

**GOVERNMENT OF INDIA
MINISTRY OF RAILWAYS**

CODE OF PRACTICE

FOR

PREVENTION OF FIRES

ON EMUs & MEMUs

No. RDSO/PE/CP/EMU/0001-2003 (Rev. 0)

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ISSUED BY

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CONTENTS

S. No.	Description	Page No.
1.0	Forward	2
2.0	Prologue	3
3.0	General	6
4.0	Part – I - Mechanical	7
5.0	Electrical (General)	11
6.0	Electrical – for AC EMUs & MEMUs	14
7.0	Electrical – for DC EMUs	17
8.0	Rescue Measures	21
9.0	Part - II - Maintenance Practices	23
Annexure - I	Clearance / creepage distance	28
Annexure – II	Analysis of fires on EMU stock	29

1.0 FORWARD

- 1.0 RDSO had issued the “Code of Practice for Prevention of fires” in the year 1980 for implementation by the Coach Builders as well as by the maintenance sheds, which was revised in October 1991. Over the years, after detailed discussions with the coach manufacturers, equipment suppliers and maintenance staff, need for review of the Code had been felt, primarily on account of practical difficulties in implementation of certain provision of the code, and also due to availability of engineering materials with improved properties. Accordingly, the present code is being revised as a second Revision to the Code issued in 1980 and issued as code no. RDSO/PE/CP/EMU/0001 – 2003 (Rev. 0) for implementation.
- 2.0 Detailed investigations on several cases of fires on both EMUs & MEMUs 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 pinpoint 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.
- 3.0 Systematic analysis of the causes of the fires have highlighted the need for complete review of the coach furnishing materials, cable insulation, design of equipments, protection system, workmanship by coach builders and repair and maintenance practices followed by the car sheds and the POH workshops. Through several discussions held among the Railways, Production Units and RDSO, various measures have been identified. Most of the measures are already detailed in the Particular Specification of the EMU/MEMU stock and other measures have been issued as instructions from time to time.
- 4.0 The purpose of this Code is to consolidate the various measures for prevention of fires at one place, so as to act as a ready reference to the designer, Coach Builders and repair and maintenance staff not to ignore these issues. 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 the Code, therefore, are by no means exhaustive and the various provisions will need updating and amplification from time to time based on the actual experience.
- 5.0 This code should be followed in conjunction with the Indian Electricity Act, 2003 and its associated Rules. All the Modification Sheets (MS) and Special Maintenance Instructions (SMIs) issued by RDSO from time to time w.r.t. prevention of fires should also be followed.

2.0 PROLOGUE

- 2.1 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 assumes great importance and is unavoidable, however expensive or intensive the steps required may be.
- 2.2 A train fire is greatly 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. The horrific speed with which a blaze can spread when some inflammable materials are used, has given rise to great concern. The following points summarise 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.
- 2.3 Fires in coaches could be broadly classified under two causes viz.,
- (i) Due to electrical origin (either in protected zone or unprotected zone) and
 - (ii) due to external causes.

Electrical origin of the fires could be due to short circuit, fuse failure, failure of the insulation due to deterioration, mechanical damage, local heating due to

loose / defective joints and loose connection, flashover, applications of abnormal voltages, etc. The potential of causing a fire depends largely upon the efficiency of the protection system.

The fires due to external causes are numerous and often do not occur, unless due to carelessness, unawareness of the consequences, and ignorance on the part of the passengers.

- 2.4. The problems of fires on coaching stock may be broadly tackled by ensuring the following aspects in design, manufacturing and maintenance: -

2.4.1 **Prevention:**

Prevention is better than cure, and therefore by use of suitable materials, protective devices, proper designs and layout, prevention of outbreak of fire should be aimed at. To prevent the fire from spreading, it is extremely important that: -

- (a) Furnishing materials shall be fire retardant, and as per the relevant specifications.
- (b) Complete protective arrangement on the circuits and sub-circuits is made such that isolation of any protective arrangement in service is prohibited.
- (c) In the unprotected zone such as pantograph, provision of adequate insulation is made (to avoid cases of stray wires shorting the pantograph and the coach body).
- (d) Protection against power arcs is provided
- (e) Prevention of hiding places in design for storing / carrying of probable sources of fire such as inflammable materials like kerosene, petrol, stove, etc. by the passengers. The electrical switchboard, cable joints etc. should be easily accessible for maintenance and detection of fires.
- (f) Provision of compartments and resistance to prevent the spread of fire.

2.4.2 **Spread of fire :**

In spite of the best possible preventive measures, the chances of fire cannot be ruled out. Therefore should a fire take place, the spread of fire and damage should be restricted. This calls for incorporation of special design features as well as use of suitable materials to reduce the combustibility of the coach furnishing and other materials such as cable insulation, switch cabinet etc.

2.4.3 Fire fighting:

A suitable built-in fire fighting system should be provided, so that in the event of a fire breaking out, it can be tackled in the minimum possible time.

2.4.4 Rescue measures:

Small fires sometimes cause disproportionately heavy loss of life due to panic among the passengers. It is, therefore, necessary that provision of adequate rescue measures be made as a part of the measures for prevention of fires. Procedure to be followed by the train crew in stopping the train, and safety instructions to the passengers need to be laid down unambiguously.

2.4.5 Investigation of fires on AC EMU motor coaches.

RDSO's report on investigation of fires on AC EMU & MEMU motor coaches no. ELPS/Report/EMU – 05 of March 1997 shall also be referred and followed.

3.0 G E N E R A L

3.1 Scope

This code lays down the guidelines for prevention of fires on EMU stock. It is divided into two parts: -

Part-I Instructions regarding measures for the prevention of fires on the newly built EMU & MEMU stock

The scope of these instructions cover the use of materials, protection system, system of wiring and workmanship, with a view to preventing occurrence & minimizing the fires and localizing the effect of the fires, should they take place. Measures to enable quick rescue of the passengers affected have been also included.

Part-II Instructions regarding measures for the prevention of fires on EMUs & MEMUs already in service.

The scope of these instructions cover the good maintenance practices, satisfactory workmanship during repairs and various preventive steps to be taken during routine maintenance of coaches in car sheds and POH in workshops.

3.2 Implementation of the Code

Guidelines for use of specific coach furnishing materials, cables and another accessories have been indicated. Production units will ensure that only materials of approved standards are used. In case it is not possible to use the materials specified due to certain reasons, specific approval of RDSO may be taken. The provisions of the code are obligatory for the new builds.

4.0 P A R T – I

INSTRUCTIONS REGARDING MEASURES FOR THE PREVENTION OF FIRES ON THE NEWLY BUILT EMU & MEMU STOCK

4.0 MECHANICAL

4.1 General

The coach shell should be made of steel. Furnishing material used for enhancing passenger comfort should be fire retardant. The test prescribed for flame retardance is similar to the test prescribed in the IS or UIC -564-2 code or better. Use of readily inflammable materials should be prohibited. Use of wood is strictly prohibited.

4.2 Inside Panels

- (a) Sidewalls, partitions and semi-bulk heads shall be panelled with laminated plastic (LP) sheet as per RDSO STR No. C - 9602. The sheets shall be procured from the list of the approved suppliers issued by RDSO.
- (b) The inside panels in the LT / HT compartment shall be IRS - M - 41 sheet.

4.3 Ceiling

- (a) The ceiling of the coach shall be of flexible non-metallic heat insulating paneling such as limpet asbestos sheet to RDSO STR No. C-8105 or NFTC sheet to RDSO STR No. C-9511.
- (b) The ceiling of the passenger compartment below the pantograph shall be provided with 10 mm thick asbestos millboard.
- (c) The ceiling of HT / LT equipment compartment shall be of IRS-M-41 sheets.

4.4 Seats

4.4.1 First Class

- (a) First class seats shall be mounted on the metal frame.
- (b) Polyurethane foam cushions for seats and backrests as per RDSO's STR No. C-8914 shall be used.
- (c) Covering material shall be as per RDSO STR No. C-9503.

4.4.2 Second Class:

- (a) The seats shall be mounted on the steel metal frame.
- (b) Seats and backrests shall be as per RDSO STR No. C-9407

4.5 Packing Rings for Axle Box Guide Arrangement :

Packing Rings shall be either ultra high molecular weight Polyethylene (UHMWPH) Natural Fiber Thermo set Composite (NFTC) confirming to RDSO STR No. C – 9703.

4.6 Fire Barrier

4.6.1 The end-to-end through passage in the coach shell helps in the propagation of fire due to “ flue effect.” The coach structure shall, therefore, be such that continuity of this through passage is broken as much as possible. Generally, the following guidelines shall be followed.

- (a) Openings in the car lines adjacent to the doorways, above the partitions between the HT/LT compartment and passenger compartment shall be blocked by 1.6mm thick Steel to IRS M-41.
- (b) In case ducting is provided below the ceiling for cable conduits and mounting of the fans, the continuity of these ducting shall also be broken at the locations adjacent to the doorways and above the portion between the HT/LT compartment and passenger compartment. The car lines openings at which conduits etc. passes shall be suitably plugged / sealed.

4.6.2 With a view to retard the spread of fire, the continuity of the roof ceiling and side paneling shall be broken by provision of steel barriers at the following locations.

- (a) Near the coach end panels
- (b) On either side of the doorways, wide enough to cover the portion up to which door slides.

The location of the various barriers shall be generally to RDSO's sketch no. 78069 and 78089 enclosed. The builders shall prepare their own drawings based on the RDSO drawings mentioned above and submit the same for approval. The fire barriers shall be of Stainless Steel.

4.7 Floor

- (a) The floor of the coaches excluding LT / HT compartment shall consist of aluminum–chequered plate as per RDSO STR No. G-8217 or chequered sheet as per RDSO STR No. C-9407.
- (b) The floor of LT/ HT compartment shall consist of steel galvanized chequered plate of approved quality laid directly on the steel support secured to the corrugated steel floor sheet.
- (c) The corrugated steel floor sheets shall be epoxy painted comprising of:
 - (i) Epoxy zinc phosphate primer to RDSO spec. no. M&C/PCN/102/96
 - (ii) Epoxy micaceous iron oxide to RDSO Spec. No. M&C/PCN/103/88
 - (iii) Epoxy chemical resistant paint to RDSO Spec. No. M&C/ PCN/104/88
- (d) 8 mm comprag board slates to RDSO STR No. G-9407 may be used as padding below the aluminum-flooring sheet
- (e) The openings in the flooring for the passage of pipes and cables through the floors shall be constructed as to prevent any seepage of the oil and in addition give effective protection against the spread of any fire originating beneath the body.
- (f) Where theft of aluminum-chequered plates is reported especially for the doorways, as an anti-theft measure, chequered sheet as per RDSO STR No. C – 9407 may be used.

4.8 Provision of heat insulation for the partitions of equipment compartment:

The partitions comprising the equipment compartments and the passenger portion shall be suitably heat insulated. For this purpose an air gap of at least 30 mm shall be provided between the sides panels of the partitions and this space shall be filled up with fibre-glass crown 150 or similar material approved by RDSO.

4.9 Provision of partitions :

Coach layout shall be such that provision of unnecessary partitions shall be avoided. Requirement of the partitions is dictated by the local traffic needs of the Railways who will arrange the accommodation on the rake in such a way that minimum numbers of partitions are required. The partitions shall, however, be so arranged that at least two doorways aside are available for each partitioned compartment, wherever seating accommodation is fifty or more.

4.10 Painting:

Painting inside the equipment compartments shall be done with fire retardant paint of approved quality. RDSO's SMI No. ELRS/SMI/115 shall be strictly followed for painting inside the equipment compartments.

4.11 Notices:

Notices to warn passengers regarding fire precautions shall be fixed in each compartment at the locations shown in RDSO's sketch no., 76240 enclosed.

5.0 ELECTRICAL - (General)

The following points are applicable to all EMUs & MEMUs :

5.1 General

- (a) All the main equipments should have their names written on them.
- (b) For holding and bunching the cables, cable ties having fire retardant properties, shall be used. For insulating the cables / cable supports wherever necessary, PVC adhesive tape conforming to IS: 7809 Pt. III Section I shall be used. The thickness of the tapes shall be 0.25 mm. Tapes with backing material as cloth or equivalent and meeting the test requirements (especially fire retardant properties) to IS: 7809 Pt. II can also be used.
- (c) Resin bonded fiberglass coated with anti-tricking compound shall be used.
- (d) Ordinary wood / wooden cleats shall not be used anywhere. All the wooden boards, blocks and cleats used in the wiring or in the vicinity of the wiring shall be painted with two coats of fire retardant paint as approved by RDSO. The following fire retardant paints are approved by RDSO and they only shall be used for painting cleats and wooden blocks and other wooden boards in the vicinity of wiring in coach.
 - (i) Acrylic superlac plastic emulsion paint of M/s. Shalimar.
 - (ii) Fire retardant paint, light grey of M/s. Jonson and Nicholson.
 - (iii) Mica base fire retardant paint of M/s. Central Glass & Ceramic Research Institute.

5.2 Application of IE Act 2003

The designer, manufacturer and maintainer of EMUs / MEMUs shall ensure compliance to the Indian Electricity Act 2003 and associated Rules to ensure safety of the passengers.

5.3 Batteries

Batteries constitute a fire or explosion risk (because of generation of hydrogen and oxygen) when they are being given heavy charge. It is therefore important that adequate ventilation is provided in the battery box. Ventilation shall be provided at a height of not less than 30 mm above rail level

5.4 Junction boxes

- (a) MCBs and emergency lighting relays generally located in the end panel of the coach shall be housed in a box of air tight construction, to prevent dust and moisture entry and also to confine a fire, if any, inside the box.
- (b) Single DIN type channel for individual MCBs as per RDSO's specification no. E – 12/1/04 of March 1992 with the extended terminal for connection of cables with crimping circuit shall be used. For this purpose RDSO drawing no. RDSO / SKEL – 3700 shall be referred.
- (c) Train line wires shall be terminated on the end panels in a box of water-tight construction for preventing dust and water entry.
- (d) Train line wires should be run in metallic conduits below the roof. Sufficient space shall be provided between conduits to enable easy coupling and uncoupling.
- (e) Not more than 3 terminations should be made in one stud of the terminal board.

5.5 Protection system

Complete protection against short circuits, overloads, earth faults and over-voltages shall be provided to ensure that faulty sections are isolated from the supply system automatically. In addition to other protective devices as may be necessary for safe and correct operation, following essential protective features shall be provided.

5.6 Electrical clearances

While designing the layout, adequate care should be taken to ensure minimum clearances to earth from the live parts. The recommended creepage distances and clearances shall be as per Annexure – I.

In case due to certain constraints, it is not feasible to adhere to the clearances indicated in Annexure – I, the effected parts will be adequately insulated with glass fibre tape as approved by RDSO.

5.7 Cables

5.7.1 Insulation

The insulation of the electric cables shall have fire-retarding properties. The cables will be procured as per RDSO's specification no. E-14/01 (Rev. II) or

latest from approved suppliers laid down by RDSO. The cables as per this specification shall be used both for new builds as well as rewiring of the existing stock. The use of HRPVC cables or elastomeric cables covered by RDSO's specification number E-14/01 (Rev. II) or latest will be governed by the guidelines laid down by RDSO from time to time.

- 5.7.2** The sizes of the cables shall be determined by taking into account the maximum safe conductor temperature. The layout and arrangement of cables and the max. continuous or intermittent circuit current should be under day-to-day operating conditions. The minimum size of the cables shall also be determined by considerations of mechanical strength and reliability in the operating environment.

- 5.7.3** The current carrying capacity of all the cables shall be such that they will safely withstand the rupturing current of the fuse or the breaker on the live side of the circuit of which they form a part.

5.8 Layout of wiring

The quality, workmanship and the layout of the wiring shall be of the highest standard so as to ensure long life of the wiring. All precautions shall be taken to prevent damage to the insulation in service. The wiring in the passenger portion of the coach shall be in metallic conduits.

5.9 Guide line for wiring

RDSO Code no. ELPS/CP/EMU/02 for Code of Practice for Electrical Wiring on Electric Multiple Units issued in December 1993 or latest shall be strictly followed on all EMUs & MEMUs.

5.10 Anti - theft measures

Many cases of fire have taken place due to short circuit caused by miscreants while attempting theft of the equipment. Therefore, while finalizing the layout theft proneness of items should be kept in mind, and equipment should be so located that pilferage is made difficult. Based on service experience, anti-theft measures are being decided upon from time to time, which should be implemented on the new builds as well as on the stocks in service as directed by RDSO. RDSO has issued various anti-theft modifications in this regard.

6.0 ELECTRICAL - For AC EMUs and MEMUs

The following points are applicable for all AC EMUs & MEMUs :

6.1 Protection of main power circuit

- (a) 400 MVA, 25 kV, 50 Hz rating single bottle vacuum circuit breaker or air blast circuit breaker shall be provided as close to the pantograph as possible.
- (b) Surge protection : A gapless lightning arrestor as per RDSO's Spec. no. E – 1/ 2/ 05 (of latest revision) of approved make shall be provided on the roof each motor coach in between VCB/ ABB and cable head.

6.2 Protective Relays / Equipments

- (a) **Primary overload relays** - One primary overload relay shall be provided in the power circuit to interrupt the supply through the tripping in VCB/ ABB in the event of the overloading on the HT side of transformers.

Mounting of CT for OLP - Presently the CT is mounted on metallic bracket on the condenser bushing. On a few coaches, it was observed that the bracket does not have adequate clearance from the bushing surface. Since the bracket is at earth potential reduced clearance will have adverse effect on the working of the bushing. Clearances as low as 2-3 mm only have been noticed. It is desired that minimum clearance of 10 mm shall be maintained.

- (b) **Transformer overload protection** - An overload relay to protect against a direct overload due to a fault in the rectifier or motor circuit or malfunctioning of tap changer shall be provided. Operation of the relay will cause tripping of VCB.
- (c) **Pressure Relief Valve** - In case of severe internal fault in the transformer the pressure may build up to a very high level and may result in explosion of tank. To avoid such a contingencies a Pressure Relief Valve (PRV) is fitted on the transformer. PRV spring loaded and has NO / NC contacts for tripping the VCB/ ABB.
- (d) **Overload relay** – Each motor shall be protected with overload relay, which will trip the individual motor contactor.

- (e) **Earth fault relay for auxiliary circuits** - A voltage sensitive type of relay which trips VCB/ ABB in the event of an earth fault in power circuit shall be provided.
- (a) **No volt relay** – For protection against the interruptions of the line voltage, a no voltage relay shall be provided which will trip the control circuit for the tap changer operation.
- (b) **Earth fault relay for auxiliary circuits** – Each auxiliary winding circuit of the transformer shall be provided with a voltage sensitive type of earth fault relay, which will trip Vacuum/ air blast circuit breaker in the event of earth fault on any part of the circuit.
- (c) **Rectifier Fan auxiliary relay** - This will prove the operation of the rectifier fan in case of forced cooled design of rectifiers. Feed to traction motors will be cut off in the event of operation of this relay.
- (d) **Current balance relay** – To detect faults on the main rectifier. This will open the motor contactors.

6.3 Transformer

Oil filled transformer represents a fire risk, which requires safeguards against fire and explosion. The main power transformer shall, therefore, be provided with:

- (a) Buchholz relay which in the event of an internal short circuit will trip air blast / vacuum circuit breaker
- (b) An explosion vent, in which a diaphragm can burst to allow the oil to release itself.
- (c) Over temperature relay.
- (d) Auxiliary windings protected by the fuses mounted close to the terminals of the windings.
- (e) Provision of Pressure Relief Valve (PRV) for tripping the circuit breaker in the event of a transformer fault with an indication of its operation to the motorman.

6.4 Piping for oil circuit

Steel piping shall be used as far as possible for the oil circuit with minimum number of joints. The joints shall be properly made so that no leakage takes place in service.

6.5 Location of auxiliaries having oil

All auxiliaries using oil for lubrication shall be ordinarily located on the under frame. In case it is necessary to locate the machine inside the coach the location shall comply with following:

- (a) HT & LT cables shall be kept away as far as possible, to reduce the deterioration of the cable insulation due to oil.
- (b) Appropriate trays should be provided below the equipment to collect the leaked oil.

6.6 Traction motor connection box

In order to ensure immediate operation of earth fault relay in the event of sparking due to loose connection in the motor connection box, the traction motor connection box should be metallic which is presently of glass – epoxy material. While changing the material, it is necessary that adequate creepage and air clearances as per Annexure-I shall be maintained so as to avoid nuisance tripping,

6.7 Use of higher size cable for connection of PFD

In the event of open circuiting of the field winding the traction motor current will be approximately 125 A on first notch. The cable used for connection from motor terminal to PFD should be 95 mm sq.(elastomeic). This cables gap over heated particularly on long duration of operation at shunt notch. Therefore to protect cable from burning or over heating the cable size shall be increased to 95 mm sq. RDSO's SMI no. ELRS/ 191 in this respect should be followed.

6.8 Protection of PFD resistance

For the protection of PFD resistance provision of 80 A fuse in series with PFD as per RDSO's modification sheet no. RDSO/ WAU/ 9 shall be followed.

6.9 Use of cable head arrangement

In view of failures of condenser bushings which need perfect vertical alignment and maintenance, it is decided to provide cable head type of arrangement to RDSO Specification no. EL/TP/E-13/6 (Aug 96).

6.9 Protection of transition resistor (RTL)

To prevent burning/ overheating of Transition Resistor (RTL), RDSO's modification sheet no. RDSO/ PE/ MS/ EMU/ 0022 (Rev. 1) or latest revision shall be followed.

7.0 ELECTRICAL - For DC EMUs

The following points are applicable for all DC EMUs :

7.1 Mounting of the Pantograph:

Mounting of pantograph on DC EMUs shall comply with the following provisions: -

- (a) The pantograph shall be located on the non-passenger portion, and should be so mounted that the maximum available clearance is attained from the passenger portion in its locked down condition. Pantograph shall be mounted on the insulated platform (false roof), the size of which shall be such that it extends at least 150 mm on either side when the pantograph is in locked down condition. Provision of asbestos millboard shall be extended 500 mm beyond false roof below the main roof.
- (b) The minimum clearance between the insulated platform and the roof shall be 70 mm.
- (c) The platform shall be of robust construction, so that it does not sag with load over time reducing the clearance referred to above.
- (d) The portion of roof below the pantograph shall be insulated with polyester resin bonded fiberglass as per RDSO's Spec. No. ELPS/SPEC/EMU/ 0028 (Rev.0) - 2002. The roof insulation shall extend to a distance of 600 mm beyond the edge of the roof fuse. The existing PCP sheets should be replaced with the above material in phased manner in all DC EMUs during POH.
- (e) The top of the pantograph platform (false roof) shall be insulated with polyester resin bonded fiberglass as per RDSO's Spec. No. ELPS/SPEC/EMU/0028 (Rev.0)-2002. The insulation shall be provided inwards on all edges of the platform to the extent of not less than 75 mm. The existing PCP sheets should be replaced with the above material in phased manner in all DC EMUs during POH.
- (f) The base insulators shall be so mounted so as to facilitate cleaning. In case the platform covers the base insulators, suitable arrangements such as cut-away or hinged type flaps approved by RDSO shall be provided, so as to expose the insulators to facilitate cleaning.
- (g) The catwalk shall conform to RDSO's Spec. No. C-9407 in new builds, and the existing catwalk shall be replaced on condition basis.

In addition, the electrical properties of the catwalk shall be as follows:

- (i) “The proof electric strength in the dry condition of the sheet for 1 minute shall not be less than 2 kV / mm when tested as per IS specification No. 2584 - 63”.
- (ii) “The electric strength of the sheet after completely immersed in water for 24 hrs. as specified in IS : 2584 – 63 shall not be less than 1.5 kV /mm thickness. “
- (h) Any roof ventilator coming in the insulated zone as specified in (b) above shall also be insulated with the materials mentioned in relevant portion.

7.2 Roof fuse box

Arc resistant cement asbestos board as per BSS : 3497–1967 shall be provided on the roof surface in front of the roof fuse box, to prevent any damage to the roof during rupturing of fuse. The board will extend at least 150 mm on either side of fuse box and 450 mm in the front.

7.3 Electric Heat Generating Equipment

7.3.1 Starting and braking resistance of DC EMUs

In case the starting & braking resistance are mounted inside the coach, they shall be housed in sheet steel cubicles complying with the following provisions:

- (a) The partition between the passenger portion and equipment compartment will not form part of resistance cubicle. The sides of the cubicle shall be independent of the partition and a gap of at least 150 mm will be provided between the partition and the cubicle.
- (b) The inside of the cubicles shall be lined with sheets of non-inflammable heat-preventing material on the bottom, top and sidewalls. For this purpose, 6 mm thick asbestos mill board or heat resistant cement asbestos board shall be provided on the side-walls wherever top and bottom is a curved surface. FRP sheet conforming to fire retardant properties and with suitable thickness shall be provided.
- (c) The ventilation ducting where they pass through the roof, shall be covered with asbestos rope on the outside.

- (d) The clearance of the resistance banks from the walls of cubicles shall be as under: -

(a)	Side walls	-	75 mm
(b)	Bottom	-	150 mm
(c)	Top	-	150

7.3.2 Auxiliary Resistance

Auxiliary starting resistance for 1500 V DC compressor motor and MG sets shall also be housed in sheet steel cubicles, and shall comply with all the provisions laid down above.

7.3.3 Resistances mounted on the under frame

The resistances mounted on the under frame shall be housed in the sheet steel boxes. The clearance between the top of the box and under surface of the floor shall not be less than 150 mm.

The top of the box on the inside shall be lined with non-inflammable thermal insulation as indicated in 4.4.1 (b) with thickness not less than 6 mm. However, in case of Head light resistance being operated at low voltage, lining with non-inflammable thermal insulation is not necessary.

7.3.4 Electrical Distribution wires

The insulation of cables used for thermostat should be of heat resistant (PTFE insulated cable) and shall be drawn through flexible metallic conduits inside the HT compartment. The conduits above the HT resistance cubicle shall be covered with asbestos rope for safeguarding against excessive heat.

7.3.5 Other resistances

Other resistances such as battery resistance etc., if not mounted inside the sheet steel boxes, shall be so located that these are away from the wiring and other equipments.

7.3.6 Cooling of the Resistances

The natural cooling arrangement of the main resistance shall be such that it will give chimney effect. Sufficient opening on the side panels will be provided for drawing in of fresh air. For improved cooling arrangement, RDSO's drawing no. RDSO/ SKEL – 4043 shall be referred.

7.4 Protection of main power circuit in DC EMU stock

- (a) Roof fuse close to the pantograph shall be provided as a back up protection.
- (b) Surge protection - A lighting arrestor of RDSO approved design shall be provided with non – metallic material.

7.4.1 Protective Relays

- (a) **Over load Relay** - Each pair of the traction motor shall be protected by an overload relay which will open the line switches.
- (b) **No current / No voltage Relay** - This will open the line switches in case the interruption of the line supply.
- (c) **Thermal Relay for resistance cubicle** - Each resistance cubicle will be provided with a thermal relay of approved design which shall be set to trip between 150° C to 175°C and shall interrupt the control supply to line switch in case the temperature rises above this limit. The thermostat should be provided at the outlet of the ventilating air for resistance. RDSO has approved Danfoss make thermostat No. RT – 120 X – SC .
- (d) **Current Balance Relay** - RDSO approved design of Current Balance Relay shall be used to detect the earth fault on the power circuit. Operation of the relay will result in opening of the line switches.

7.5 Protection of auxiliary circuits

- (a) Protection of auxiliary circuit shall be done with HRC fuses and miniature circuit breakers (MCB). Miniature circuit breaker up to 60 Amps. Rating of approved make shall be generally used for protection of sub-circuits while for main circuits HRC fuses shall be used. The sizes of fuses and MCBs shall be properly related with the cable size and the loading of the circuit. The complete protection scheme shall have the approval of RDSO.
- (b) All MCBs and fuses shall be provided at the origin of the circuits which may be protected

8.0 RESCUE MEASURES

8.1 Communication between motorman and guard

- (a) Inter communication between the guard and the motorman shall be provided through a bell code. A separate signal bell shall be provided for this purpose in every driving cab. In addition to the normal signal bell system, arrangement shall be provided to make use of passenger alarm bell (Clause 3.3) in case of normal signal bell fails.
- (b) The above equipment shall be capable of being operated even when there is power failure.

8.2 Communication between passenger and motorman / guard

- (i) A passenger emergency alarm communication consisting of bell electrically operated by pulling alarm handles shall be provided on EMUs in each passenger and luggage compartment. The bell shall sound simultaneously in all the driver cabs in the train, and shall be efficiently loud to be heard above the noise of the train when traveling through tunnels and cuttings and shall ring continuously till switched off. The arrangement of the alarm system shall be generally to RDSO sketch no. 74153 (enclosed.)
- (ii) The alarm system shall be provided with external indicators on one end of each coach on both sides, which shall give a visual indication of the coach from which the alarm handle has been pulled.
- (iii) The electrical circuit for the alarm bell shall be duplicated and two wire shall be carried in different inter - vehicular couplers.
- (iv) The system shall be capable of being operated even when there is power failure.

8.3 Indication of emergency equipment

Indication boards with essential instructions for equipment which can stop the train in any emergency on operation by passengers shall be prominently displayed.

8.4 Fire fighting arrangement

In spite of good protective system as well as improved layout, cabling and equipment, the possibility of fire can not be ruled out and therefore, in the event of any fire breaking, the same should be adequately dealt within the minimum time by a suitable fire fighting system design.

- 8.4.1 Provision of one dry chemical powder (DCP) type fire extinguisher in each motor coach (in equipment compartment in AC EMUs / MEMUs and HT compartment in DC EMUs), and two DCP type fire extinguishers in each driving cab occupied by the motorman / guard shall be ensured on all EMUs and MEMUs. In the driving cab of AC EMU / MEMU the mounting of fire extinguishers shall be in between LT compartment door and LT cupboard (Relay panel). For DC EMUs these may be mounted at a suitable location behind the guard seat in Driving trailer coach.
- 8.4.2 Portable 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 cupboards.
- 8.4.3 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 and refilling date.

8.5 Portable ladders

Two numbers of aluminum portable ladders shall be carried in each driving cab occupied by guard and motorman to enable passengers to get down in case of emergency. Proper fixing arrangement for the ladders with anti theft arrangement shall be ensured.

Part II

MAINTENANCE PRACTICES FOR PREVENTION OF FIRES ON THE EMU / MEMU COACHES IN SERVICE

1.0 General

Part I of the Code lays down the guidelines for the new builds. If adequate care is taken at the building stages, chances of fire occurrence will be less, and the damage caused will be very much reduced and localized should a fire take place. However, in spite of the precautions taken at the coach building stage, constant vigilance is required by the maintenance staff to prevent occurrence of the fires.

2.0 Preventive Maintenance and Inspection

Carry out the maintenance of the equipment with care as per the schedules laid down. Malfunction of the equipment can lead to fires due to flashovers, earth faults, etc.

3.0 Maintenance of Protection System

- (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. Check calibration of MCBs during POH. Use MCBs and fuses of only approved suppliers as laid down by RDSO.
- (ii) Ensure that all the protective relays are in good working order and are properly calibrated. Do not by pass any protection on the running stock. All the relays should be calibrated as per the schedules laid down.

4.0 Transformer & capacitors

- (i) Oil removal from condenser bushing should be ensured.
- (ii) Dissolved gas analysis of transformer shall be carried out periodically in every IC schedule and above. Instructions contained in RDSO's SMI no. RDSO/ELRS/SMI/138 issued vide EL/3.2.1/3 of April 1991 shall be followed.
- (iii) Check of the capacitance value of all oil filled capacitors to ensure that the change in capacitance value is not more than 5% as per schedule.
- (iv) RDSO's SMI no. ELRS/ SMI/ 120, 121, 158, 159 and modification sheet no. RDSO/ WAU/ 01 should be followed.

5.0 Batteries

Batteries constitute a fire or 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.

6.0 Cleanliness of under frame

- 6.1 The exhaust from the compressors sometimes contains undesirable amount of oil mist which is blown on the under frame and bogie, and due to sparks from brake blocks, fires may take place. This area should be cleaned during schedule inspections as laid down.
- 6.2 Fire can also be caused by brake block sparks due to contamination of bogies and under gear, specially near the gear case, suspension bearing and lubricating points. It is to be ensured that these points close to the wheels are kept clean.

7.0 Topping up of lubricating oil

- 7.1 Care should be taken to prevent spilling of oil at the time of topping, and that there is no overfilling. The spilt oil may be a potential source of fire due to sparks from the brake blocks etc.
- 7.2 Proper shape of funnel should be used for topping of oil to prevent spilling of oil. Use of such funnels at outstation depots tends to be neglected and should be watched carefully.
- 7.3 Drains and overflows should be kept clean so that these are not choked and therefore ineffective.

8.0 Leakage in oil piping

Ensure that leakage in oil piping is obtained to at the earliest possible opportunity as the oil leakage will contaminate the surroundings and increase the risk of fire.

9.0 Brake Binding

Panic has been noticed to have been caused among the passengers due to smoke emission due to brake binding especially with composition brake blocks. Ensure that the brake system is maintained to the highest standard possible to minimise brake-binding cases.

10.0 Control Equipment Cubicles

The fires in control equipment cubicles are a problem and usually lead to considerable damage. A particular difficulty is the detection of fire and, therefore, the fire is likely to get a good hold before it is noticed. Ensure that improper maintenance of the equipment inside the cubicles is done and carefully looked for developing faults.

11.0 Tightness of Connections

A loose connection is a potential source of fire 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.

12.0 Repairs to Wiring

- 12.1 Use only approved quality of cables for repairs. Use proper size of cable. Undersized cables and unapproved type of cables should not be used even as a temporary expedient. Cable jointing should be prohibited and this instructions should be displayed prominently at the work place.
- 12.2 Proper care should be taken while laying down the new cables so that no damage to the insulation is caused. Repairs should be carefully carried out to that no damage is caused to other cables.
- 12.3 Condition monitoring of fuses as per RDSO's SMI no. ELRS/ SMI/ 76 should be followed.

13. Cleanliness of Electrical Equipment

- 13.1 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, bush bars, insulators and equipments is done during schedules as laid down to remove oil and dust particles.
- 13.2 Thorough cleaning of oil and oil soaked dust should be done from the equipment compartments and cables.

14. Insulation resistance test of wiring & equipments

In order to monitor healthy condition of insulation of wiring and equipments, insulation resistance should be measured periodically in sheds and during POH in shops and records kept coach-wise and equipment-wise.

15. Electro-Pneumatic & Electromagnetic Contactors

These contactors create an arc during normal operation. This arc is quenched by combined effect of arcing horns and arc chutes. A badly arced arcing horn or arc chute and grime covered arc chute is incapable of quenching the arc quickly inside a highly ionized and confined space. Therefore, ensure that arcing horns and arc chutes are properly maintained. Arc chutes should be properly fitted and may fall if not properly secured.

16. 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 as detailed in Part I should be kept in the sheds and shops, depending upon the requirements so that there is no temptation to the maintenance staff to use other non-standard materials.

17. Fire fighting system

- 17.1 Ensure that portable fire extinguishers are in working order and are available at the nominated places 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.
- 17.2 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 especially in vicinity of the apparatus which are alive. Following staff should generally adequately trained. The training programme may be decided by each Railway.
 - (a) Motorman, Guards,
 - (b) All Supervisors and skilled artisans of EMU Car Sheds and outstation depots.

They should be trained to be familiar with physical location of fire fighting equipment, correct method of operating the equipments and precautions to be observed, location of the Municipal fire bridges and how to summon them.

18. Technical Investigation of Fires

The possible causes of fires and preventative steps listed in Part I & Part II are by no means exhaustive. Based on the actual experience, the list will need to be amplified and updated.

Timely investigation of causes of fires is very essential. Every case of fires, even smoke emission, minor or major, irrespective of location, in power, control or auxiliary circuit, should be investigated very carefully, even though a formal enquiry in accordance with accident rules may not be called for. The causes as established by investigation should be analyzed to identify areas requiring design/layout/material modifications and tightening up of 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 be maintained. This should be done in every shed as per Annexure II.

ANNEXURE I

RECOMMENDED CLEARANCE / CLEPAGE DISTANCES FOR EMU STOCK

Volts	Creepage distance in mm			Clearance in mm		Dirty condition
	Clean	Clean & humid	Dirty Condition	Clean Condition	Clean & humid	
500	13	18	26	10	15	20
600	13	18	26	10	15	20
750	20	30	40	12	18	25
1000	25	37	50	15	23	30
1500	30	45	60	20	30	40
3000	60	90	120	30	45	60
11000	130	195	260	40	60	76
15000	160	240	320	50	75	100
25000	230	345	460	80	120	160, 270 for roof mounted.

Code of Practice for Prevention of Fires on EMUs & MEMUs
no. RDSO/PE/CP/EMU/0001 – 2003 (Rev. 0) of August 2003

Annexure – II

ANALYSIS OF FIRES ON EMU STOCK

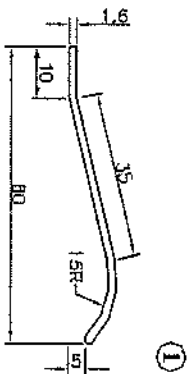
Coach No.	Type of stock	Date of fire/smoke	Location of fire/smoke	Extent of damage	Method used for fire extinguishing	Any casualty / injuries	Brief reasons for fire	Whether enquiry conducted	Classification
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- Note:** (i) Continuous record of the fire incidents shall be kept.
(ii) At the end of year, cause-wise / stock wise analysis will be carried out.

Classifications

1. Due to overheating of starting resistances.
2. Due to deterioration of the insulation of LT cables.
3. Due to deterioration of the insulation of HT cables.
4. Due to failure of the insulation caused by mechanical damage – LT cable
5. Due to failure of the insulation caused by mechanical damage – HT cable
6. Due to flash over of the EP contactors etc.
7. Due to flash over of the pantograph by stray wires etc.
8. Due to failure of the protection devices.
9. Due to spark / overheating from the brake block etc.
10. Due to external causes such as carrying inflammable material / throwing of cigarettes ends etc.
11. Due to any other causes not listed above.

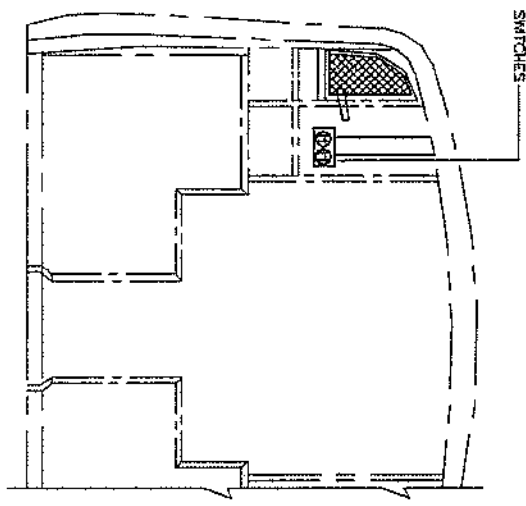
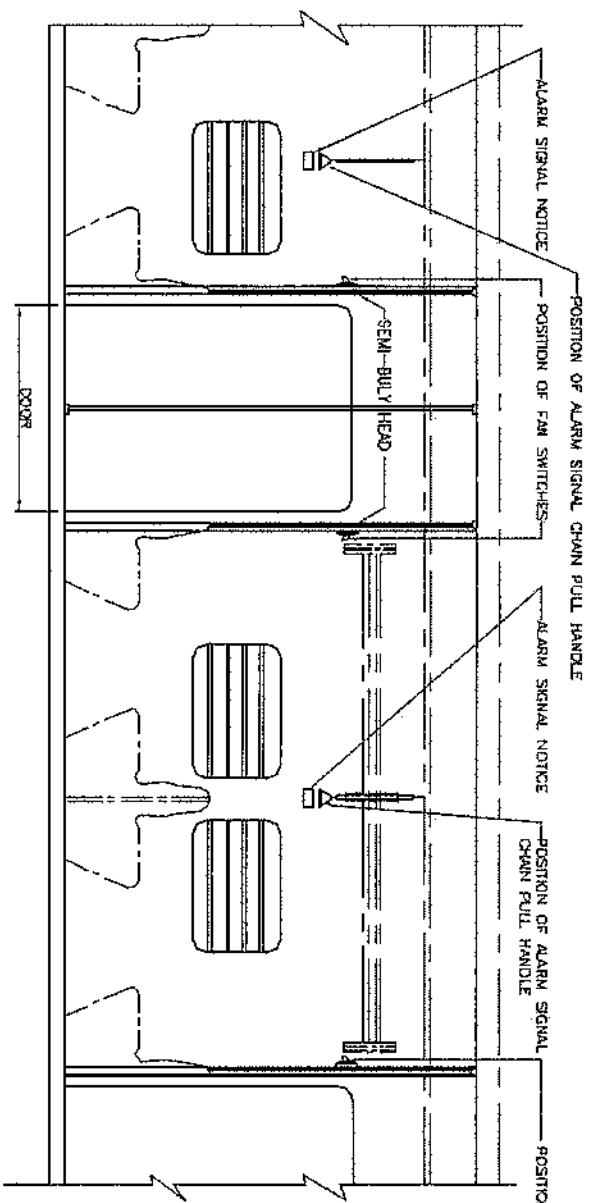
WRLY DRG. NO. SK/FP/51	SCALE- N.T.S.	APPROVED BY- FOR DG.
<p>PROPOSED VENTILATION FRAME FOR H.T. COMPARTMENT</p>		
RDSO, ELEC. DTE.	SKEL-4043	



DETAILS OF LOUVERS

NOTE:—

1. ALL ITEM SHOULD BE GIVEN TWO COATS ANTI-CORROSSIVE PAINT ALL OVER.
2. ALL JOINTS TO BE WELDED WITH FILLET CLASS 'C'.



①	-	REPAIRED	7/81
ACT. ITEM	ACT. ITEM	DESCRIPTION	DATE

CHECK SHEET No.		SUPERSEDED BY:-		EMD STOCK	
ASSEMBLY DRAWING:-		SCALE 1/8"		POSITIONS OF ALARM SIGNAL CHAIN PULL HANDLE AND FAN SWITCHES	
REFERENCE:-		B.G.		R.D.S.O. (C)	
		1		GROUP	
		0			
		J.S.			
				SKETCH 74153	