuring effectiveness of FPS in a non-air conditioned bus, where 50% of the windows are expected to be open at any given time, the water mist injection rate has been kept in the range 0.65 litres per m^3 per minute or higher. When applied to an air-conditioned bus the same level of mist injection rate shall provide additional factor of safety.

5.0 INSTALLATION REQUIREMENTS

5.1 The fire protection system shall be installed according to the system manufacturer's installation manual.

5.2 To obtain the requisite discharge rate condition, the protection system is to be assembled within its maximum piping limitations with respect to the number of fittings, size and length of pipe, if relevant. The water cylinder shall have applicable capacity or higher and appropriate pressure rating. The air cylinder or gas cartridge pressurized with propellant gas ***or suitable technology*** is expected to achieve constant operating pressure, with the help of adjustable pressure reducing valve, or any suitable mechanism, for at least 180 seconds or higher. The material of construction for components in contact with water shall be SS304 or better.

5.3 The fire protection system shall be installed by the system manufacturer or supplier based on as-built drawing to show the area where ~~extinguishing~~ ***fire suppression*** agent discharge points such as of nozzles, ~~extinguishing~~ ***fire suppression*** agent cylinder or ~~extinguishing~~ ***fire suppression*** agent discharge tubes are located. The discharge points are recommended to be positioned inside occupant compartment along the length of the bus, angled downwards or in such a way to provide wet coverage to window and seats located just below, as the case may be, in three different headers:

a. Above the windows on right side (RS) of the occupant compartment on the ceiling or just below the luggage rack.
b. On the ceiling of gang way i.e. mid-section (MS), upto 1.5 times the spacing being used in RS discharge points.
c. Above the windows on 'Left Side' (LS) of the occupant compartment, on the ceiling or just below the luggage rack with an offset upto 750 mm from similar installations on the RS, wherever possible.

SNo.	Seating Capacity	No of Nozzles RS	No of Nozzles MS	No of Nozzles LS
1.	20	3	3	3
2.	30	5	4	4
3.	40	7	5	6
4.	50	8	7	7
5.	60	9	8	9
6.	70	11	9	10
7.	80	13	10	12

5.4 The number of discharge points in each LS and RS section shall depend upon number of seats on each side. Any deviation from the table at clause 5.2 above

be justified and recorded. The system set-up and configuration shall be observed and documented 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.

5.4.1 Pipe layout network from water cylinder to distribution manifold for connecting all three headers consisting atomizers to be optimized for pressure drop.

5.4.2 The pipe network shall be welded / bolted securely at sidewalls or ceiling of the compartment with support brackets and clamps. The pipe distribution network shall be installed in such a way so that the entire working fluid in the pipe network can be easily drained and ease of refilling is achieved.

5.4.3 After installation of the pipe distribution work, the pipe work shall be hydrostatically tested as per ***IS 15519*** ~~relevant Indian standard~~ and performance ***shall be*** documented for review of approval agency.

6.0 LIMITATION

The design features elaborated in clause 4 & 5 above are applicable to the standard bus of volume and seat matrix i.e. upto $80m^3$ and having 80 number of seats. The buses having special comfort arrangements or sub-compartments in occupant area shall be subject to simulated fire tests as per Appendix 6."

5. Page 8/35, Annex I

Add following Annex IA after existing Annex I

ANNEX IA
(See Part III, clause 2.1.2)

INFORMATION TO BE SUBMITTED FOR TYPE APPROVAL OF BUSES WITH REGARD TO FIRE ALARM SYSTEM (FAS)

S. No	Parameter	
1.	Name of the Model(s)	
2.	Variant(s)	
3.	Vehicle category (s)	
4.	Name and address of vehicle manufacturer	
5.	Type of fire detector(s) used	
6.	Number of fire detector (s) for each type	
7.	Name and address of manufacturer of the Fire detectors for each type	
8.	Name and address of manufacturer of the alarm system and control panel	
9.	Description of the device installation and sketch showing locations within occupant compartment and relevant dimensions of fire detectors	
10.	Detection Devices provided additionally Acoustic or visual If visual, duration and type of optical signal	
11.	Test report number of the FAS	

6. **Page 9/35, Annex II**

Add following Annex IIA after existing Annex II

ANNEX II A
(See Part IV, clause 2.2)
INFORMATION TO BE SUBMITTED FOR TYPE APPROVAL OF BUSES WITH REGARD TO FIRE PROTECTION SYSTEM

S. No	**Parameter**	
1.	Name of the Model(s)	
2.	Variant(s)	
3.	Vehicle category(s)	
4.	Dimensions of the occupant compartment	
5.	Name and address of vehicle manufacturer	
6.	Make and type of the fire protection system	
7.	Test report number of the FPS	
8.	Water reservoir max operational pressure (kg/cm^2):	
9.	Quantity of ~~extinguishing~~ ***fire suppression*** agent (deionized water in litre):	
10.	Numbers and characteristics of discharge point(s):	
11.	Total Length of discharge tube in occupant compartment	
12.	Number of discharge points(s):	
13.	Type of propellant gas, dry air cylinder:	
14.	Stored pressure of propellant gas (dry air)	
15.	Minimum operating temperature	
16.	Dimensions of pipes and fittings	
17.	Detailed description, layout drawings and installation manual of the fire suppression system and its components	

7. Page 10/35, Annex III

Add following Annex IIIA after existing Annex III

" ANNEX III A

(See Part III clause 2.1.2, and Part IV clause 2.2)

INFORMATION TO BE SUBMITTED FOR COMPONENT LEVEL APPROVAL OF FIRE ALARM SYSTEM AND FIRE PROTECTION SYSTEM

S. No	**Parameter**	
1.	Make (trade name of manufacturer):	
2.	Type and general commercial description:	
3.	Name and address of manufacturer:	
4.	Type and numbers fire detector(s) used	
5.	Name and address of manufacturer of the Fire detectors	
6.	Description of the device or sketch showing location, relevant dimensions of fire detectors	
7.	Devices provided additionally Acoustic or visual If visual, duration and type of optical signal	
8.	Water mist system (make and type of key components):	
9.	Quantity of ~~extinguishing~~ ***fire suppression*** agent (Water):	
10.	Type & characteristics of nozzles/discharge point(s):	
11.	Total length of discharge tube in occupant compartment	
12.	Number of discharge points(s):	
13.	Type of propellant gas (dry air) cylinder:	
14.	Stored pressure of propellant gas (dry air)	
15.	Minimum operating temperature	
16.	Dimensions of pipes and fittings	
17.	Detailed description, layout drawings and installation manual of the fire protection system and its components	
18.	Test report no. complying to IS/FM/UL standard for each component supplier	

"

8. Page 11/35, Annex IV

Add following Annex IVA after existing Annex IV

"ANNEX IVA

(See Part III, Clause 2.1.5.1)

REQUIREMENTS FOR FIRE ALARM SYSTEM (FAS)

APPROVED AS A COMPONENT

1.0. Specifications

1.1 Fire Alarm System (FAS) conforming to this standard shall comply with the requirements of class A fire and smoke test described in Appendix 6.

1.2 The test apparatus, class A smoke and fire test and general test conditions are described in Appendix 6 to test the response time of FAS.

2.0. Requirements

2.1 The detectors forming part of FAS shall ~~have dust compensation feature and~~ conform to relevant IS / UL / FM-Global Standard. The number of detectors shall be sufficient in numbers that when mounted in the occupant compartment, with or without partition, will be line of sight to at least one detector from every class A fire source present in the occupant compartment, when the bus is empty. This is to ensure optimal coverage of threats of fire liable to break out in the occupant compartment.

2.2 The numbers of detectors in any FAS may be higher or lower for special sensors such as multi-sensor type, ***linear type***, aspirating type to meet the criteria mentioned in paragraph 2.5 below.

2.3 The audio-visual alarm unit and control panel, having ingress level protection of IP54 or higher, will be positioned in the vicinity of the driver's dashboard. Additional audio-visual alarm unit may be installed at the rear of occupant compartment, if required.

2.4 In addition, provision for manual means of activation of audio-visual alarm may be incorporated in the control panel as an option.

2.5 The fire shall be detected and warning signal shall be activated within 30 seconds after ignition of test fire #8.

2.6 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."

9. Page 12/35, Annex V

Add following Annex VA after existing Annex V

"**ANNEX V A**
(See Part IV, clause 2.6.1)

REQUIREMENTS FOR FIRE PROTECTION SYSTEM (FPS) APPROVED AS A COMPONENT

1.0. Specifications

1.1. Fire protection System (FPS), conforming to this standard, as a component, shall comply with the requirements of Part IV of this standard.

1.2. The test apparatus for functional test, evaluation of design and documentation are described in Clause 4.0 of Appendix 6.

2.0. Requirements

2.1 The FPS system key components are type tested and meet all the requirement of safety, design and operation from this standard to achieve the service requirements.

2.2 The FPS to be tested for appropriate occupant compartment and to be activated remotely/manually through an electrical switch positioned in the vicinity of the driver's dashboard, to actuate the connected solenoid valve or pumping device to perform one or more functional tests in Appendix 6.

2.2 The FPS is expected to achieve intended purpose and considered passed if compliance is achieved in all the parameters of 12 point check list in Clause 4.1 in Appendix 6.

Note:- For components level tests for Fire Protection System (FPS), please refer clause no. 4.0 of Appendix 7.

10. Page 15/35, Annex VI

Add following Annex VIA after existing Annex VI

"ANNEX VIA
(See Part III, clause 2.1.5.2)

REQUIREMENTS FOR FIRE ALARM SYSTEM (FAS) INSTALLED IN A SPECIFIC OCCUPANT COMPARTMENT

1.0 Specifications

1.1 A specific occupant compartment means compartments which do not differ in the following essential aspects:
(a) No of Seats in compartment(s) for occupants including drivers' cabin;

(b) Maximum gross volume;
(c) General layout of components in the compartment (i.e. position of fire hazards determined).
(d) Marking of exit routes, combustion heater and engine on the layout

1.2 The fire alarm system (FAS) conforming to this standard shall comply with the requirements of class A smoke and fire test.

2.0. Requirements

2.1 The class A smoke and fire test shall be conducted in accordance with Appendix 6 to test the response time of FAS.

3.0. FAS Installation

3.1 The detectors shall be mounted in the occupant compartment in such a manner that there will be line of sight to at least one detector from every class A fire source present in the occupant compartment, when the bus is empty, to ensure optimal coverage of threats of fire liable to break out in the occupant compartment.

3.2 The installation of the smoke detectors in occupant compartment without partition, shall be in such a way that each zone of 3.0 ± 0.5 meters of the bus length is covered by at least two detectors placed on the ceiling farthest from each other while maintaining a distance of about 0.8± 0.2 meter from zone boundary / sides of the bus. This is to provide the maximum coverage as well as to avoid false alarm from a smoke entering from windows.

The numbers of detectors in each zone may be higher or lower for special sensors such as multi-sensor type, aspirating type to meet the criteria mentioned in paragraph 3.7 below.

3.3 The installation of the smoke detectors in occupant compartment with partitions, shall be in such a way that each partition is covered by at least two smoke detectors placed on the ceiling farthest from each other while maintaining distance of 0.5 meter or more from sides of the bus/partition. The aim is to provide the maximum coverage within the partition.

3.4 The audio-visual alarm unit and control panel, having ingress level protection of IP54 or higher, will be positioned in the vicinity of the driver's dashboard in occupant compartment. Additional audio-visual alarm unit may be installed at the rear of occupant compartment, if required.

3.5 In addition, provision for manual means of activation of audio-visual alarm may be incorporated in the control panel as an option.

3.6 The fire shall be <u>detected and warning signal shall be activated within 30 seconds after ignition of test fire #8. The test to be repeated at each of zone boundary, to cover atleast two of the following fire locations farthest from the passenger exit.</u>

a. <u>near driver's seat,</u>
b. <u>in the middle of the passenger compartment</u>
c. <u>rear of the passenger compartment</u>.

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

11. Page 16/35, Annex VII

Add following Annex VIIA after existing Annex VII

"ANNEX VII A
(See Part IV, clause2.6.2)

REQUIREMENTS FOR FIRE PROTECTION SYSTEM (FPS) INSTALLED IN A SPECIFIC OCCUPANT COMPARTMENT

1.0. Specifications

1.1. A specific occupant compartment means compartments which do not differ in the following essential aspects:
(a) Position of passenger exit (s) in the vehicle;
(b) Maximum gross volume;
(c) General layout of components (seats, partitions, luggage rack etc.) in the compartment (i.e. position of fire hazards determined) and placement of engine outside the compartment.

1.2 The fire protection system (FPS) conforming to this standard shall comply with the requirements of Part IV in order to achieve intended purpose of occupant protection from fire to provide time for evacuation with and without windows open.

2.0. Requirements

2.1 The FPS system key components are type tested and meet all the requirement of safety, design and operation from this standard to achieve the service requirements.

2.2 The FPS installed for an appropriate occupant compartment to be activated manually through an electrical switch positioned in the vicinity of the driver's dashboard, to actuate the connected solenoid valve or pumping device to perform one or more functional tests in Appendix 6.

3.0. FAS Installation

The functional and evaluation test conditions in Appendix 6 may be adapted for the specific occupant compartment. The adaptation shall be based on the provisions given in Part IV, Clause nos. 4 and 5 determining the fire hazards within the compartment and the volume based scaling of the fire protection system. Any adaptation shall provide an equivalent level of safety. The principles for the adaptation, if any, shall be verified by the Test Agency responsible for the tests. The principle of adaption shall be documented and added to the test report.

4.0 Test and Evaluation of FPS installed in Occupant Compartment.

4.1 The FPS shall be capable to be remotely activated from control panel positioned in the vicinity of the driver's dashboard, through electrically operated solenoid valve either on confirmation of fire or immediately after receiving Audio-visual Signal from Fire Alarm System

4.2 Fire protection System (FPS) conforming to this standard shall comply with the requirements of Part IV of this standard within occupant compartment.

4.3 The test apparatus for functional test, evaluation of design and documentation are described in Clause 4.0 of Appendix 6.

4.4 A declaration by the manufacturer, that an additional test has been conducted with the water vessel as well as the dry air (propellant gas) vessel ***or suitable technology*** cooled to the minimum operating temperature ("5" degrees celsius) and the discharge point flow characteristics (Clause 4.3 Appendix 6) were found to be conforming to the Part IV of the standard, to be submitted.

4,5 The FPS is expected to achieve intended purpose and considered passed if compliance is achieved in all the parameters of 12 point check list in Clause 4.1 in Appendix 6."

12. Page 18/35, Annex VIII

Substitute following Annex VIII for existing Annex VIII

" **ANNEX VIII**

(Clause 3.0 of Parts I & II and Clause 3.1 of Parts III & IV)

GUIDELINES FOR DECIDING WHETHER TESTING IS NEEDED

1. In general, when changes in technical specifications of vehicle do not affect the FDAS / FDSS/ FAS /FPS 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 and FAS / FPS performance are listed in clause No. 2 and 3 respectively.

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

1.	Change in volume of engine compartment	To be tested if volume of engine compartment is increased which increases the number of nozzles derived from clause no. 4.5.3
2.	Type of ~~extinguishing~~ ***fire suppression*** agents	To be tested in case of any change
3.	Change in capacity of ~~extinguishing~~ ***fire suppression*** agent	To be tested in case of decrease in capacity
4.	Dimensions of pipes & fittings of FDSS & FDAS	To be tested in case of any change

5.	Pressurized cartridge system	To be tested in case of decrease in pressure of the system

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

1.	Change in volume category of occupant compartment	To be tested for compliance as the change will lead to increase in the number of nozzles as per from clause no. 4 & 5 Part IV
2.	Exceeding maximum number of seats corresponding to specific volume category of occupant compartment	To be tested with volume corresponding to applicable seats which increases the number of nozzles derived from clause no. 4 & 5, Part IV
3.	Change in water capacity of ~~extinguishing~~ ***fire suppression*** system	Compliance with Part IV to be tested
4.	Dimensions of pipes & fittings of FPS	Compliance with Part IV to be tested
5.	Change in Pressurized dry air cylinder	Compliance with Part IV to be tested in case of decrease in stipulated pressure and/or change in capacity
6.	Type, characteristics and location of the nozzles	Compliance with Part IV to be tested
7.	Type of solenoid valve, pressure regulating valve, safety / relief valve	Compliance with Part IV to be tested
8.	Type of detector in FAS or number of detection zones	To be verified for compliance with Part III

4. 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."

13. Page 33/35, Appendix 5

Add following Appendices 6 and 7 after existing Appendix 5

"APPENDIX 6

TEST APPARATUS, TEST FIRES AND GENERAL TEST SPECIFICATIONS FOR OCCUPANT COMPARTMENT

1.0 This test protocol intends to provide basis for tests for FAS under Part III and FPS under Part IV, for buses having occupant volumes upto $80m^3$ and having corresponding seating capacity upto 80.

2.0 Tests and Test Apparatus

2.1 For functional tests and evaluation check list of FAS and FPS, the test apparatus of specific volume bus body, complied to AIS-052 (Rev.1), for which approval is being sought, to be used.

2.2 The tests for FAS and FPS include functional tests, design evaluation check list as well as mandatory documentation as per clause 4 and 5 of Part IV

a. Fire Alarm System – functional test
b. Fire Protection System – functional test (Water Discharge Rate Test) and design parameters verification using check list.

2.3 For optional simulation tests the test apparatus to be based of bus body CAD drawing, for which approval is being sought, along with details of all the combustible materials in occupant compartment and the water mist injection system of requisite size and key design features using test protocol fire size and temperature measurement using thermocouple (clause 6 below) to be used for performance evaluation.

3.0 Test of Fire Alarm System – The functional test for FAS involve a limited design fire for evaluating the performance of detectors and audio-visual alarms system.

Time	**Action**
00:00	Start igniting design fire #8
00:30	Alarm should have activated automatically. *
* Time in seconds after which alarm activates along with location of fire shall be recorded in the test report.	

4.0 Test and Evaluation of Fire Protection System

4.1 Evaluation Tests for FPS include a checklist for fire protection system to be used for review and record pertaining to installation of FPS, a 12 point check list to be used for test and approval as per this standard. The column "Criteria" indicates either the national /international standard being referred in the design or system requirements elaborated in Clause 4 and 5 of Part IV and test in this Appendix.

S. No.	Test Parameter	Criteria
1.	Propellant Gas Quality	Dry Air standard
2.	Propellant Gas Cylinder Capacity and Operational Pressure	Sufficient to provide 3 mins system operation
3.	Propellant Gas Cylinder Test Pressure	Relevant safety code or 1.5 times of operation pressure whichever is higher
3.	Pressure Reducing Valve	Required reduction and lockable adjustment knob
4.	Propellant Gas Cylinder Safety	Relevant IS standard
5.	Solenoid Valve	Remote Activation for 3 minutes operation
6.	Water Cylinder Capacity and Operational Pressure	Sufficient to provide 3 mins system operation
7.	Water Cylinder Test Pressure	Relevant safety code or 1.5 times of operation pressure whichever is higher
8.	Nozzle Characterization – three parameters in Clause 4.5.6 Part IV ***for each nozzle***	Certification from ***Test agencies*** /BIS/***NABL*** recognized lab
9.	Total Nozzles and layout	As per clause 5.3 Part IV
10.	Pipe Network pressure optimization	As per clause 4 & 5 Part IV
11.	Pipe & Fittings material & type	Relevant Standard and Record as per Clause 4.2 Appendix 6
12.	FPS Functional Test - flow characteristics of each nozzle for 3 minutes operation	Record as per Clause 4.3 Appendix 6

4.2 Hydrostatic testing of pipe network requires atomizer locations to be plugged before the test takes place. Each section shall be pressurized upto 1.5 times the working pressure ***or as per Indian standard*** IS 15519 ***criteria of acceptance whichever is stringent***. During the test no pressures loss to be observed and record to be made. In the event of leakage, the pressure shall be removed from the system, appropriate corrective action to be taken and the test procedure to be repeated.

4.3 Functional Test of FPS are intended for checking flow characteristics of installed Fire Protection System. Each discharge point is ***loosely*** wrapped ***(to allow air to escape)*** with 10 liters capacity plastic bag to collect the water during 3 minutes of system operation.

Time	Action
00:00	Start FPS
00:10	FPS activation confirmation
03:10	Manual switch off of FPS
* Time in seconds for system operation, normal operational pressure and water volume at each discharge point, in liters, shall be recorded in the test report.	

5.0 Optional Simulated Fire Test for FPS

5.1 Simulated conditions for four fire scenarios are recommended to be used for design validation, improvements and performance evaluation of FPS using Fire Dynamics Simulator software (i.e. PYROSIM). The pre-burn time for heat and smoke from external fire is given as 45 seconds. These optional tests are intended to provide a standard framework for evaluation of FPS irrespective of the size and type of buses and where full scale fire tests are not feasible.

a. Occupant Compartment Fire using simulated fire test #9
b. Engine Fire using simulated fire test #10
c. Fuel Tank Fire using simulated fire test #11
d. Braking System/Tyre Fire using simulated fire test #12

5.2 The Occupant Compartment Fire using test #9 is intended for generation of response data for Fire Protection System in case of simulated design fire in occupant compartment. Following is the expected outcome:

Time	Action
00:00	Simulate start of design fire #9 at designated location
00:45	Activation of water mist system
01:45	FPS should have suppressed the Fire

5.3 The Engine Fire using simulated test #10 is intended for checking thermal management of Fire Protection System when subjected to external engine fire using simulation with following expected outcome:

Time	Action
00:00	Simulate ignition /start of engine fire #10
00:45	Activation of suppression system
01:45	FPS should have managed the temperature inside the occupant compartment and cooled the smoke layer
03:45	Fire Protection System to control the temperature upto 50^0C.

5.4 The Fuel Tank Fire using simulated test #11, intended for checking thermal management of Fire Protection System subjected to fuel tank pool fire, is expected to have following outcome:

Time	Action
00:00	Simulate ignition start of external fuel tank fire#11
00:45	Activation of suppression system
01:45	FPS should have managed the temperature inside the occupant compartment and cooled the smoke layer
03:45	Fire Protection System to control the temperature below 50^0C.

5.5 The Braking System / Tyre Fire using simulated test #12 intended for checking thermal management of Fire Protection System subjected to braking system /tyre fire, is expected to have following outcome:

Time	Action
00:00	Simulate ignition start of external fire
00:45	Activation of suppression system
01:45	FPS should have managed the temperature inside the occupant compartment and cooled the smoke layer
03:45	Fire Protection System to control the temperature below 50^0C.

5.6 In the case of simulated tests under clause 5.2 to 5.5 above, in non-air-conditioned bus, each simulation study to be performed for following two conditions

a. With all windows open
b. With all windows open and the bus moving at 10km/hour at the start of the test fire and the bus comes to complete halt in next 10 seconds.

6.0 Test fires

6.1 For external fire where test apparatus made of real scale occupant compartment cannot be used, the CAD design of test apparatus passenger compartment will be used for fire simulation studies using specialized software.

6.2 The test fires in table below are to be used in the different test scenarios described in the standard. For test and simulated fires Diesel oil (commercial fuel oil or light diesel oil), heptane (C_7H_{16}) and engine oil 15W-40 with a flash point of 230 °C and viscosity at 40 °C of 107 mm²/s shall be used as test fuels.The peak HRR is based on 45 sec after ignition

Test Fire No.	Description	Fuel	~ peak HRR KW	Purpose
#8	Smoke & Class A Fire, on a middle Seat between the nozzles	PU foam+ fibreboard+ cotton fabric wrap	40	FAS Test and Simulated Fire Suppression
#9	Multiple Class A Fire in each zone 300×300x70 mm	Diesel oil and n-heptane	40xNo of Zones	Simulated Fire Suppression in each zone
#10	Engine Fire, Large Spray (External)	Diesel oil (#6, Appendix 1)	520	Simulated Thermal Management
#11	Fuel Tank Fire, Large Pool (Indirect)	Diesel oil	500	Simulated Thermal Management
#12	Bus Braking/tyre fire, Large Pool (Indirect)	Diesel oil	520	Simulated Thermal Management

6.3 Square type of pool fire trays as per the description given for the respective fire tests.

Dimensions	Rim height	Nominal thickness	Used for test fire
300 mm × 300 mm	70 mm	1.5 mm	#8, #9
500 mm × 500 mm	70 mm	1.5 mm	#11, #12

6.4 The Test fire #8 consist of a fibreboard with a dry density of 3.5 kg/m3. The dimensions of the fibreboard shall be 12 mm × 295 mm × 295 mm. The fibreboard 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.

6.5 The fibreboard along with a PU foam of size 50 mm × 295 mm × 295 mm shall be completely wrapped with upholstery cotton cloth of not less than 1000 mm in length and 500mm in width. Two rolls of cotton to be each soaked in 20 ml diesel and 10 ml n-heptane to be placed on top for fire ignition using a torch. The amount of PU foam,

fibreboard, cotton cloth, water, diesel and heptane used in the tests should be in accordance with following table.

PU Dimensions (mm)	**Diesel**	**n-Heptane**	**PU Foam weight**	**Test fire**
300 × 300 × 50	40 ml	20 ml	~280gm	#8, #9

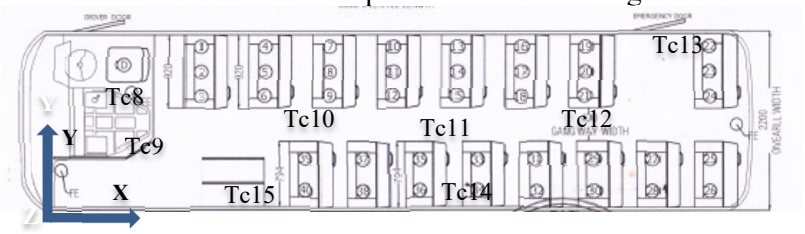
6.6 The set of one fiberboard, one PU foam wrapped with cotton upholstery shall be positioned flat inside the square fire trays in such a way that two small rolls of cotton fabric for fire ignition can be placed on top to meet the requirements of test #8. Similar arrangement needs to be made in each zone for test #9. Simulated Test fire #10 consists of diesel oil spray fires while Test fire #11 & #12 consist of large oil pool fire (by hot surface ignition).

7.0 Thermocouples in Simulation Studies

7.1 Four thermocouples (Tc) shall be mounted on the surface while another four towards the ceiling as per coordinates given. At least two (Tc8 & Tc9) over the engine area on the passenger floor, three (Tc10, Tc11, Tc12) to be placed equidistant from each other along the length on the ceiling. Here Tc10 & Tc12 will be placed close to ceiling while Tc11 to be placed 0.5 meter below the ceiling. Further one thermocouple each at main service door (Tc15) 1.6 meter from floor, at just above the fuel tank (Tc14) and at emergency exit (Tc13) to be placed along the floor. The coordinates of thermocouple locations from the front edge of Service door and their temperature in every 30 seconds from start of simulation to be studied for evaluation of FPS.

Thermocouple	**Coordinates** [x; y; z]	**Thermocouple**	**Coordinates** [x; y; z]
Tc8	[x1; y1; 0]	Tc12	[x5; y3; z3]
Tc9	[x2; y2; 0]	Tc13	[x6; y4; 0]
Tc10	[x3; y3; z3]	Tc14	[x7; y5; 0]
Tc11	[x4; y3; (z3-0.5)]	Tc15	[x8; y6; 0]

7.2 The location of the thermocouples is illustrated in figures below.



8.0 Tolerances

8.1 A tolerance of ±5 per cent of the stipulated values shall apply (for time values: ±5 seconds). These tolerances are applicable to test set up parameters only. These tolerances are not applicable to performance duration (e.g. FAS / FPS performance time parameters).

APPENDIX 7

GENERAL GUIDELINES

1.0 These guidelines are ***being included*** to facilitate implementation of a fire safety system, ***which is reliable*** during its life cycle. For desired results from proposed FAS and FPS, it is essential to include reliable components at design stage, adherence to good engineering practices during installation and regular preventive and breakdown maintenance of the

system during operation. ***In order to keep the FAS and FPS functional at all times***, it is essential that ***relevant*** communication is shared with ***concerned*** agencies dealing with the system in its different stages. Following aspects are considered essential for being covered.

a. Components Selection and testing for FAS and FPS
b. Documentation on
    i. Maintenance Requirements
    ii. Reactivation of FPS after release of water mist
    iii. Training Requirements

2.0 Components Selection and testing for FAS and FPS

2.1 It is recommended that ***the*** selection of components, even at the initial stage of implementation, should be based on the overall objective of achieving high system reliability. This goal ***will be achieved if*** components of higher reliability ***selected in the beginning***. Initially it is not expected to have reliability data of all the components, however as the implementation of this standard progresses, the reliability is expected to ***improve with time.***

2.2 The recommended type testings' of components are shock, vibration, cyclic and drop tests. The component level tests guideline are recommended to be as per clause 4.2 of this appendix or as per AIS-018. ***However complying to the relevant aspects of tests and approval requirements of water mist systems as per IS 15519 shall be recorded***.

2.3 Any of the components, where choice between national/international standard exist, is recommended to adhere the more stringent standard. Identifying the relevant standards early on will ensure development of a quality fire alarm system and fire protection system.

2.4 While selecting the components, routing of cables, wires, pipes etc. a careful consideration is expected to be given to system safety. Any component which might get impacted due to tempering by passengers also needs to be suitably protected and/or laid accordingly. For example, the water mist nozzles may include a protection cap to protect the nozzles from dust and other blockages over the years. The nozzle protection cap, if provided, shall be released or ruptured as soon as the pressure is build-up in water distribution header. Similarly, wherever smoke detectors are being used in FAS, their installation is to be undertaken in such a way that interference from dust is minimized. This presents a challenge for non-air-conditioned bus and therefore a specially designed housing, dust protector along with dust compensation may provide better results and lower day to day maintenance.

3.0 Documentation

Besides the drawings, installation manual **and** necessary documentation as part of the standard, some add-on documentation covering different aspects of maintenance and training are required to supplement a good engineering design.

3.1 Maintenance Requirements:

There will be a day to day up-keep requirements to keep the system in operational mode. For example, this may include testing /cleaning of smoke sensors, nozzles, checking of water in the water cylinder and pressure in the gas cylinder. Then there would be preventive maintenance to ensure the continued functionality of FAS and FPS which may include the charging of auxiliary power batteries and step by step method to make the system functional if the system is not working as intended. The guidelines here are not exhaustive but only for illustration purposes.

3.2 Reactivation of FPS after release of water mist

The SOP provided by the manufacturer is expected to elaborate on reactivation of FAS and FPS, ***including leak test*** after a fire incident or accidental actuation.

3.3 Training Requirements –

The FAS and FPS in occupant compartment compliment other fire safety measures such as already installed FDAS and FDSS in engine compartment and the mandatory portable fire extinguisher kept on-board the buses. Therefore, the choice of fire safety measure primarily rests with the driver or the attendant. A bus fire incident (internal or external to the occupants) in the initial stage can be effectively managed using the portable extinguishers. Similarly, in case of engine fire, the incident can be effectively managed using FDSS if detected in time. Making the drivers and attendants to understand their role in handling different fire scenarios will be the key element to save precious lives of bus occupants. The manufacturer is expected to clearly spell out the roles of driver and attendant during operation and maintenance. This followed by regular training and mock drills to the concerned personnel will alone enable best use of FAS and FPS.

4.0. Guidelines for Component Level Tests (common requirements for FAS & FPS)

4.1 Functional Test:

This test is applicable on all electronics devices (e.g. detectors, solenoid valves etc.) of FAS & FPS system. The component shall be connected to rated voltage. The component shall be coupled with the suitable rig which can simulate the required function of device. The maximum current consumption (A) shall be recorded. The maximum current shall not exceed the values specified by the manufacturer.

4.2 Endurance Test under Vibration Test:

Each electronic component (e.g. detectors, solenoid valves etc.) and the water pressurization system (WPS) (filled with water) shall be mounted in actual vehicle's orientation with suitable fixture and subjected to following Vibration Tests:-

A. Sine Sweep Vibration Test:

Frequency Range1	: 10 to 30 Hz
Amplitude	: ± 2 mm
Frequency Range2	: 30 to 1000 Hz
Acceleration	: 2.5g
Sweep Rate	: 1 Octave/min.
Test Duration	: 1 hr. in each axis (X, Y & Z)

B. Mechanical Shock Test:

Acceleration	: 50g
Duration	: 11 ms
No. of Shocks	: 60 Nos. [20 shocks in each axis {10 positive and 10 negative}]

After performing above vibration tests, the functional check shall be done as per clause no. 3.1. For WPS, there shall not be any breakage or crack of mountings and other component

4.3 Endurance Test at High Temperature:

Each electronic component (e.g. detectors, solenoid valves etc.) shall be mounted in actual vehicle's orientation and subjected to endurance test at high temperature in climatic chamber at temperature of 65 ± 5°C for 12,500 cycles.

The mechanical components shall be subjected to high temperature at 100 ± 5°C for 240 h.

After performing above tests, the functional check shall be done as per clause no. 3.1. For mechanical components, there shall not any breakage, crack, discoloration etc.

4.4 Endurance Test at Low Temperature:

Each electronic component (e.g. detectors, solenoid valves etc.) shall be mounted in actual vehicle's orientation and subjected to endurance test at low temperature in climatic chamber at temperature of -20 ± 5°C for 12,500 cycles.

The mechanical components shall be subjected to low temperature at -20 ± 5°C for 240 h. The size of test component shall be mutually agreed between test agency and the manufacturer.

After performing above test, the functional check shall be done as per clause no. 3.1. For mechanical components, there shall not any breakage, crack, discoloration etc.

4.5 Endurance Test – Salt Spray Test:

Each electronic component (e.g. detectors, solenoid valves etc.) shall be mounted in actual vehicle's orientation and subjected to endurance test while keeping the component in salt spray chamber with 5% concentration of sodium chloride and internal temperature of 35°C ± 2°C for 12500 cycles.

The mechanical components (e.g. tubings, connectors, water tank, nozzles etc.) shall be subjected to salt spray test as per above said specifications for 240 h. The size of test component shall be mutually agreed between test agency and the manufacturer.

After performing above test, the functional check shall be done as per clause no. 3.1. For mechanical components, there shall not any corrosion or any other abnormal sign.

4.6 Endurance Test at High Humidity:

Each electronic component (e.g. detectors, solenoid valves etc.) shall be mounted in actual vehicle's orientation and subjected to high humidity test while keeping the component in a humidity chamber at 95% ± 3% Rh for 12500 cycles.

After performing above test, the functional check shall be done as per clause no. 3.1.

4.7 Drop Test:

Each electronic component (e.g. detectors, solenoid valves etc.) shall be subjected to drop and topple test as per Clause 4.10 of IS: 10250-1982 with a drop height of 200 mm. The number of drops shall be 6 Nos.

After performing above test, the functional check shall be done as per clause no. 3.1. Also there shall not be any breakage or crack of component."

4.8 Hydrostatic testing

A hydrostatic test as per clause 5.4.3 of Part IV is a pressure test in which the piping network of FPS is pressurized to evaluate its integrity. This test evaluates the structural

integrity of pipeline or other pressure containing sub-systems. During the test, the pipe is filled with water and the water pressure is gradually increased, held for a certain duration to check the pressure drop, leakages etc. and then released. The test is mandatory to be performed when the FPS is put into service and after a certain length of operation to evaluate the integrity of the system. It is important to remove all water used for hydrostatic test and dry the pipeline before operation, otherwise the segment of the system which generally remain dry may accumulate water and become susceptible to internal corrosion.

4.9 Reference is made to para 4.5.6 of Part IV of this standard to elaborate on nozzle characteristics. The D32 is used here as one of the measures of central tendency in droplet sizes, based on ratio of volume to surface area, for heat transfer applications. And Dv90, an indication about polydispersity of droplet sizes in the water jet, represent maximum droplet size of 90% volume fraction.

4.10 For protecting the occupant compartment at atmospheric temperatures below 50C, the water as suppression agent may be used with additives (to reduce the freezing point) at pre-determined specific concentration that has been evaluated as safe for human exposure by an appropriate authority.