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COMPRESSED AIR BREAKING SYSTEM - A NEW DIMENSION OF FIRE SAFETY IN LOCOMOTIVES

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ABSTRACT

The issue of fire safety in locomotives gained significance in recent years. This can be attributed to new international regulations and directives on the one hand and the lessons learned from fires in trains on the other hand. The requirements for fire safety in railway and other automobiles are complex. Passenger and freight trains provide a variety of fire risks, dependent on the type of train, and operating conditions. However it is now recognised that the consequences of a fire in an underground passenger or freight train is much more serious. In order to improve the safety of passengers, a number of steps are being taken by the Indian Railways to prevent fire accidents in trains. Indian Railways have always endeavoured to enhance fire worthiness of coaches by using fire retardant furnishing materials to mitigate effect of fire. With a view to improve fire safety in running trains, a pilot project for provision of Comprehensive Fire and Smoke Detection System has been taken up in one rake of New Delhi – Bhubaneswar Rajdhani Express on East Coast Railway. Besides, one LHB (Linke Hofmann Busch) New Delhi – Jammu Tawi Rajdhani and one rake of LHB AC Double Decker Coaches running between Kachiguda – Tirupati/Guntur have also been provided with such a system. Fire extinguishers are being provided in all Air-conditioned coaches, Second class – cum – guard and luggage vans, Pantry cars and train locomotives. Improved materials for electrical fittings and fixtures such as MCB, light fittings, terminal boards, connectors, etc., are being used progressively. Detailed instructions have been issued to zonal railways for observance of safe practices in handling of pantry cars and for ensuring periodical inspection of electrical and LPG fittings in the pantry cars. Further with an aim to spread awareness among passengers, intensive publicity campaigns are being launched to prevent the travelling public from carrying inflammable goods along with them. Besides all of the these, In this paper, the authors made an attempt to give a new technology to prevent the fire accidents in locomotives by using compressed air breaking system.

Keywords: Fire Safety, Loco Motives, Air Breaking System, Air Booster, Sensors.

I. INTRODUCTION

The fire incidences in trains are among the most serious disasters to human lives and the property of Indian Railways. Thus the prevention of train fire has become a serious concern for Railways. A train fire is different from a fire in other places in the manner in which it breaks out, grows and spreads, and in the method of fighting it, as well as the damages it causes. Fire on a running train is more dangerous than a static one, because the fanning effect may spread the fire very quickly to other coaches and in panic the passengers might jump out of running train as it had happened in past train accidents. Fire especially in uncontrolled state is a source of very rapid destruction and this gets compounded when loss of human life is involved. Hence, taking all possible

steps to prevent a fire from breaking out in coaches, and if it breaks out, to prevent it from spreading and causing further damage is being given great importance.

The following points summaries the characteristics of a train fire, which need special consideration when deciding upon counter measures: -

1) A train consists of long narrow vehicles with limited exits coupled with each other.
2) High travelling speeds prevent quick escape and assist the rapid spread of fire.
3) Wide range of track conditions, including confined sections such as bridges, tunnels, ghats, etc., make it difficult for passengers to get off the vehicle easily in times of emergency.
4) Restriction in movement of passengers and fast spread of fire aggravates the situation.
5) A large number of passengers travelling on trains are attended to by a small team of train crew.
6) Even a delay of few initial seconds due to inadequacy of direct communication with the crew can be devastating.
7) Even smoke emission in a confined place may lead to panic.

Train engine compartments have traditionally been fitted with fixed fire protection systems but passenger compartments and driver's cabins have relied on manual intervention with portable fire extinguishers. Freight wagons have not been protected. In diesel-engine trains the fire risk in the engine compartment normally involves the accidental release of diesel or lubrication oil onto nearby hot surfaces such as a hot exhaust manifold. On electric trains the risk is from overheating of electric motors or ancillary equipment. In passenger compartments the risk is accidental fires from smoking, as well as arson. In freight wagons a variety of fires risks occur. The objective of a fixed fire protection system in a train is therefore to extinguish engine fires, and suppress any fire in the passenger compartment and driver's cabin without comprising safety of staff or passengers. Systems must be robust enough to withstand constant movement, vibration and possible vandalism. They should not harm the environment, nor damage sensitive electronics and electrical equipment. Current state of the art Engine compartments in trains have traditionally been protected with Halon or foam systems. Some of the Halon systems still exist, but many have been replaced with other gaseous agents. Fixed fire protection systems are not common in passenger compartments but conventional low-flow sprinklers have been fitted in rare instances. Freight wagons have not traditionally been protected. As Halon has continued to be phased out for environmental reasons alternative gaseous agents have been used, although systems do not provide cooling to prevent re-ignition and may be ineffective if enclosure integrity is not maintained. Foam systems can damage surrounding equipment and special clean-up procedures are needed. In passenger compartments conventional sprinklers have not proved popular as the amount of water needed to be effective has meant severe weight penalties. Recent advances in water mist fire protection technology now allow the introduction of fixed systems to protect all parts of trains – engine spaces, passenger compartments and freight wagons. In engine compartments water mist can provide fast extinguishing and cooling without clean-up or environmental problems. In passenger compartments and freight wagons water mist systems can provide fast and efficient suppression without undue weight penalties

This study is an investigation of fire safety on intercity and interregional multiple unit trains. In the study the major fire risks are identified using a Preliminary Hazard Analysis, which is followed by an estimation of the consequences for different fires onboard trains using simulations and hand calculations. The improvements

when introducing self-closing doors and a water mist system are also evaluated. In this study experiments are also performed, problems concerned with turned over railway vehicles are discussed briefly and the existing emergency rescue cards for Regina are reviewed.

II. CHARACTERISTICS OF FIRE

Fire occurs as a result of a chemical reaction that requires three essential elements namely Fuel, Oxygen (Air) & Heat.

$$\text{Fuel + Air (Oxygen)} \xrightarrow{\text{Heat}} \text{Fire}$$

The fire triangle is a simple model for understanding the necessary ingredients for most fires. The triangle illustrates the three elements a fire needs to ignite: heat, fuel, and an oxidizing agent (usually oxygen). By eliminating any one of the element, fire can be extinguished

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a. Class A fires are ordinary materials like burning paper, lumber, cardboard, plastics etc.
b. Class B fires involve flammable or combustible liquids such as gasoline, kerosene, and common organic solvents used in the laboratory.
c. Class C fires involve energized electrical equipment, such as appliances, switches, panel boxes, power tools, hot plates and stirrers. Water can be a dangerous extinguishing medium for class C fires because of the risk of electrical shock unless a specialized water mist extinguisher is used.
d. Class D fires involve combustible metals, such as magnesium, titanium, potassium and sodium as well as pyrophoric organometallic reagents such as alkyllithiums, Grignards and diethylzinc. These materials burn at high temperatures and will react violently with water, air, and/or other chemicals.

III. MEASURES TO IMPROVE SAFETY

General Safety Action Plans were continually executed to reduce accidents caused by human errors. A multi-pronged approach with focus on introduction of newer technologies, mechanization of maintenance, early detection of flaws, etc. to reduce human dependence in the first place, along with upgrading the skills of the human resources were the prime drivers for accident prevention. Periodical safety audits of different Divisions by multi-disciplinary teams of Zonal Railways as well as inter-railway safety audits were conducted on regular

basis. During 2011-12, 80 internal safety audits and 30 inter-railway safety audits were carried out. Training facilities for drivers, guards and staff connected with train operation have been upgraded. Disaster Management Modules have also been upgraded. During 2011-12, 98,891 safety category employees attended refresher training.

3.1 Measures to Reduce Incidents of Fire in Trains

IR have always endeavoured to enhance fire worthiness of coaches by using more fire retardant furnishing materials such as Compreg Board/PVC for coach flooring, laminated sheets for roof, ceiling wall & partition panelling, rexene and cushioning material for seats and berths, FRP windows and UIC vestibules etc. Specifications for such furnishing materials have been periodically upgraded to incorporate the fire retardant parameters in line with UIC/other international norms. All new manufacture of coaches/periodical overhauling of existing coaches is being carried out with fire retardant specifications of the furnishing materials. With a view to improve fire safety in running trains, a pilot project for provision of Comprehensive Fire and Smoke Detection System has been taken up in one rake of Rajdhani Express on East Coast Railway. Similar automatic fire alarm system in 20 more rakes for extended field trials has also been decided. Guard-cum-Brake Van, AC coaches and Pantry Cars in all trains are provided with portable fire extinguishers to cater for emergencies due to fire accidents. Improved materials for electrical fittings and fixtures such as MCB, light fittings, terminal boards, connectors, etc., are being used progressively. Detailed instructions have been issued to Zonal Railways for observance of safe practices in handling of pantry cars and for ensuring periodical inspection of electrical and LPG fittings in the pantry cars. Intensive publicity campaigns to prevent the travelling public from carrying inflammable goods are regularly undertaken. Measures have also been taken to prevent fire due to electrical short circuits in coaches, which include three levels of protection in non AC coaches in case of short circuits. Failure of 1st level fuse protection will cause fuse at 2nd level and 3rd level to protect the coach from short circuit. To enhance electrical safety of coaches, only halogen free, fire retardant, low smoke e-beam irradiated cable is being provided in new coaches. Two separate Fire Safety Audit Teams have been constituted recently to plan fire safety audits.

3.2 Examples for Less Fire Safety in Indian Locomotves

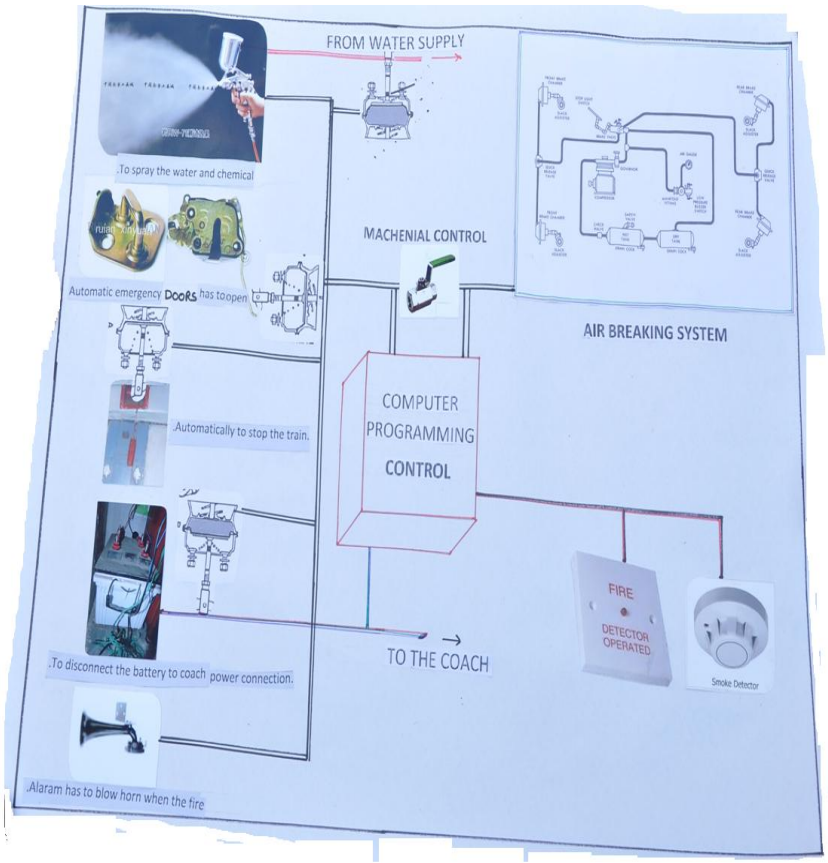
TRAIN	*DIED*	*INJURED*
GOWTHAMI EXPRES (5/12/14 at 16:00) 	**35**	**8**
GORAKHBHM EXPRES (26/5/14 at 11:00)	**25**	**100**

		
HAMPI EXPRES (22/5/12 at 16:58) 	**25**	**30**

IV. AIM AND PRINCIPLE OF THE PRESENT WORK:

The fire accidents in trains can be controlled by using less electric power. The compressed air and the potential energy is converted into mechanical energy with the help of compressed air breaking system in locomotives.

4.1 Schematic Representation of the Present Work



4.2 Steps Involved in this System

	Alarm will be blown down when fire occurs in a coach. It alerts the passengers by blowing pneumatic horn.
	The fire can be controlled by spraying water and dry powder of any fire exhausting chemical.
	Automatic emergency doors can be opened.
	Disconnection of the battery from coach.
	Automatically the train can be stopped.

4.2.1 Alarm Has to Blow Horn in Coach

The horn has to blown to immediate identification where the fire occurred and if the fire accident happend at night time, to wake up the passengers as they will get sleep.

Process

It is already used in automobiles, locomotives etc., in this pneumatic horn is usually used.

4.2.2 Spraying Water and Chemical

i. Water extinguishers are suitable for class A (paper, wood etc.) fires, but not for class B, C and D fires such as burning liquids, electrical fires or reactive metal fires. In these cases, the flames will be spread or the hazard made greater! Water mist extinguishers are suitable for class A and C; see below. Water extinguishers are effective on pool chemicals provided that they are correctly stored away from electrical hazards and equipment.

ii. Dry chemical extinguishers are useful for either class ABC or class BC fires (check the label) and are the best all around choice for common fire situations. They have an advantage over CO_2 and "clean agent" extinguishers in that they leave a blanket of non-flammable material on the extinguished material which reduces the likelihood of reignition.:

- Type BC fire extinguishers contain sodium or potassium bicarbonate.
- Type ABC fire extinguishers contain ammonium phosphate.

Process:

IT works as same gun paints to spray the chemical or water on the fire. From air reservoir to control unit and control unit to the air enters in to the nozzles. From the nozzle the chemical and water is release to stop the fire. The chemical and water is operated from the special equipment.

4.2.3 Automatic Emergency Doors Has to Open

The automatic window has to open when fire occurs. The people has to come outside through this emergency window and also to get out the smoke outside because passengers gets damaged. For this reason automatically emergency window has to open. In present generation the windows are not getting opened and also the smoke occurs the people will breathe air. It affects and kills the passengers. For this purpose automatically window has to open.

Process

It is same as car boot and same process. It will automatically open the emergency doors. From the air reservoir the air comes to control unit. And from control unit enters in to the special equipment in to door lock and opens the lock.

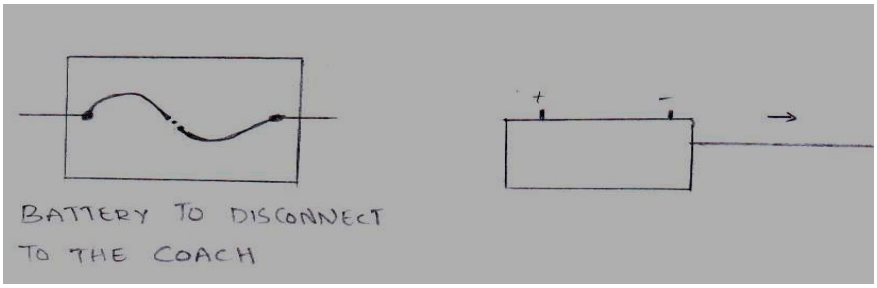
4.2.4 Automatically to Stop the Train

The train has to stop automatically because when the fire accident occurs the passengers has to come outside.

Process

In locomotives already chain alarm is there in Indian railways. But in the present work, the authors had made a special equipment to connect the chain alarm. The special equipment works as air braking system in diaphragm like that it works.

4.2.5 To Disconnect the Battery to Coach Power Connection



There is need to disconnect the battery from coach, to mitigate the short circuit when fire is occurred.

Process

Compressed air will blow from air reservoir to control unit and to the special equipment to disconnect the current from battery to coach. The special equipment works as air braking system in diaphragm.

V. CONCLUSION

Keeping in view the fact that the Railways will have to lift more originating traffic during the coming years, there is a growing emphasis on strengthening of infrastructure on the Railways. This is a continuous process and the investments made and Strategies adopted in the past have indicated this by way of reduction in the number of consequential train accidents over the years. Water mist is the ideal solution for fixed fire protection of all areas on trains. The technology combines optimum suppression performance with lightweight. Water mist is safe for people, equipment and the environment. HI-FOG is the leading water mist technology with more approved systems and a larger reference list than any other water mist manufacturer today. Safety education wasn't just used for railway workers. Although railway travel was relatively safe compared to railway work, large numbers of passengers were still injured or even killed. Sometimes this was the railway companies' fault, and other times it was a consequence of the actions of the passengers themselves. Companies used safety education to try to show passengers and children how to avoid the dangers of the railway, from getting in and out of carriages safely to preventing trespassing on the lines. They took advantage of the latest technologies and ideas to give safety messages, trying to be as eye-catching and interesting as possible.

Fire on a running train is more dangerous than a static one, because the fanning effect may spread the fire very quickly to other coaches and in panic the passengers might jump out of running train as it had happened in past. Fire especially in uncontrolled state is a source of very rapid destruction and this gets compounded when loss of human life is involved. Hence all possible steps to prevent a fire from breaking out in coaches, and if it breaks out, to prevent it from spreading and causing further damage are of paramount importance.

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