Fire Causes and Preventive Measures in Railway Coaches

END USER: FOR GENERAL AWARENESS TO ALL

CAMTECH/E/14-15/Fire Coches/1.0
March, 2015

Indian Railways
Centre for Advanced Maintenance Technology

महाराजपुर, ग्वालियर — 474 005
Maharajpur, GWALIOR - 474 005
Fire Causes and Preventive Measures in Railway Coaches

QUALITY POLICY

“To develop safe, modern and cost effective Railway Technology complying with Statutory and Regulatory requirements, through excellence in Research, Designs and Standards and Continual improvements in Quality Management System to cater to growing demand of passenger and freight traffic on the railways”.
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.

There are many cases of fire consequences like damages to human lives and property in which many of them are of avoidable nature which can be eliminated by proper attention and awareness.

Therefore, it becomes imperative that all required steps are taken to prevent and control fires. CAMTECH has made efforts in this direction by incorporating information on probable causes, preventive measures during manufacturing and maintenance of Railway coaches in this handbook.

It is expected that this handbook will be very useful in disseminating knowledge on various aspects of train fire and its prevention.

CAMTECH, Gwalior

Date: 26th March 2015

A. R. Tupe

Executive Director
A train fire is different from a fire in other places in the manner in which it breaks out, grows and spreads. 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.

This handbook on “Fire Causes and Preventive Measures in Railway Coaches” has been prepared by CAMTECH with the objective to create awareness about the train fire, causes and preventive measures. This handbook includes brief description of probable causes, preventive measures being taken at the time of manufacturing, attention during maintenance and dos and don’ts etc.

This handbook also includes recommended role of on board staff in case of fire and CAMTECH recommendation along-with photographs.

It is clarified that this handbook does not supersede any existing provisions/guidelines laid down by RDSO or Railway Board/ Zonal Railways. The handbook is for guidance only and it is not a statutory document.

I am sincerely thankful to all field personnel who helped us in preparing this handbook.

Technological upgradation and learning is a continuous process. Hence feel free to write us for any addition/ modification in this handbook. We shall highly appreciate your contribution in this direction.

CAMTECH, Gwalior
Date: 26th March 2015

Peeyoosh Gupta
Director Electrical
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The correction slips to be issued in future for this handbook will be numbered as follows:

CamTech/E/14-15/Fire Coaches/C.S. # XX date---------

Where “XX” is the serial number of the concerned correction slip (starting from 01 onwards).

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CHAPTER 1

INTRODUCTION

1.1 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 are 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 traveling 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 traveling 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.
1.2 CHARACTERISTICS OF FIRE

The basic of fire is explained below for awareness among staff.

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

![Fire Triangle Diagram]

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.

1.3 CLASSIFICATION OF FIRES

- Fires are classified according to the type of fuel that is burning.
- If you use the wrong type of fire extinguisher on the wrong class of fire, you might make matters worse.
- Its very important to understand the four different fire (fuel) classification:
  
  i. **Class A**: Wood, paper, cloth, trash, plastics—solids that are not metals.

  ii. **Class B**: Flammable liquids—gasoline, oil, grease, acetone. Includes flammable gases.

  iii. **Class C**: Electrical—energized electrical equipment (as long as it’s “plugged in” or supply ON)

  iv. **Class D**: Metals—potassium, sodium, aluminum, magnesium. Requires Metal-X, foam, and other special extinguishing agents.
1.4 TYPES OF FIRE EXTINGUISHERS

Different types of fire extinguishers are designed to fight different classes of fire. The 3 most common types of fire extinguishers are:

1. Water (APW)
2. Carbon Dioxide (CO2)
3. Dry Chemical (ABC, BC, DC)

1.5 STEPS TO USE A DCP TYPE FIRE EXTINGUISHER

There are four important steps you must know to correctly use a fire extinguisher. The PASS method can help you to easily remember those steps.

- Pull the pin
- Aim the extinguisher or nozzle at the base of the fire
- Squeeze the handle and release the extinguishing agent
- Sweep the extinguisher from side to side across the base of the fire until it appears to be out

1.6 PROBABLE CAUSES OF FIRE

It is quite difficult to pin point the exact cause of fire in railway coaches due to extensive damages and only general observations are available. There are variety of reasons which may be a source of initialization of fire, some of them are mentioned below-

1. Carrying Inflammable goods like stove, gas cylinder, kerosene oil, petrol, fireworks etc. in passenger coaches.

2. Making fire/ using fire near paper, wood, petrol or such other inflammable articles.
3. Throwing waste material out side the dust bin near door. Non-removal of garbage from pantry car/coaches

4. Malpractices like carelessly thrown lighted match sticks, cigarette butts, Bidi butts etc.

5. Leakages/Blasts of Pantry Gas Cylinders.

6. Careless storage of inflammable materials like news papers, edible oil etc. in pantry cars.

7. Insertion of cigarette butts, Bidi butts, Gutakha wrapper etc. in fan base, fuse distribution board, roof openings.

8. Sabotage/Discrepancy.

9. Mishandling/careless use of pantry equipment by pantry car staff.

Panic has also been noticed to have been caused among the passengers due to smoke emission due to brake binding/hot axle.

CHAPTER 2

*Handbook on Fire Causes and Preventive Measures in Railway Coaches*
CAMTECH RECOMMENDATIONS

Various suggestions received from participants during the seminar held on date 01.12.2014 at CAMTECH, on the subject “Fire Causes and Preventive Measures in Railway Coaches” have been discussed and given below as “CAMTECH Recommendations”.

1. Fire extinguishers should be provided in all coaches i.e. also in general second class coaches, non AC 3 tier coaches and non AC chair cars etc.

2. The size of emergency exit windows in General Coaches/ 3 tier sleeper coaches/ non AC chair car shall be of larger size as in case of AC coaches so that it can be identified easily and easy to exit as these coaches are highly occupied.

3. The location /seat numbers for the emergency exit windows along with their operation shall be vigorously advertised through stickers, public address system, display boards at the stations, tickets and other media.

4. Vestibuling in the General Coaches may be explored, this will help in evacuating passengers in case of any disaster/emergency.

5. Authority to be given to AC mechanic to ask passengers to not to smoke.

6. Use of thermo vision camera (infrared thermography) for detecting hot spots on cable joints, switch boards, fuses etc. to be used vigorously at least begin with Rajdhani, Shatabdi expresses.

7. Overhead water tanks of toilets may be provided with fusible drain plug. In case of fire this fusible drain plug will melt due to high temperature and water will spill out in door way area which may reduce the intensity of fire.

8. Utilization of existing water in the overhead water tanks on the coaches to suppress the fire in the gangway area may also be explored.

9. Emergency exit door with ladder may be explored so as to provide adequate and safe outlet for the train passengers to escape in case of any emergency.

10. The material of the coach door handle and the latch may be modified having thermal insulating properties so that it is possible to grab the handle even when the coach is afire.
The clearance between door and door frames may be increased to avoid the possibility of the doors getting jammed due to heating, with suitable **flexible lining** provided to fill up the gap.

**Fire protective accessories** (gloves, apron etc.) may be provided for the crew as part of emergency tool kit to help them in performing the uncoupling of coaches as well as rescue work in case of fire.

Similar set of accessories may also be provided in MRV/ARTs so that the railway staff involved in rescue /relief work can carry out the work safely.

**Minimum 2 Stretchers** in the brake van of mail/ express/ passenger trains shall be provided.

The checking of unreserved compartments of the trains by the squad TTEs, the Government Railway Police and the Railway Protection Force should be more purposeful, vigorous, repetitive and streamlined. Proper coordinated efforts should made by these departments to detect the **carriage of inflammable materials** by the passengers.

Provision of portable battery operated loud speaker for the coaches for special trains like **Teerth Yatra, Bharat Darshan** for the special use by IRCTC so as to avoid **temporary connection** for sound system etc.

**INFRARED THERMOGRAPHY**

Coach supply systems contain many sub-systems such as batteries, alternators, RRU/ERRU, switchgear, transformers, panels, receptacles, controls and lighting. Common to all of these components are connections, insulation and over current protection, MCBs etc.. Infrared thermography may be one of the better tool for finding hot spots to take corrective action accordingly.
CHAPTER 3

FIRE PREVENTIVE MEASURES

3.1 POWER SUPPLY ARRANGEMENT & PROTECTION SCHEME FOR PASSENGER COACHES

Code of practices for prevention of fire for different type of rolling stock are issued by RDSO and updated time to time for railways for implementation. The salient features of power supply arrangement are summarized below:

- 110 V DC two wire insulated system with each wire placed in a separate conduit to prevent any short circuit is adopted.
- In 110 V system, fault current is 10 times more than the load current hence the faults are promptly cleared (24 V system had very narrow discrimination between fault and load current).
- 110 V DC system has reduced the load current to approx. 1/5th as compared to 24 V DC system and so the overheating at various junction points has also reduced.
- All the circuits are protected by suitable sizes of fuses.
- It does not cause shock to any person due to floating system.
- Use of over voltage protection has been provided to prevent any damage to the equipment.
- Insulation scheme for alternators has been upgraded.
- Cables from alternator to RRU/ERRU have been changed to copper from aluminium, along with fire retardant moulding compound cleats.
- Supply scheme has multi level protection system in the event of short circuit & more than two earth faults.

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*Handbook on Fire Causes and Preventive Measures in Railway Coaches*  
March, 2015
3.2 FIRE PREVENTIVE MEASURES BEING TAKEN DURING MANUFACTURING AND MAINTENANCE OF COACHES

1. The air-conditioned coaches are provided with E-beam irradiated thin walled elastomeric cable as per RDSO specification no. RDSO/SPEC/ELC/0019 (Rev “0”) - 2002.

2. The layout and cable harness scheme for electrical wiring in the coaches are such as to minimize the number of joints and junction boxes.

3. The maintenance units of railways are directed to ensure the use of proper sizes of cables in different circuits as per standard designs of production units for these coaches.

4. Positive and negative cables for train lighting system working with 110 V DC are run in separate conduits.

5. The size of cables used in different circuits are based on electrical load for the particular circuit under normal operation as well as fault conditions after considering various de-rating factors for the cable like higher ambient temperature, bunching of cable, running in conduits etc.

6. All cables for other than branch circuits are secured to the coach structure by cleats located at an interval not exceeding 500mm. Extra cleats are provided on either side of a bend and also near all the end connections made on equipments, terminal boards and junction boxes.

7. The cleats are made in two halves having semi circular grooves in each half with inside radius which conforms to the maximum overall outside diameter of the cable. The cleats have separate groove for each and every cable. More than one cable in one groove of the cleat should not be allowed.

8. Only PVC/FRP cleats with non-inflammable properties are being used.

9. Edges of the groove for holding the cables in the two halves of the cleat are suitably chamfered to avoid pinching of cable insulation. The cleats are properly secured to the coach body to avoid vibrations.

10. Branch cables either single or in bunches are secured by PVC insulated clips. These clips are attached to the coach body by screws, machine screws or self-tapping screws.

11. When wires are run through the carline openings in the roof, adequate precautions are taken to prevent damage to cable insulation while drawing cables through such openings.

12. Wiring for fan points, berth lights, step lights, tail lights and side light fittings etc. on the coach are terminated in a connector. This will ensure that when these fittings are removed from the coach, the coach wiring is not disturbed and remains in position.
with its opposite polarities terminals adequately apart. The connectors are covered under IS: 6896-1973 and are made of tough non-ignitable moulding material or rigid PVC.

13. Distribution fuse boards and various terminal boards used in coach wiring are made of FRP/SMC with fire retardant properties.

14. The canvas ducts for air conditioning system are made of fire retardant quality of preferably woven material to IS- 1424 –1983 (Third Revision) Amendment 2.

15. The dry type air filter conform to RDSO specification no.ELPS/PE/SPEC/AC/0055-2003 (Rev.1) of fire retardant property are being used.

16. The mobile charging sockets are being provided with glass fuses to protect in case of over loading.

17. Fuse distribution board covers are being modified to restrict entry of foreign material. (Ref: RDSO modification sheet no. RDSO/PE/MS/TL/0059-2012, Rev. 0)
19. In SLR coaches **flush type** light fittings are being provided with **mesh** to avoid damage while loading/unloading luggage.

20. Fuse distribution boards and rotary switch boards are made of fire retardant fiber glass (FRP/SMC).

21. Cables in the superstructure are being laid in insulated PVC conduits.

22. Cables in the under frame are being laid in metallic conduits.

23. Cables with fire retardant insulating material are being used.

24. Sparkless BLDC fans with inbuilt overload protection have been developed and are being provided.

25. Electronic regulators with improved voltage and current regulation and inbuilt over voltage protections have been developed and are being provided.

26. Modified epoxy moulded terminal board has been introduced for alternators to prevent shorting of terminals.

27. Modified epoxy moulded Emergency Feed Terminal (EFT) has been introduced and are being provided.
3.3 FIRE FIGHTING ARRANGEMENT

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. The fire extinguishers provided in the coaches for electrical fire should be of DCP type as per following specifications.

1) DCP type fire extinguishers as per IS: 2171 of 1995. (Portable fire extinguishers, dry powder cartridge type)
2) IS: 307-1977 for carbon dioxide
3) IS: 4947 - 1995 for gas cartridge for use in fire extinguishers
4) IS: 4308-1982 for dry powder for fire fighting

The following shall be ensured:

- Portable fire extinguishers are in working order and are available at the nominated place before the rake is given for service.
- Sufficient number of spares should be kept in stock to ensure prompt replacement of defective/missing extinguishers. Regular checks should be carried out for operation for extinguishers.
- Fire extinguishers shall be so located on the brackets at the approved points that these are easily visible and accessible in case of emergency. They shall not be placed in locked cupboards.
- All the fire extinguishers shall be painted red and shall carry an instruction plate wherein the clear instructions for operation shall be written in English & Hindi and any other regional language. The plate shall also carry a label for last checking, refilling date and due date.
- The maintenance and periodic checks on DCP type fire extinguishers should be as per IS: 2190 of 1992 (Code of practice for selection, installation and maintenance of portable fire extinguishers). The salient features of this IS as per clause 10.8 which deals with the quarterly checking, replacement of powder and its quality, checking of gas cartridge by weighing, checking of end fittings, life of fire extinguishers and sample checking.
• Efficient use of fire fighting appliances necessitates adequate **training** to be given to the running and other staff who should be familiar with fire fighting techniques and operations and handling of the extinguishers.

• Staff should be familiar with physical location of fire fighting equipment, correct method of operating the equipments and precautions to be observed.

### 3.4 INDICATION OF EMERGENCY EQUIPMENT

Indication boards with essential instructions for equipment which can help in passengers to stop the train, exit from emergency windows etc. in any emergency shall be prominently displayed.
3.5 HOW TO OPEN EMERGENCY WINDOW

*Emergency window is provided in 3rd coupe of every AC coach.*

**Step 1:** Pick any heavy article such as water bottle, shoe etc. and break the chain handle glass.

**Step 2:** Pick the chain handle and pull out the complete sealing rubber of the emergency window glass.

**Step 3:** Hold the emergency window glass handles firmly with both hands, remove the glass and keep it on any berth/seat.

**Step 4:** Now emergency window is completely open. Check outside the window for it’s height.

**CAUTION**

FIRST ENSURE THAT NO TRAIN IS PASSING ON ADJACENT TRACK.
3.6 PREVENTIVE MEASURES TO BE TAKEN BY AC COACH MAINTENANCE STAFF

1. Ensure provision of two numbers of DCP type fire extinguishers in A.C. coaches.
2. Ensure that no protection (MCB/FUSE etc.) is by-passed.
3. Proper rating of MCBs / fuses shall be used.
4. Look for any overheating sign after putting ON all electrical loads. Check the electrical connections, switches, fuses with the help of Infrared temperature gun to detect any overheating.

In the absence of infrared cameras, carry out at least close visual monitoring of all bolted or crimped joints. Look for tell-tale signs of overheating, such as softened, distorted or charred cable insulation or terminal boards.
5. Loose or temporary connection, hanging wires/ exposed joints etc. should not be allowed.
6. Check condition of PVC bushes/ glands provided in junction-boxes. Replace worn-out bushes/ glands during schedules.
7. Check condition of insulation especially in junction-boxes. Don’t permit damaged/ broken/ cracked insulation.
8. Rubbing of cables shall not be permitted.
9. Check physical condition of wire/ cables for external damage and overheating marks, discoloration of lugs due to excessive flow of current/ overheating.
10. If smoke/fire observed anywhere in the coach then switch ‘OFF’ power supply immediately.
11. The locking and securing arrangement for the doors and covers of electrical control/power cubicle and terminal boards should be ensured to prevent unauthorized access to the live parts of electrical equipments.

3.7 PREVENTIVE MEASURES TO BE TAKEN BY PANTRY CAR STAFF

1. Ensure that there are no gas leakages.
2. Ensure that specified number of gas outlets only to be used.
3. Gas cylinders are kept on proper rack including upper shelf duly clamped if any.
4. Gas regulator, flame arrester & pressure gauge are in working order.
5. Ensure that Gas manifold is available.
6. Ensure that Exhaust fans are working.
7. Ensure that All main doors are free to be opened.
8. Ensure that Passages are kept free for movement.
9. Ensure that Vestibule area, passage, pantry car & LPG chamber are kept cleaned.
10. Ensure that adequate numbers of fire extinguishers should be clamped/ hanged at nominated place and should not overdue for refilling.
11. Don’t Tamper with gas flexible pipes, regulators, flame arresters & clips on adopter.
12. Don’t Use hot cases for storage of unwanted materials.
13. Don’t permit extra persons to travel in pantry car.

3.8 PREVENTIVE MEASURES TO BE TAKEN BY ON BOARD STAFF

On board train staff (TTE/GRP/ RPF etc.) should observe the following.

1. Whether any passenger is carrying dangerous articles such as explosives of any variety including fireworks, inflammable materials such as oil, grease, ghee, paint, dry grass and acids, LPG cylinders, Kerosene stoves, etc. and other corrosive substances in passenger coaches. If any, stop him doing so and take corrective action.

2. Interrupt passengers on malpractices like smoking, throwing ignited butts of smoking sticks, lighted match sticks into the compartments.

3. Whether any passenger is operating heater or electric equipment other than mobile/laptop or using extension boards through the mobile/ laptop charging points provided in the coaches. If any, stop the passenger to do so and take corrective action if necessary.

4. Some AC Coach attendants keep linen/ bedding items in the vestibules. Catering staff also block vestibule area by keeping food trays etc. there. The vestibule area is most critical place for safe exits in case of fire. Interrupt them on these activities.

5. Doorways area, corridors and vestibule area should be kept clear always for easy evacuation in emergency.

6. Ensure hammer is available near toilet for breaking window glasses in case of emergency. The cover shall of flap type for quick removal.

7. Ensure regular cleaning and disposal of waste from dust bin by the On –Board Housekeeping Staff (OBHS).

8. Stretcher and first-aid box should be in good condition and shall be checked periodically.
CHAPTER 4

ATTENTION DURING MAINTENANCE FOR PREVENTION OF FIRES

4.1 GENERAL

In spite of the precautions taken at the coach design, manufacturing stages, constant vigilance is required by the maintenance staff to prevent failure of the equipment or protection system of the coaches. Preventive maintenance and inspection play vital role in safe operation of trains.

Carry out the preventive maintenance and repair of the equipment with care as per the schedules laid down.

4.2 MAINTENANCE OF PROTECTION SYSTEM

Protective devices are necessary to provide protection in the event of any short circuit or excessive current on the coaches. If proper functioning of protective devices is ensured, it will help in avoiding failures of electrical equipment on the coaches.

(i) Ensure that the proper sizes and types of fuses are used for replacement. No short cut should be done such as providing temporary fuse wires. Use MCBs and fuses of only approved suppliers as laid down by RDSO/ original equipment manufacturer (OEM).

(ii) Ensure that all the protective relays are in good working order and are properly calibrated as per the schedules laid down. Do not by pass any protection system.

(iii) As the quality of protective devices is also important it should conform to their relevant specification and should be of approved makes.

(iv) The re-wirable fuses should be as per IS-9926-1981 and HRC fuses shall be as per IS-13703 (part 2/ sec 2) 1993 and should be procured from approved sources.

(v) In rotary junction box fuse ratings such as 35A, 16A, 6A etc. shall be displayed by providing proper sticker/paint and should be ensured during maintenance so as to avoid any possibility of providing wrong size fuse.

4.2.1 Working of VANE relay

The proper functioning of protection system i.e. checking the working of vane relay should be checked during weekly inspections. Using a piece of small board, block the return air opening through the duct with vane relay. The system should trip due to scarcity of air through vane relay.
4.2.2 Working of Thermostats for Heater Circuit

The proper functioning of protection system with thermostats for checking the overheating of heater should be checked during every IOH/POH. The vane relay should be isolated by shorting the terminals at control panel. And then using a piece of small board, block the return air opening through the duct with vane relay. The system should trip through OHP due to over heating of heaters because of scarcity of air.

4.2.3 Working of Over Voltage Protection (OVP) Relay

The working of OVP should be checked as per SMI no. RDSO/PE/SMI/AC/0019-2002 (Rev-0) for “Testing procedure for proper working of over voltage protection provided in 25 KW/22.5 KW alternators in AC coaches. The testing of OVP should be carried out during following.

i. During POH

ii. Before commissioning of new alternators on AC coaches at production units (PUs)/workshops

iii. Whenever RRU is repaired/ replaced at AC depots.

4.3 Batteries

Batteries constitute a explosion risk when they are being given heavy charge. Heavy charging can be either due to malfunctioning of the charging equipment or carelessness when charging on the coach from the shop floor rectifier. It is, therefore, important to check that the ventilation provided in the battery box is not choked. The staff should be made aware of the dangers of overcharging and interfering when the battery is on charge.

4.4 Cleanliness of Under Frame

The under-slung equipment such as alternators, battery boxes, RRU/ERRU, battery fuse boxes etc. shall be cleaned properly in each schedule and any foreign material shall be removed to avoid any failure.

4.5 Control Panels

The control panels comprise cables, connections, contactors, fuses, MCBs etc. and require proper attention during maintenance. Ensure that proper maintenance of the equipment and switchgears inside the panel is done as per schedules laid down and carefully looked for developing any fault.

4.6 Tightness of Connections

A loose connection may a potential source of failure as not protected by any protective device. Proper tightness of all the connections is, therefore, to be ensured and this point is to be given particular attention during inspections. Awareness campaigns should be lodged for the workman with prominent display.
Proper lug with sleeve shall be provided on wires before connecting them on switch/sockets.

4.7 REPAIRS TO WIRING

Use only approved quality of cables for repairs. Use proper size of cables. Undersized cables and unapproved type of cables should not be used even as a temporary measure. Cable jointing should be prohibited and this instructions should be displayed prominently at the work place. Repairs should be carefully carried out so that no damage is caused to other cables.

4.8 CLEANLINESS OF ELECTRICAL EQUIPMENT

“Cleanliness is next to Godliness” is no where more true than for electrical equipment. Insulation failures can result from surface flashovers due to presence of dirt, dust and moisture. It is, therefore, essential that proper cleaning of terminal connections, bus bars, insulators and equipment is done during schedules as laid down to remove dust and dirt particles.

4.9 EARTH CHECKING

The earth fault in the wiring of the coach is the first stage for causing a short circuit in the supply system and so should be checked and attended promptly. The earth fault shall be checked both on phase and neutral wires separately and on positive and negative wires separately (for 110V DC system).

Light point, fan point, pantry equipment and the switches are particularly prone to earthing in metal bodied coaches and therefore to minimize this possibility, proper attention is required to be paid at the time of fitment of these light/ fan fittings, brush holder of the fan, toggle switches and also while carrying out their maintenance in service.

Proper attention should also be paid during laying of wires in lavatory, near water tank and wash basin area to avoid contact with water.

The insulating bush shall not be provided in the mounting lug of the fan. It shall be ensured that fan base of all the fans should not be insulated with the coach body.

All the electrical fittings both on super structure and on under-frame shall be mounted directly on the coach body and shall not be electrically insulated.

All the electrical equipment above 110 V shall be individually provided with earthing shunts between equipment body and coach body.
4.10 AIR CLEARANCES

Air clearance of 10 mm has been specified between any live part and the coach body and 4 mm between parts of opposite polarities (EL/TL/48 clause 3.9.4) for 110V system. The clearance for live parts for other voltage grades will generally meet the requirement of IS: 13947 Part-I, 1993.

This is primarily to ensure adequate separation to facilitate ease of fitment and maintenance in service. In case of clearance being inadequate, there can be a possibility of short circuit due to the working tools or any other inadvertent reason. It is therefore, important that adequate clearances, as specified, are maintained in all the fittings i.e. between live parts and earth and between live parts of opposite polarity.

4.11 CABLE INSULATION

Cable insulation on coaches gets damaged due to various reasons, resulting in earth fault on wiring, which in turn may cause short circuit. Therefore, any damage to the cable insulation should be prevented and attended promptly.

Maintenance staff should not chip cable insulation between the circuits for test feed etc. and should test at terminals only. It is dangerous practice of chipping the cable insulation for testing purpose. This leaves a permanent scar on the cable insulation and even its subsequent taping with insulated tapes will not be quite satisfactory.

The cables passing through the holes in the metallic members of the coach should be protected by providing proper PVC grommets to grade 6 of IS: 5831-1984 (First rev.) with non-inflammable properties, to avoid insulation damage because of pressing and rubbing against the sharp edges.

At cable terminals, cable lugs should always be provided with heat shrinkable sleeves. The effort should be made that stripped portion of cable is fully inserted inside the lug gland and is not exposed outside. This will avoid shorting of the cables at the terminations where the clearances are critical.

The insulating FRLT tape as per ICF specification No. ICF/Elec./921 and RCF specification No. EDTS 174 should only be used in the coaches.

Crimped connections are to be made properly as specified in annexure II of EL/TL/56-1992. The poor joint will cause overheating and damage to the insulation of the cables at the end. A poor joint can always be detected easily by checking the temperature of the socket with full load current passing through it. A hot terminal indicates either an improper/loose connection or a badly crimped joint. The contact-less infra red thermometers should be used for detecting the over heated joints in the terminal board.

A record of insulation of the coach wiring should also be maintained to monitor the health of insulation of wiring.
4.12 COACH INSULATION RESISTANCE TEST

The following should be followed to measure the insulation resistance of coaches:

i. Superstructure wiring and under frame wiring shall be tested separately for which the main fuses in the power panel and terminal boards shall be removed and controlling switches shall be kept off. Insulation resistance shall be measured with all fittings and equipment connected, both on underframe and superstructure. The underframe wiring shall be tested with battery fuse in open condition.

ii. Insulation resistance for train lighting circuits of 110 V ac/dc, under fair weather conditions shall be minimum 2M ohm. However, under adverse (high humid/wet) weather conditions, the minimum insulation upto 1 M. ohm will be acceptable. (Table-1).

iii. While taking the IR for power circuit with Inverters, the cables should be disconnected from inverter terminals.

iv. In case the insulation resistance is found to be less than the above mentioned values, the individual sub circuits and control panel i.e. Light, Fan, WRA and air-conditioning equipment etc., for superstructure wiring and different feeder for under frame wiring shall be megered separately and the coach shall be treated to have passed the test if insulation resistance’s values of these feeders tested individually is within the limits prescribed in above para.

v. Insulation resistance for other equipment of different type of train lighting/air conditioned coaches working at different voltages will be measured as per the following table. The megering voltage and the values of the insulation resistance for the various circuits shall be as given below:

<table>
<thead>
<tr>
<th>S.No.</th>
<th>Rated circuit Voltage</th>
<th>Meggering Voltage</th>
<th>Insulation Resistance value</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>750 V a.c.</td>
<td>1000 V d.c.</td>
<td>Not less than 5 M. ohms</td>
</tr>
<tr>
<td>2</td>
<td>415 V a.c.</td>
<td>1000 V d.c.</td>
<td>Not less than 3 M. ohms</td>
</tr>
<tr>
<td>3</td>
<td>230 V a.c.</td>
<td>500 V d.c.</td>
<td>Not less than 2 M. ohms</td>
</tr>
<tr>
<td>4</td>
<td>190 V a.c.</td>
<td>500 V d.c.</td>
<td>Not less than 2 M. ohms</td>
</tr>
<tr>
<td>5</td>
<td>110 V a.c.</td>
<td>500 V d.c.</td>
<td>Not less than 2 M. ohms</td>
</tr>
</tbody>
</table>

The insulation resistance is to be measured during every IOH/POH schedule of maintenance and record for the same should be maintained coach wise.

4.13 BRAKE BINDING

Panic has been noticed to have been caused among the passengers due to smoke emission due to brake binding. Ensure that the brake system is maintained to the highest standard possible to minimise brake-binding cases.
4.14 REPAIRS OF INTERIOR FURNISHINGS

While carrying out the repairs to the interior furnishings, ensure that only the approved quality of the furnishing materials are used. Unapproved materials should not be used even as a temporary arrangement as this would become a practice over the course of time. Sufficient stock of the approved furnishing and paneling materials should be kept in the depots and workshops, depending upon the requirements so that there is no temptation to the maintenance staff to use other non-standard materials.
CHAPTER 5

RECOMMENDED ROLE OF ON BOARD STAFF
IN CASE OF FIRE

5.1 INTRODUCTION

In case fire on train, typical time available for rescue is 2-3 minutes before smoke fills up and passengers start getting disoriented. Smoke (toxic/non-toxic) can cause suffocation and loss of consciousness in two minutes. Fire in personal clothing causes loss of consciousness in 10-15 seconds and Deaths or incapacitation (followed by death) can happen in five minutes. A fire in train destroys the train carriage(s) completely in a few minutes.

In most of the cases, relief reaches a burning train when the carriages are completely burnt and passengers dead or badly burnt. Under such situation, role of on-board Railway servants becomes vital and they should plunge into action to save the precious lives on priority. In this context, the Railway servants are expected to have a basic knowledge on fire and fire fighting methods.

It is desired that the role of onboard staff need to be communicated through various training programs.

5.2 INSTANT ACTION TEAM AGAINST FIRE

An instant action team comprising the following available on the train may be formed:

- Loco pilot, Asst. loco pilot, Guard
- All TTEs, AC Coach attendants, AC Mechanics
- Pantry car staff (railway and / or contractor)
- OBHS (On-board Housekeeping Staff) (railway and / or contractor)
- TXR staff (as provided on some trains)
- RPF/ GRP staff
- Railway employees either on duty or on leave as passengers traveling in the fire affected train
- Doctors traveling by the train
- Passengers traveling on the train who volunteer for rescue and relief work
- Railway staff working at site or available near the site of the fire incident
5.3 ROLE OF INSTANT ACTION TEAM

1. Don’t panic.
2. Pull the Alarm Chain and stop the train immediately.
3. Evacuate the passengers to the adjacent coaches which are away from the fire through the vestibules; if the fire is not extinguished. After complete evacuation the rolling shutters of coaches on fire to be closed to contain the spread of fire.
4. More people expire due to suffocation from smoke rather than due to actual burning. Advice passengers to take a cloth, wet it in their drinking water and cover their nostrils. This reduces the smoke inhalation & subsequently its bad effects.
5. Insist that passengers should save themselves first and not to bother about their luggage which can be retrieved later on.
6. Isolate the affected coaches from other coaches by decoupling both Mechanical & Electric couplers.
7. Locate the fire extinguishing substances viz, fire extinguishers, water bucket with water/sand, etc. Use water from the coaches.
8. Try and put out the very source of the fire before it becomes a big blaze.
9. Turn off Electrical Appliances. In case of fire from electricity switch off the source.
10. Report it to the nearest station/control/fire station. (fire services : 101, it can be dialed by mobile also)

When a person is on fire

- Approach him holding the nearest available wrap in front of you.
- Wrap it round him.
- Lay him flat and smother the flames.
- He may roll on the floor, smothering the flames.
- On no account should he rush into the open air.
- Call for assistance.

Handling of injured passengers

1. Building up confidence of injured passengers by suitable advice is of great importance.
2. First aid should be rendered to the injured passengers.
3. Ordinarily give nothing ORALLY to injured one, but if medical treatment is delayed more than 4 hours, give ORS drinks preferably bio-carbonated soda.
4. In serious case, remove the patient quickly to hospital as the injured may require an anesthetic, medical soothing.
5.4 ROLE OF AC COACH MAINTENANCE STAFF

- Immediately isolate the affected coach/coaches electrically.
- Use fire extinguisher to extinguish fire to the extent possible.
- Immediately check lights in the coaches and provide light in dark coaches.
- Provide light at accident site.
- Take necessary action as a man of common prudence will take not only to help the stranded passengers but also to arrange such helps as would be demanded by the circumstances.
- Help in extricating the trapped passengers/bodies.

5.5 ROLE OF CREW (LOCO PILOT/CO-PILOT, GUARD)

1. Stop the train immediately.
2. Arrange the stretcher and first-aid box for the injured passengers.
3. Arrange for isolating the affected coaches from other coaches by decoupling both Mechanical & Electric couplers.
4. Report it to the nearest station/control/fire station.
5. Provide anti rolling arrangement on the isolated coaches and train as well.
6. Render first aid to injured passengers, obtaining assistance of the railway staff, doctors and / or volunteers on the train, or near the site of accident; and transport the injured to the hospital by taking the help of Ambulance service, means available.

5.6 ROLE OF TRAIN SUPERINTENDENT/ TTEs

1. Don’t panic.
2. Pull the Alarm Chain and stop the train immediately.
3. Evacuate the passengers to the adjacent coaches which are away from the fire through the vestibules; if the fire is not extinguished. After complete evacuation the rolling shutters of coaches on fire to be closed to contain the spread of fire.
4. Advice passengers to take a cloth wet it in their drinking water and cover their nostrils. This reduces the smoke inhalation & subsequently its bad effects.
5. Arrange the stretcher and first-aid box for the injured passengers.
6. Insist that passengers should save themselves first and not to bother about their valuables/luggage which can be retrieved later on.
7. Locate the fire extinguishing substances viz, fire extinguishers, water bucket with water/sand, etc. Use water from the coaches.
8. Report it to the nearest station/control/fire station. (fire services : 101, it can be dialed by mobile also)
9. Take assistance of volunteers from passengers, Railway employees traveling, doctors on train, on-board contractor staff etc. in rescue operation.
5.7 ROLE OF PANTRY CAR STAFF

1. Protect the inflammable available at pantry car.
2. Extinguish the fire by using fire extinguishers available at pantry.
3. Provide necessary assistance to TTE as directed.

5.8 ROLE OF ON BOARD HOUSEKEEPING STAFF & TXR

1. Open the doors of both sides of coaches.
2. Evacuate the passengers to the adjacent coaches which are away from the fire through the vestibules; if the fire is not extinguished. After complete evacuation the rolling shutters of coaches on fire to be closed to contain the spread of fire.
3. Open Emergency Windows for Evacuation of the passengers.
4. Provide necessary assistance to TTE as directed.

5.9 ROLE OF RPF/GRP

1. Separate the area of incident by establishing temporary barriers and ensure that the onlookers and spectators do not enter the affected area to disturb the scene or hamper the rescue operations.
2. Baggage of passengers should be isolated and protected and should be taken care of, till they are handed over to claimants or taken over by Railway authorities.
3. RPF personnel should respond to any call for assistance to rescue victims and transport them to the nearest hospital.
4. Check, save and record the evidences/clues of the fire.
CHAPTER 6
DOs AND DON’Ts

Keep the fire extinguishers in clean condition. There should be no sharp bend in rubber pipe.

Train on board staff shall be conversant with the emergency window positions in different type of coaches. It should be displayed properly. Passengers should also be counseled.

Pantry staff should keep the pantry stove plat form clean and no foreign material shall be left on it.
Do not stack material in pantry car corridor it should be clear for easy movement in case of any emergency exit.

Do not keep bed rolls, etc. in vestibules, for easy movement in case of any emergency exit. It can also be a source of fire if any lighted cigarette/bidi, match stick etc. is thrown by passengers.

Do not throw waste material (polythene bags, wrappers, papers etc. near/out side the dust bin/ in vestibule. These materials may also be a source of fire if any lighted cigarette/bidi, match stick etc. is thrown by passengers.

Do not store inflammable material like news papers, empty paper boxes in the pantry as these items may add as combustible material in case of fire which may intense the fire.
Do not keep combustible material like poly bags, paper, edible oil etc. near electrical panel/switch board in pantry.

Do not allow smoking in the train, if you see any person doing so stop him immediately.

Do not plug extra load/ loose wire on socket provided in pantry car or in mobile charging socket.
Do not allow any un-authorised vendor in train or at platforms. Check all vendors for their material to check cigarettes/ Bidi etc. with them.

Ensure availability of hammer in hammer box provided for breaking window glass in any emergency. The glass cover shall be of **slide type** so that it can be removed easily whenever required.

Do not fix hammer as shown, it will take time and require screw driver to remove in case of any emergency.

Ensure availability of fire extinguishers at easily visible and accessible places. They shall not be placed in **locked cupboards**.
Do not hang any material/bucket etc. on LPG pipe lines in pantry cars.

Ensure the isolating cock of LPG line is in **OFF** condition when not in use in pantry car.

Do not keep inflammable material like edible oil tin/can etc. near gas burner/stove.

Ensure proper instructions for opening emergency window are displayed (painted/stickers) near emergency windows.

Don’t keep empty cartons, gunny bags, plastic crates/bags or other material in LPG chamber.
CHAPTER 7

ANALYSIS OF FIRE

7.1 ANALYSIS OF FIRES ON COACHING STOCK

The causes as established by investigation should be analyzed to identify areas requiring design/layout/material modifications, preventive maintenance and supervision. To build up the history of fires as a guide for the new builds, it is necessary that proper records of fire accidents shall be maintained. The proposed format is given below:

<table>
<thead>
<tr>
<th>Coach No.</th>
<th>Type of Coach</th>
<th>Coach manufacturing year</th>
<th>Date of last Major Schedule</th>
<th>Date of last depot attention</th>
<th>Date of fire/smoke</th>
<th>Location of fire/smoke</th>
<th>Extent of damage</th>
<th>Method used for fire extinguishing</th>
<th>Any casualty / injuries</th>
<th>Brief reasons for fire</th>
<th>Whether enquiry conducted</th>
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</table>

7.2 INVESTIGATION OF FIRE – ELECTRICAL POINT OF VIEW

1. Open a file or folder to maintain the details of investigation.

2. Collect the details of each failure for study/ investigation such as

   - Make of the equipment/ component failed first.
   - Date, time, place of failure.
   - Date of installation, previous maintenance schedule & repairs.
   - Name of operator.
   - Try to identify cause and effect.
   - Keep note about the observation, with photographs.
   - Make list of probable causes.
   - Examine similar component in other equipment in service.
   - Study the following documents carefully.
     - Operating & maintenance manuals.
- Manufacturing drawings.
- Failure reports & photographs, if any of previous incidence.

- Keep an open mind until all the data are collected.
- Discuss the failure with other field personnel.
- Interrogate the person who first detected the fire to localize the starting point.
- Check the condition of MCB & fuse boards, whether these are operated or not.
- Check and locate the point of wiring portion where molten or congealed shows sign of arcing.
- The observation shall be made as early as possible after the fire has been extinguished.

**CONCLUSIONS**

Detailed investigations on several cases of fires on passenger coaches during the last few years have been carried out by the concerned CRSs, Railways and RDSO. In some cases, it quite often becomes difficult to pin point the exact causes due to extensive damage, and only general observations are available. It is equally important to investigate every case of even smoke emission, which can lead to fire.

The entire process of the mechanism of fire, its outbreak, prevention, fire extinguishing methods and method of evacuating passengers is complex. The complicated phenomenon of fire is not reproducible in model experiments regardless of how they are carried out. The preventive measures as detailed in this book, therefore, are by no means exhaustive and the various provisions will need updating and amplification from time to time based on the actual experience.

**NOTE:**

**ALL THE MODIFICATION SHEETS (MS) AND SPECIAL MAINTENANCE INSTRUCTIONS (LATEST VERSIONS) ISSUED BY RDSO FROM TIME TO TIME WITH RESPECT TO PREVENTION OF FIRES SHOULD BE FOLLOWED.**
Intensive publicity campaigns to prevent the traveling public from carrying inflammable goods to be undertaken regularly in addition to provision of stickers.
Handbook on Fire Causes and Preventive Measures in Railway Coaches

March, 2015
Paste stickers over FDB cover showing instructions not to insert waste material inside it.

Paste stickers on emergency window and ensure that they are in good condition.

Paste stickers near alarm chain and ensure that they are in good condition.
Paste stickers at various locations for cleanliness in the coaches and ensure that they are in good condition.
REFERENCES

1. CODE OF PRACTICE FOR TRAIN LIGHTING MAINTENANCE ON PREVENTION OF FIRES ON 110 V DC SG COACHES NO. EL/TL/56-1992 ISSUED BY RDSO.

2. CODE OF PRACTICE FOR PREVENTION OF FIRE IN AC COACHES NO. RDSO/PE/O/0008-2005 (Rev.0), October 2006 ISSUED BY RDSO.

3. CODE OF PRACTICE FOR PREVENTION OF FIRES ON EMUS & MEMUS NO. RDSO/PE/CP/EMU/0001-2003 (REV. 0) AUGUST 2003 ISSUED BY RDSO.

OUR OBJECTIVE

To upgrade maintenance technologies and methodologies and achieve improvement in productivity, performance of all Railway assets and manpower which inter-alia would cover reliability, availability, utilisation and efficiency.

If you have any suggestions and any specific Comments please write to us.

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