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Low cost Fire Detection Systems for EMU/MEMU Stock

Gaurav Kumar Singh ED/Carr/IIShyam Shankar SSE/Carriage

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I. Introduction:

Indian Railways approach to passenger rail vehicle fire safety primarily relies on performance criteria for fire retardant furnishing materials such as seats, wall and ceiling panels, curtains, flooring material etc. As far as Fire detection systems are concerned, IndianRailways, to begin with, has developed Fire detection cum alarm systems for AC coaches and Fire detection cum suppression systems for Power car/Pantry cars. Based upon the experience gained and technical literature&market survey, RDSO recently has developedFire detection cum alarm system for EMU and MEMU trains for both air conditioned as well as non-air-conditioned stock.

ARGE guidelines (Part-1) details the requirements related with choice of detection system, functional requirements as well as target time to measure detection time etc. The systems developed by Indian Railways for AC coaches are tested and certified as per these ARGE guidelines however as the condition inside EMU and MEMU coaches is different from that inside an AC coaches and also with an aim to optimize the expenditure towards procurement as well as maintenance for these systemsfor EMU/MEMU stock it was planned to develop an alternate low cost Fire detection cum alarm system meeting relevant standards/specification for EMU and MEMU coaches

This paper explains and attempts to find out about use of point type detectors (which work on principle of smoke as well as heat sensing) for use in EMU and MEMU coaches as these detectors are relatively cheaper and easy to maintain.

II. Technologies presently available over Indian Railways

2.1 Fire Detection cum Suppression system to RDSO/2013/CG-06

This system is provided in pantry cars and power cars. The main feature of this system is provision of smoke & heat detectors to detect fire as well as of an automatic suppression system for suppression of fire by using water-mist. The system uses high pressure nitrogen stored at 200bar for converting water into water-mist for extinguishing the fire. The fire is detected by EN 54-7 compliant point type smoke detectors (3%obs/m) and/or by EN 54-5 compliant point type heat detectors (90^0C) in generator/pantry area. In addition to it, LHD cable (Linear Heat Detector 105-110^0C) is also provided in the roof over these areas to provide for built-in redundancy. In addition to generator/pantry area, smoke detectors are also provided in Guard area, staff area, store area in power car and pantry car etc. The activation of suppression system is automatic as far as detection by heat detector is concerned however in case of detection by smoke detector, activation of suppression system is manual

2.2 Aspiration type smoke detection system to RDSO/2008/CG-04

This system is used for smoke detection in AC coaches. Smoke detection is done via aspiration system that samples the air in different places and analyses it in a centralized detector. In comparison to point type smoke detector, Aspiration type smoke detection system are active smoke detection system due to which it can detect smoke at a very early stage. This system makes use of aspirator (EN-20 compliant). Aspirator is provided along with control panel and sampling points (class-A compliant) are provided in passenger and other areas. The aspirator continuously sucks the compartment air through sampling points and alerts the passengers by way of hooter/brake application in case obscurity level due to presence of smoke reaches the specified respective threshold values.

2.3 Brief advantages and Limitations

SN	Description	Advantages	Limitations
1	Fire Detection cum Suppression system to RDSO/2013/CG-06	Cost effective system for heat/smoke detection in non-passenger area	Less effective in non-confined spaces due to air dilution
		This is not Maintenance intensive	Detection is passive

2	Aspiration type smoke detection system to RDSO/2008/CG-04	Active system hence takes less time for detection	Needs continuous maintenance
		Threshold levels can be adjusted as per local requirements	Less effective in non-confined spaces due to air dilution
		Can cover a large area	difficult to determine the location of fire

III. ARGE Requirements on fire detection

The ARGE Guideline Part 1 "Fire Detection in Railway Vehicles" defines functional testing of installed fire detection systems on railway vehicles with the target to measure detection response to optimize the detector positioning in the vehicle. It addresses both occupied areas as well as technical areas. The defined target values on thresholds are chosen in order to establish personal safety in the railway vehicle.

Detection principle

The ARGE Guideline generally considers both smoke and heat detection. It defines the following choice:

- Potentially occupied areas smoke detection
- Technical areas smoke or heat detection

Potentially occupied areas are considered areas in which passengers or train personal can stay, examples are passenger areas, compartments, staff compartments, restrooms, driver's cabins, restaurants etc.

Technical areas are electric cabinets in the passenger area, technical compartments on the roof or under the vehicle, engine compartments etc.

Thresholds of time

SN	Area	Time limit
1	Potentially occupied areas	1 min
2	Technical areas (not combustion engines)	2 min
3	Combustion engines	1 min

These times are based on the test assessment and include the time of alarm transmission. That means that the time between start of the test and the alarm signal is assessed.

IV. Detection mechanism

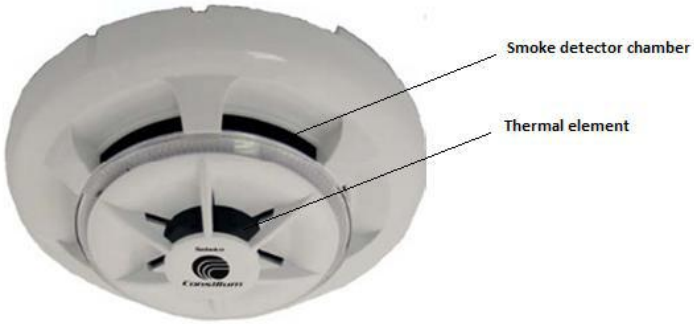
Generally, following types are detectors are utilised for detection of firedetection

- Smoke detection
- Heat detection
- Flame detection
- Gas detection

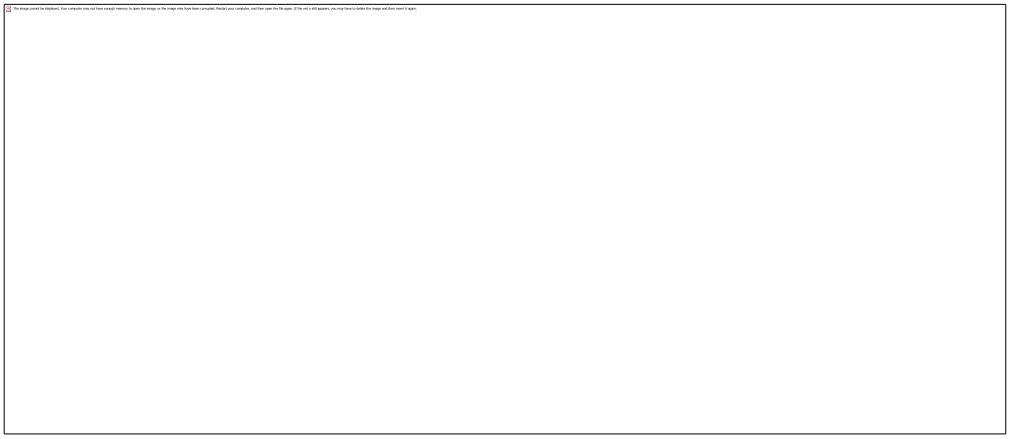
Since the detection time is only 60sec in passenger occupied areas hence usually point type smoke detectors (to EN 54-7) or aspiration smoke detectors (to EN 54-20) are used in passenger areas whereas in technical areas, generally heat detectors (to EN 54-5) are used.

RDSO has carried out detailed analysis and literature survey to assess the requirement of a Fire detection cum alarm system for EMU/MEMU coaches which not only should be low cost but also should be capable to meet ARGE guidelines. After a lot of deliberations and discussions with stake holders, RDSO has decided to use Combined/multi detector in EMU/MEMU coaches

Combined/Multi detectorscombine an optical smoke detector with a heat detector as seen below. This gives the advantages of both systems and a more reliant detector. Often are the signals that activate each detector analysed by control unit and a pre decided combination of the signals activates the detector.



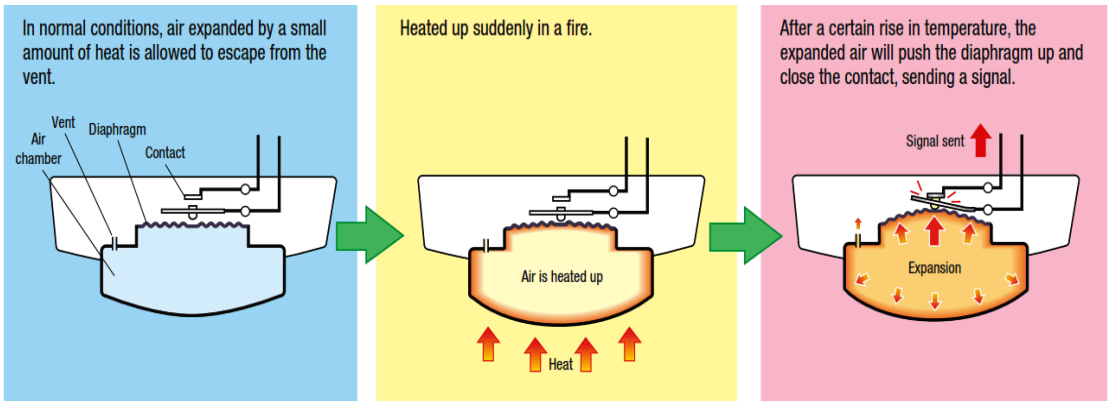
Optical smoke detectors- This detector consists of a light source and a photocell positioned at an angle to each other. In normal conditions the transmitted light passes into a "light maze" which prevents the reflection of light onto the receiver. In the event of fire, the passing fumes through the detector scatters the light onto the photocell and at a specific threshold value of light intensity the detector activates.



Heat detector- This system uses classical heat transfer analogy; heat is transported to colder areas. In point heat detectors there are one or more thermal elements, which are heated when hot fumes pass through the detector. These elements have a mass and a specific heat capacity, which results in a thermal inertia when heated. Thermal inertia controls how fast a surface reaches a specific temperature for detector to bell the alarm.
Heat detectors are normally divided into two main classifications of operation:

I. Fixed temperature, which will activate once the thermal element has reached a specific temperature.
II. Temperature Rate of Rise (RoR), which will activate at a certain temperature increase rate.

Also, there are detectors that operate using a combination of both. This combination has the advantages of both detectors and has proven to be a more reliable detector



V. Development of specifications/Guidelines

RDSO has issued following guidelines for Fire detection cum alarm system(FDAS) for different types of EMU/MEMU stock

5.1 Retro fitment of FDAS in Air conditioned EMU stock

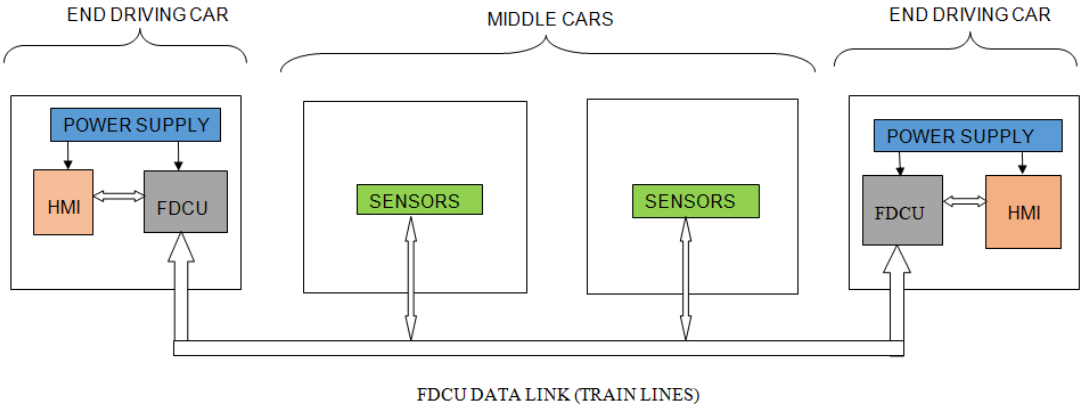
Air conditioned EMU is generally a 12 car rake. 3 coaches form a basic unit and 4 such basic units are used to make a train. Normally these trains run in a combination of DMC-TC-TC-TC-TC-NDMC-NDMC-TC-TC-TC-TC-DMC. The smoke-cum heat detectors are provided in various areas/cubicles as per following table

SN	Location	DMC coach	NDMC coach	TC coach
1	Passenger area	Number and location of detectors to meet ARGE guidelines		
2	HT compartment			
3	LT compartment			
4	MCB panel	1	1	-
5	ECAB panel	1	1	-
6	EWP1/EWP2/EWP3/EWPP4 cabinet	1 in each cabinet as per availability in coach		

In addition, Fire detection & control unit (FDCU) and Driver display (HMI) are to be provided in each DMC. Other salient features of the system are as below

1. The system should be SIL-2 compliant
2. Provision of audio alert to running staff
3. The system to be self-diagnostic in order to identify failures immediately
4. FDCU must provide LED and other hardware interface with HMI for major system status
5. On detection of a possible smoke/fire by means of suitable detection, the system shall have different levels of response (minimum two i.e. pre alarm and alarm).
6. The system to provide a dynamic two detector dependency (smoke and/or heat) in the passenger areas along with provision of drift compensation in order to decrease the risk of false, or unwanted alarm
7. All the major events (alarms, faults etc.) to be recorded in FDCU and should be retrievable on maintenance terminal for analysing any issue
8. All the key components of Smoke/fire detection system shall comply with the relevant standards viz EN54-5, EN 54-7, EN 50155 etc.
9. Railways to spare 6 connections points for train control lines for communication and transmission of data between Detectors and FDCU. Any other requirement of hardware/software to make the system fully functional in the scope of supplier

Architecture of the system



5.2 Retro fitment of FDAS in non-air conditioned EMU and MEMU stock

Non air conditioned EMU rake is typically a 12 car formation with 3 coaches constituting a Basic Unit and 4 basic units are integrated to form a rake. On the other hand, MEMU rake is typically an 8 car formation with 4 coaches constituting a basic unit and 2 basic units are integrated to form a rake.

The salient features of the system are as follows:

1. Provision of smoke-cum-heat detectors (to EN 54-7 and EN 54-5) in LT room, HT room and in technical enclosures/cubicles/cabinets. The sensitivity and location of detectors in LT and HT compartment has to fulfil the requirements of ARGE.
2. Provision of Fire Detection & Control Unit (FDCU) and HMI in Driving cab at both ends.FDCU must provide LED and other hardware interface with HMI for major system status
3. The system should be SIL-2 compliant
4. Provision of audio alert to running staff
5. The system to be self-diagnostic in order to identify failures immediately.
6. On detection of a possible smoke/fire by means of suitable detection, the system shall have different levels of response (minimum two i.e. pre alarm and alarm).
7. All the major events (alarms, faults etc.) to be recorded in FDCU and should be retrievable on maintenance terminal for analysing any issue.
8. The system to have provision of drift compensation in order to decrease the risk of false, or unwanted alarm.
9. Railways will spare 6 connections points for train control lines for communication and transmission of data between Detectors and FDCU. Any other requirement of hardware/software to make the system fully functional in the scope of supplier.
10. All the key components of Smoke/fire detection system shall comply with the relevant standards viz EN54-5, EN 54-7, EN 50155 etc.
11. The architecture of the system is similar to that for AC EMU coaches.

VI. Conclusion

Presently Indian railways is providing aspiration based fire detection cum alarm systems in AC coaches which are maintenance intensive. Further, Indian Railways is operating approx. 10000 EMU/MEMU coaches over IR networktherefore requirement of a low cost fire detection cum alarm system is always desirable especially for these kind of stock being operated in day time. As the proposed system is approx. 30-40% cheaper along with added advantage of lesser maintenance requirements, it is likely to reduce the expenditure both during initial procurement and during maintenance. RDSO in association with concerned Zonal Railways have also arranged demonstrations wherein detection of fire in less than 60seconds was also observed thereby meeting the ARGE guidelines.

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