SN-419

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GOVERNMENT OF INDIA
MINISTRY OF RAILWAYS

TECHNICAL SPECIFICATION FOR FRP CAB INTERIORS FOR 25 KV CONVENTIONAL AC ELECTRIC LOCOMOTIVES

SPECIFICATION No. RDSO/2008/EL/SPEC/0058 (Rev. '1')

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Approved by	Signature
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Status of Revision

S. N.	Date of Revision	Page No.	Revision	Reasons for Revision
1.	---	All	0	First Issue (March' 2008).
2.	Jan' 2014	,,	1	- Rectification of typographical errors - Standardization of reinforcement layer of each type for given thickness of laminates. - Specified RTM in relevant drawings of FRP panels - Edited about selection of test specimen - Standardization of screw used in panel assembling - Deletion of panel handling & gel coat of hole - Deletion of Complete FEA - Standardization of fasteners - Deletion of Warranty clause - Deletion of matter in the FRP roof & FRP back wall - Edited Field trial - Standardized hinges used in FRP panels. - Edited full-scale steel superstructure of the drivers' cabin

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1.0 INTRODUCTION:

1.1 Presently, the interiors of the cab in conventional 25 Kv AC electric locomotives are traditionally designed having the items like drivers' desk, roof, doors, windows, floors & sidewalls made of metallic sheets. The ergonomically designed and improved interiors of the cab are felt essential to fulfill the need for reducing the level of fatigue in crew by designing the cab by using non-metallic materials and make it user friendly. The improved interiors can be achieved by using widely accepted FRP laminates and moldings. The overall design and applications will be required to meet the following criterion:

1.2 To provide a user friendly, ergonomically designed and aesthetically pleasing cabin which will reduce the driver's fatigue level.

1.3 To enable the use of materials in cabins this should have –

a) Good impact resistance.
b) High stiffness.
c) Fire retardant and non-toxic.
d) Long service life i.e. high abrasion and corrosion resistance.
e) Cabins should have long life with easy maintainability
f) Cabins should be airtight & rattle free.
g) Aesthetic considerations will be overriding and will integrate all the design factors.

1.4 The modular cabin is required to suit the space constraints of the different locomotives. The design should not impede the inspection & maintenance of various equipments inside the locomotive. Each locomotive shall be equipped with two nos. driver's cabin.

1.5 The location of cab equipments & instruments like brake valves, cab meters, gauges, switches, push button etc shall not be changed with respect to their present position in conventional locos. This is essential so that the crew should not feel inconvenience while working the locomotives with FRP cab interiors. The uniformity and ease in operation shall be maintained but the tenderer is permitted to make minor changes in the original design of the system to meet IR's requirements. However, this shall be done in consultation and with the approval of Railways.

1.6 The FRP laminates/mouldings and their fixation should be able to withstand the following operational requirement and must resist the inclement weather conditions without any defects/damage –

Temperature	: 0ºC to 60ºC (working) & 70ºC max.
Humidity	: 90% (max.)
Shock & vibration	: Longitudinal – 3g, Lateral – 2g & Vertical – 1g

The above level of vibration will be continuously observed. However, the intermittent maximum level can be up to 10 g.

2.0 SCOPE:

2.1 This specification deals with the major requirements as given below: -

- The raw materials for construction and their properties.
- Test schedules and their procedures at different level of testing.
- General lay out arrangement.
- Quality of workmanship.
- Schedule of technical requirements containing minimum infrastructural facilities and testing facilities required with the tenderers.
- Vendor approval, development & trials.

3.0 GENERAL ARRANGEMENT AND GEOMETRY:

3.1 Materials:

3.1.1 Materials shall consist of fire retardant thermosetting polyester resin with the combination of e-glass fibre in conformity with the properties given in BS: 4994/1973 or latest. The glass reinforcement materials shall be purchased from reputed brand with an internal test certificate. The glass material shall be in various forms e.g. Continuous Filament Mat (CFM), Wooven Roving (WR), Chopped Strand Mat (CSM), and Stitched Chopped Strand Mat (SCSM).

3.1.2 Resin system:

3.1.2.1 The resin for FRP bonding shall be fire retardant un-saturated polyester resin. No filler shall be used except those required for obtaining fire retardant properties. The heat distortion temperature of resin shall be more than 100ºC and nominal percentage elongation of the resin shall be more than 3%.

3.1.2.2 Neutral colour polyester resin system shall be used for GEL coated finish. This will not impart colour or tinge up during curing. The GEL coating shall be fire retardant. The GEL coating (solid surface) thickness should be 1.5 mm (min).

3.2 **Geometry**:

3.2.1 The dimensions of the FRP driver's cabin shall be such so as to suit Electric locomotives and shall be as per relevant drawings.

3.2.2 The reinforcement content specified for each thickness must be provided in terms of number of layers of WR and CSM or stitched chopped strand mat (SCSM) with specified surface density of the layers. The minimum reinforcement layers of each type for given thickness of laminate are given below:

Less than or equal to 4mm –Top layer of one finished Gel coat surface (Solid Surface) of 1mm thickness + 1 layer surface mat of 30 gm/m2.

More than 4mm - Top layer of one finished Gel coat surface (Solid Surface) of 1.5mm thickness + 1 layer surface mat of 30 gm/m2,

Rest of the thickness should be built up by using 600 gm/ m2 WR and 450 gm/ m2 Chopped Strand mat (CSM) or stitched chopped strand mat. At the most, two layers of CSM or stitched chopped strand mat should be sandwiched between alternate layers of WR.

3.3 The manufacturing process of FRP laminates and mouldings shall be done with Resin Transferred Moulding (RTM) techniques or otherwise as specified in relevant drawing. The manufacturers should have in-house facilities for the same.

4.0 TESTING:

4.1 The properties of FRP Laminates will be tested as per the schedule given below. These tests shall be done in the premises of manufacturers. Extended flanges are to be provided on the FRP laminates/panels and mouldings so that test specimen can be taken for carrying out the test at various stages. In absence of the flanges, the tests would be done on test specimens cut from the panels.

SN	Property	Quantum of Check	Reqd. value	Test Method	Type test	Acceptance test	Routine test
1	Specific Gravity	1 no. per Cabin	1.5 – 1.75	ASTM: D-792	✓	✓	✓
2	Tensile Strength – Min (N/mm^2)	-do-	80	IS:1998	✓	✓	✓
3	Elongation at break – Max	-do-	1.0%	IS:1998	✓	✓	X
4	Fibre Glass Content (w/w)	2 nos. per Cabin	35% (+ 5% - 2%)	IS:13411	✓	✓	✓

5	Water/humidity absorption	1 no	0.5% (max)	ASTM:D-570 or IS:1998 latest	✓	✓	X
6	Resistance to boiling water	1 no	To pass test	RDSO Specn No. C-8409 Annex-4	✓	✓	X
7	Resistance to impact/charpy shock (KJ/m^2)	1 no	40 (min.)	As per specn no. ICF/MD/ Spec-107 Rev 2. Jan'01 Annex A	✓	✓	X
8	Critical oxygen index	-do-	28 % min.	ASTM:D-2863	✓	✓	X
9	Smoke Density	1 no per cabin	Class A or B	UIC 564-2 OR Appendix 15	✓	✓	X
10	Toxicity	-do -	1.5 max	NCD 1409	✓	✓	X
11	Crack and Blister Test (Ink Test)	100%	Shall not show any crack in the surface coat	As per ICF/MD Spec–107 of 2001 or latest Annexure-B	✓	✓	✓
12	Barcol Hardness	5 nos/ cabin	40 min	ASTM D 2583	✓	✓	✓
13	Surface Finish (by 60 Degree Gloss Meter)	5 nos/ cabin	40 min	ICF/MD/Spec -107 (Rev 2)	✓	✓	✓
14	Visual Examination	100% of the lot	---	As per Clause 4.2 given below	✓	✓	✓

Note: - Test pieces are tested on GEL coat side.

- Tensile strength test will be done on samples which are less than or equal to 4 mm thickness.

4.2 **Visual defects**:

The surface shall be free from visual defects or any other surface defects. These defects are mainly termed as puffiness/blisters, cracks of surface, flakings, De-lamination of edges, Internal De-lamination, foreign inclusions, scaling, air bubbles, pimples, craters, porosity, resin pocket, resin rich edge, wash zones, scratches and mould mark.

The fibers coming out, burns and the crumbly zones are unacceptable. Gluey & tacky surface are forbidden.

5.0 FABRICATION & ASSEMBLY:

The different components of the cab shall be assembled by using stainless steel & recessed head screw. Panels with thickness of 6 mm or more should be assembled by using 6 mm stainless steel recessed head screw. Panels of thickness lesser than 6 mm should be assembled using 6mm stainless steel round head screws. Perforated stainless steel inserts shall be bonded to the panels wherever required for fixing the panels/laminates. The overall workmanship of the assembly shall be of highest engineering standards and highest level of engineering procedure shall be followed. During assembly due care should be given to the followings –

- Mechanical fixing of complex piece should be done by the application of metallic stainless steel inserts and/or integrated support on the pieces made of polyester should be used.
- Suitable jigs and fixtures should be used for drilling, coating, machining works during assembly and fabrication so that the correct installation and interchangeability of different pieces may be achieved.
- Tenderers should ensure uniformity in using the standard metallic inserts and other fixing arrangement.

6.0 SCOPE OF SUPPLY:

6.1 FRP Parts:

The following FRP items shall be supplied by the tenderer.

6.1.1 **FRP floor panels.** Floor paneling should be in three parts to facilitate easy maintenance of pneumatic pipelines at LH/RH side in cab and cabling in centre. It should be possible to remove the floor without dismantling the control desk. The floor panels shall be covered with at least 2 mm thick PVC incorporated with silicon carbide across its entire cross section so as to provide good anti-slip properties. However, floor panels covering with PVC sheet may be retained in single piece to have better aesthetics.

6.1.2 **FRP front wall:** This wall shall cover the full width of the cabin and shall be fitted with looking glass, driver's control desk etc.

6.1.3 **Left and right side walls:** These should be complete with looking windows, main doors and all other accessories as per Railways requirement.

6.1.4 **Control Desks:**

6.1.4.1 Each driver's cabin shall be supplied with one no FRP control stands which should provide easy access for maintenance of all the mechanical, electrical, control equipment and access to the wiring.

6.1.4.2 The control desk shall provide convenience and comfort to the drivers.

6.1.4.3 The control desk shall be in one part and shall not have any sharp bends, edges and corners.

6.2 **Other items in scope of supply:**

6.2.1 **Chairs**: Each Driver's cabin shall be supplied with two nos. rugged steel chairs with the following provisions:

- 360 degree rotation for easy ingress and egress.
- Height adjustment.
- Back rest and seat covered with foam cushion.
- Securing the base with the floor with suitable Mounting bolts.
- Front & back adjustments.

6.2.2 **Windows:** Side windows complete with glass, rubber sealing etc and fixing arrangement. The provision of tourve shutters should also be there.

6.2.3 **Reading lights with covers:** 2 nos. per cabin.

6.2.4 **Roof lights:** 2 nos. per cabin shall be provided.

6.2.5 **Door locks, Hinges, Latches, Handles etc.:** These shall be supplied by the tenderer as per the requirement. They should be of stainless steel. Box type locks having chiseled square head should be used which may open both from a screw driver or box spanner. Hinges used in FRP panels must be of stainless steel and should be continuous type.

6.2.6 **Looking glass:** Laminated toughened glass as per IS: 2553 shall be supplied complete with rubber sealing and fixing arrangement.

6.2.7 **Fasteners:** Fasteners used in FRP panel should be of stainless steel. CSK screw for thick FRP panel and oval head screw for thin FRP panel should be used.

7.0 SCHEDULE OF TECHNICAL REQUIREMENTS:

7.1 Tenderers must fulfill the minimum requirement in terms of manufacturing, testing facilities available with them as given below -

7.2 **Machinery, Plant, & Infrastructure**:

7.2.1 The manufacturers shall have adequate space and covered area with cemented floor to accommodate the following:

- Damp free place for storage of powder, chemicals reinforcement and other raw materials including bought out items.
- Independent manufacturing areas for various FRP components.
- Finishing, Assembly and inspection area.

7.2.2 The manufacturer shall have at least one Resin Transfer Moulding Machine and dispensing system material pump capable to develop up to 7.5 bar fluid pressure and 50 liter capacity.

7.2.3 The manufacturers should have a system to ensure that moulds are checked at regular intervals. They shall have adequate mould handling facilities like chain pulleys or electric hoist or any other suitable method for movement of heavy moulds.

7.2.4 Manufacturer shall have one GEL coating system with Spray gun.

7.2.5 The firm must ensure availability of a separate close space for spraying of Gel Coat Resin with required ventilation keeping in view the use of chemicals, which are toxic.

7.2.6 Manufacturer shall have compressed air arrangement of 10 kg/cm^2 with Air dryer attachment.

7.2.7 Manufacturer shall have one number oven (0-300^{0}C) with digital temperature indicators fitted with control panel for post or pre heating of moulds.

7.2.8 The firm shall have suitable tools, cutters, fine polishing files, drilling machine, Buffing Machine for de-flashing the moulded products.

7.2.9 Proper weighing facilities for measuring various raw material constituents should be available. One electronic weighing balance of minimum10 mg. accuracy and one mechanical weighing balance of 100kg. capacity and 0.2% accuracy shall be available.

7.2.10 The firm will ensure that one number full-scale steel superstructure of the driver's cabin is available at the firm's premises. Before the submission of prototype samples for field trials, the firm will be required to do the fitment of their product in driver's cabin available with them and have the same inspected and approved by RDSO / Railways before supplying the same for field trials.

7.3. **Testing Facilities**:

7.3.1 The manufacturer shall have one tensile testing machine of 2.5MT capacity having a least-count of 2.0 Kg or lesser with adequate speed of testing required for FRP components.

7.3.2 The firm shall have one Barcol impressor (Model No.934-1) for conducting hardness test.

7.3.3 The firm shall have electronic balance (least count - 0.0001 gm) with density determination kit.

7.3.4 The firm should ensure that arrangements are available for resistance to impact test.

7.3.5 The firm should ensure that the arrangements are available for measuring water absorption percentage.

7.3.6 One muffle furnace (800^0C) with digital temperature controller and indicator required for glass content determination should be available.

7.3.7 Bunsen burner and necessary stand/holder required for flame test should be available. A hot plate for boiling water test of FRP shall also be available.

7.3.8 The manufacture shall have at least 3 Nos. of silica crucible of 4" size for glass content test and two Nos. of glass desiccators. Other glassware like beakers, watch plate, funnel etc. should also be available.

7.3.9 The firm must ensure that the measuring instruments like steel scales (300, 600 & 1000mm), and vernier calipers (0-200mm) are available.

7.3.10 The manufacturer shall have test sample preparation arrangements like vice, cutter, polishing files etc. for preparation of various samples for tests for tensile strength, hardness, specification gravity etc.

7.3.11 The firm should have in house test facilities for critical oxygen index, smoke density and toxicity.

7.3.12 Digital Gloss meter with 60 deg. gloss head as per IS: 101 (Part-4/Section-4)-1998 to measure gloss value of the surface, of the FRP products shall be available.

7.3.13 Manufacturer shall have at least one number flow cup B-4 (Ford) for measuring the viscosity of Resin.

7.3.14 Manufacturer shall have necessary arrangement for measuring the gel time for resin like beakers, pipette, conical flask etc.

7.3.15 Jigs & fixtures for conducting load test, tensile test etc. should be available.

7.3.16 Prior to release of dies / moulds for production, it should be ensured that these are checked dimensionally in all respects. Proper records of die/moulds inspection checking showing the date of checking should be available

8.0 DOCUMENTATION & RECORDS:

8.1 Supplier shall provide reference of all those projects executed by them for Railways for last five year wherein they has used polyester fire retardant resin with gel coat finish or paint finish for the FRP interior panels.

8.2 Tenderers must consult the purchaser with respect to detailed drawings, location of cab equipment and for any other dimension and tolerance. The colour of the interior will be decided by the mutual agreement between purchaser and the tenderers. It would be better on the part of the tenderers to visit and physically assess the existing cab interiors for better appreciation of the work content.

8.3 The tenderers must submit QAP for the complete process for approval by Railways.

9.0 DEVELOPMENT OF PROTOTYPE UNIT:

9.1 Tenderers will develop one no. prototype unit to the dimension for prototype testing and approval by RDSO. This prototype unit shall be made after receipt of order and after clearance by RDSO, bulk supply will commence after installation of the prototype unit in locomotive. During the prototype testing the adjustments/alterations will have to be done by the tenderers as advised by Railways in consultation with RDSO.

10.0 MARKING, PACKING & TRANSPORTATION:

10.1 The firm's name, date of manufacturing, consignee shall be marked on 4 to 5 locations in the cab on major assembled components. The marking should not be deep so as to avoid any damage to the parent materials. Materials should be packed for safe transportation to the consignee. Since the installation is also to be done by the tenderers, safe transportation & handling will be the responsibility of the tenderers.

11.0 FIELD TRIAL:

11.1 First installed FRP interiors for electric locomotive drivers cab shall be subjected to field trials for a minimum period of six months before further implementation of order.

12.0 DEVELOPMENT & APPROVAL OF VENDOR:

12.1 Suppliers shall use their industrial design to fabricate and make one model of the cab interiors. The purchaser shall give one set of complete equipment as free of cost to the tenders to make such walk in type model.

12.2 Tenderers should have past experience for designing, manufacture and supply of cab interiors for Indian Railways or other train interiors to the other leading train operators in the world. The past performance should be satisfactory and a certificate to this effect from the earlier customers shall be submitted. Preference may be given to the established and proven manufacturers having experience of carrying out of similar work in past.

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