RAIL COACH FACTORY, KAPURTHALA

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Please find enclosed a copy of under mentioned **MDTS Specification,** for information and necessary action at your end.

Specification No. **MDTS-133 Rev.-06**

Description: **TECHNICAL SPECIFICATION FOR FRP COMPONENTS COMPLYING FIRE RETARDANT CHARACTERISTICS AS PER EN 45545-2**

DY.CME/FD

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SET OF AMENDMENTS

SN	Amendment Date	Revision	Details
1.	29.03.2003	Rev-NIL	First Issue
2.	29.03.2003	Rev-01	Para 3.1 modified and Warranty's para added.
3.	06.11.2006	Rev-02	Specification modified. Specification MDTS084 and MDTS-133 clubbed.
4.	26.04.2011	Rev-03	I. Requirement of testing on supplied components/ products added in para 3.2. II. MDTS-03 Rev-1 is withdrawn, and MDTS-133 Rev-3 shall be applicable for all practical purposes wherever MDTS-03 Rev-01 has been referred in the past.
5.	17.09.2011	Rev-04	**Section-A** I. Woven roving, surface mat added in para 2.5. II. Para's 2.6.2 &4.2.2 added. III. Surface mat and woven roving, no of layers deleted and note "two consecutive layers woven roving are not be used" added in para 4.0. IV. Para 1.2, 2.2.1, 2.2.2, 2.2.3 & 4.3.2 modified. V. Para 1.4 & 1.5 of Rev-03 deleted. VI. Styrene content for resin change from 22% to 22-24% **Section-B** I. Smoke density added in Para 4.2 and para 4.22 added.

SN	Amendment Date	Revision	Details
6.	02.02.2015	Rev-05	i. Para 3.2 modified.
7.	18.04.2026	Rev-06	I. The specification has been redrafted to comply with fire-retardant characteristics as per EN 45545-2 (HL-3) and the manufacturing process is VARTM/ Vacuum Bagging.

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0 Introduction:

This specification provides the technical requirements for the interior FRP paneling of passenger Coaches of Indian Railways.
Manufacturers shall use VARTM (Vacuum assisted resin transfer molding)/ Vacuum bagging process for manufacturing FRP components with proven composition as per the available standards to meet the technical requirement specified in the specification.

1 Terms and Definitions:

Fiber Reinforced Plastic (FRP): Heterogeneous material, consisting of thermosetting resin as the matrix and an embedded reinforcing material.

Thermosetting Resin: Two component mixture consisting of resin and hardener as well as possible additives.

Reinforcing materials: Materials generally in form of fiber products, which are embedded in a matrix to improve the critically required properties.

Laminate: A moulded part which is manufactured by placing layers of reinforcing material on top of each other together with thermosetting resin.

Sandwich laminate: Two laminate layers connected by means of an intermediate core of lighter material.

Roving: A Large Number of parallel filaments placed together with or without twisting.

Mat: Irregular layering of continuous filaments (Fleeces) or Chopped roving (minimum 50mm long) which are joined together by means of binder.

Fabric: Roving woven together by means of weaving techniques used in textile industry. Different materials and/or filament thicknesses are possible for warp and weft.

Non-woven fabric: Unidirectional layers of fibers which are laid on each other in an arbitrary manner. The Layers are fixed by thin fiber stands, either together or on mats. Different materials and/or filament thicknesses are possible in individual layers.

2 Foreword & Scope:

2.1 This schedule is intended to cover the technical requirements/provisions relating to materials, constructions and tests and does not include all the necessary provisions of the contracts. This schedule draws references to some of the relevant EN, ASTM, UIC and other Indian Standard specifications. Unless otherwise specified, the latest version of the relevant specifications shall be taken as reference.

2.2 Glass fiber reinforced plastic (FRP) panels are to be used for IR passenger coaches. These FRP components are required to meet the following objectives.

- Components should be ready to assemble resulting in lower manpower input.
- Reduction in weight of coaches.
- Reduces the extent of corrosion.
- Provide a clean, odorless, hygienic and aesthetically pleasing atmosphere.
- Good impact resistance.
- High specific stiffness.
- Good fire-worthy properties
- Long life with easy maintainability.

2.3 The tenderer is permitted to make minor changes in the original design of the system to meet IR's requirements. Prior approval of RCF is must for any change.

2.4 Drawing numbers and numbers of components required shall be indicated separately at the time of placement of orders.

3 List of standards Referred:

SN	Standard	Title
1.	IS:11551 -1996	Glass fiber chopped strand mat for the reinforcement of epoxy, phenolic and polyester resin systems.
2.	IS :11273-1992	Woven roving fabrics of 'E' glass fiber
3.	IS:2500-2000	Sampling procedures for inspection
4.	ASTM-D792	Standard Test Methods for Density and Specific Gravity (Relative Density) of Plastics by Displacement
5.	IS: 1998-1962	Methods of test for thermosetting synthetic resin bonded laminated sheets
6.	BS:4994	Specification for Design and Construction of Vessels and Tanks in Reinforced Plastics
7.	ASTM–D-2583-81	BARCOL Hardness
8.	IS: 13411	Glass reinforced polyester dough moulding compounds

9.	ASTM D-570-2018	Test Method for Water Absorption of Plastics
10.	ASTM –D-2863	Measuring the Minimum Oxygen Concentration to Support Candle-Like Combustion of Plastics
11.	EN45545-2	European standard for Fire retardant
12.	MDTS- 44374	Fire Retardant Rigid Foam
13.	MDTS-092	Granular corundum particles
14.	MDTS-118	Painting system for FRP components
15.	MDTS-115	3D Glass Fabric
16.	MDTS-094	Painting System
17.	IS:101	Methods of sampling and test for paints
18.	EN 10204	Inspection documents for steel (and other) product
19.	ASTM G154	Accelerated weathering test
20.	ASTM-D-6578/ D6578M-13 (2018)	Anti-Graffiti Properties
21.	IS:2046	Resistance to stains for acetone and black tea
22.	ICF/MD spec. 107 (rev-2)	Crack & Bluster test

Table 1: List of referred standards

4 Abbreviation/Terminology:

S.N.	Abbreviation /Terminology	Expansion/Explanation
1	FRP	Fiber Reinforced Plastic
2	FAI	First Article Inspection
3	QAP	Quality Assurance Plan
4	RCF	Rail Coach Factory
5	ICF	Integral Coach Factory
6	MCF	Modern Coach Factory
7	KXH	Indian Railways station code for Kapurthala
8	LHB	Linke-Hofmann-Busch the transfer of technology partner for RCF/KXH.

Table 2: Abbreviations & Terminology

5 Materials:

The Laminate for interior paneling shall be manufactured using the following material and any other material if required for manufacturing to get approved from RCF and it should be mentioned in the QAP.

5.1 Laminating Resin:

Laminating resin should have good impregnation characteristics when being processed. In cured stage they shall be resistant to fuels, river and sea water and shall

exhibit high resistance to ageing. The resin may be unsaturated Polyester or Vinyl ester or Epoxy or Phenolic type to be reinforced with suitable reinforcements.

5.2 Gelcoat and Top coat resin:

Gelcoat and coat resins shall protect the surface of the laminate from mechanical damage and environmental influences. Therefore, in cured stage the resin is to have high resistance to high to existing media (Fuel, River and Sea water). It shall be resistant to maritime and industrial environment and to abrasion for use in Railway coaches. It shall have low water absorption capabilities. Thixotropic agent and coloring pigments are the only permitted additives for gel coat resins. In top coat additives for low styrene evaporation are also permitted. Compatibility shall be demonstrated for the combination of gelcoat and laminating resin if the basic formulation of the resins is not same.

5.3 Filler Material:

The Filler Material shall not significantly impair the properties of the cured resin. In general, the proportion of the filler material in laminating resin preferably shall not exceed 12% by weight (including the maximum of 1.5% by weight of thixotropic agent) or as required to achieve properties mentioned in Table-4. The proportion of thixotropic agent in gel coat resin shall not exceed 3% by weight. Laminates used for fuel and water tanks shall not contain filling materials.

5.4 Coloring Pigment:

Coloring Pigments shall be climate proof and consist of inorganic or non-fading organic Dyes. The maximum permissible proportion shall not exceed the value specified by the manufacturer; if no value is specified then it shall not exceed 5% by Weight.

5.5 Reinforcing material

Manufacturers are allowed use any of the following reinforcing materials with filaments of Glass or Carbon or any other superior fiber. For Glass base filaments Only Low Alkaline Aluminum boron silicate glass (E Glass) to be used as per the ASTM D 578 and for Carbon Fiber it shall be complying with DIN 52332.

5.5.1 Rovings

Woven roving fabrics for the reinforcement of epoxy, phenolic and polyester resin systems of 'E' glass fiber shall be as per IS: 11273-1992 or alternatively any other type wove Roving as per any national/international standard may be used with prior approval in QAP. The Roving shall be compatible with resin system to be used. Manufacturer shall provide details of the type of Roving used in QAP.

5.5.2 Mat

The Glass fiber chopped strand mat for the reinforcement of epoxy, phenol and polyester resin systems shall be as per IS: 11551 -1996 or alternatively any other type wove Roving as per any national/international standard may be used with prior approval in QAP. The Roving shall be compatible with resin system to be used. Manufacturer shall provide details of the type of Roving used in QAP.

5.5.3 Fabric and Non-Woven Fabric:

These are the roving woven together as per the different weaving techniques used in textile industry. Any type of reinforcing fabric as per any national / international standard may be used with prior approval in QAP. The fabric shall be compatible with resin system to be used. Manufacturer shall provide details of the type of Roving used in QAP.
Manufacturers may use any other type of reinforcement with prior approval of RCF. The construction scheme of laminate shall be such that it should meet the mechanical properties specified in the specification.

5.6 Rigid Foam material:

Rigid Foam material which are used as core material for sandwich laminates, or as shear webs shall be of closed cell type and have high resistance against the laminating resin or the adhesive as well as against aging, fuels, river and sea water. The foam shall have low water absorption capability with minimum apparent density of 60kg/m^3 to 80kg/m^3.

5.7 Adhesives:

When bonding fiber reinforced plastics together, or with other materials, only solvent free adhesives shall be used. Preference shall be given to two component reaction adhesives, if possible, with the same basis as the laminating resin. Laminates shall only be bonded in the cured state. The Laminates shall be used in accordance with the processing guidelines issued by the manufacturer. They shall not affect the material to be bonded and shall exhibit a higher resistance to humidity and aging. Adhesives shall be usable within minimum temperature range of -20 ◦C to +60 ◦C. The material parameters are to assure a safe functioning of the component under corresponding operating conditions.

Note: All raw material used for the fittings shall be traceable to its original sources. The chain of documents establishing traceability shall be provided with each consignment. This chain shall be verifiable.

6 General guidelines for processing laminates:

6.1 Resin, hardener and resin additives shall be mixed in such a way as to ensure uniform distribution and to minimize the amount of air introduced into the mixture as far as possible.

6.2 The surface protection is to be achieved by providing Gel Coat with uniform thickness of 0.4 to 0.6 mm using a suitable process.

6.3 The first laminate Layer shall be applied as soon as possible after application of the Gel Coat. A fiber mat or fabric with low weight per unit area and high resin content shall be used.

6.4 Transition between different thicknesses of the laminate shall be made gradually. A minimum value of 600 g/m^2 reinforcing material can be used. In the transition region from a sandwich construction to solid laminate the core material shall be tampered with gradient not more than 1:3.

6.5 If cutting of reinforcing layers is unavoidable in the case of complicated moldings, then the cut edge shall overlap, or reinforcement strip shall be provided. In the butt or seam region of laminates, every reinforcing layer shall overlap by at least 25mm per 600g/m^2.

6.6 Different components may be laminated together only while they are not fully cured. Special attention should be paid to crossing of laminates.

6.7 The length of roving cut shall be between 25mm and 50 mm.

6.8 A powder bound textile glass mat of maximum 450g/m^2 shall be used for the first laminate layer. The glass part of this layer shall be less than 30 % by weight.

6.9 The glass weight per unit area of the spray laminate layer shall not exceed 1150 g/m^2. After maximum of 1150 g/m^2 of fibers have been sprayed, air shall be removed and composite shall be compacted.

6.10 It should be ensured that two layers of roving are not placed one upon each other on both finished product and panel.

6.11 Curing and Tempering

6.11.1 The complete component may only be taken from moulds after adequate curing of the thermosetting resin compounds. The required cure time depends on manufacturer instructions. Otherwise, a minimum cure time of 12 Hrs. at 20◦C shall be observed.

6.11.2 Resin system which cure under Pressure, UV radiation and /or increased temperature shall be treated in accordance with manufacturer ‘s instructions.

6.11.3 Immediately after curing the component should receive post treatment at increased temperature. The tempering time shall be as specified by resin manufacturer. If such values are not available, then following tempering conditions can be used.

- At least 16 h at 40/50 ◦C
  Or
- At least 9 h at 50/60◦C.

6.12 Workmanship: The surface must be smooth and free from visual defects or any other surface defects such as delamination, cavities and discontinuities etc. The finished surface shall be superior abrasion resistance properties.

6.13 The dimensions of the FRP components shall be as per relevant drawings.

6.14 The thickness given in the drawings is minimum nominal thickness. However, the reinforcement content specified for each thickness must be provided with fiber layers of specified surface density mentioned in the above said clause. At radius, continuous filament to be used.

7 Construction of Lavatory Module:

7.1 For FRP Lavatory modules, the items made of sandwich construction (outer portions are of FRP and fire-retardant rigid foam). The fire-retardant rigid foam shall be as per specification no. MDTS-44374. The details of the fire-retardant rigid foam shall be as per drawings indicated by the purchaser. In floor of lavatory module, granular corundum particles as per specification no. MDTS 092 shall be used.

8 Manufacturing Surveillance:

The purchaser reserves the right to carry out inspections in the production facilities without giving prior notice. The manufacturer shall grant inspectors access to all the areas used for production, storage and testing and shall present all documentation concerning records and tests carried out.

The scope of third-party surveillance can be reduced in case of production facilities that have a certified quality management system.

8.1 Incoming inspection:

The characteristic value and properties of the material shall be verified by the manufacturer by means of inspection documents. The following inspection documents according to EN 10204(ISO 10474) are required as a minimum:

EN 10204-2.2:	Fiber Products, Gel coat Resins, Paints
EN 10204-2.3:	Laminating resins, Prepregs, Core materials, Adhesives.

Table 3: Inspection Documents

8.2 Production Surveillance:

8.2.1 Detail of the production process shall be laid down by the QAP which shall also contain specimen documents for production and testing of the components. The task of the production and quality control departments should be defined clearly.

8.2.2 The batch Numbers of the material used in the components shall be given in production documentation, in order that they can be traced back to the manufacturer

if need be. Reinforcing Layers introduced into the laminate shall be checked off immediately during the production process, with indication of fiber direction.

8.2.3 From every batch of reaction resin compound a sample shall be taken and tested. If mixing is performed continuously, one sample per batch and production step is sufficient. These samples shall be randomly checked for their degree of curing, and the results shall be recorded.

8.2.4 On request of purchaser reference for FAI laminate of 50 cm x 50 cm shall be produced in parallel. This shall result in confirmation of the material values used as basis for strength calculations.

9 Technical Requirement of FRP Laminates:

9.1 The properties of the 03 mm thick FRP test Panel fabricated and shall meet the values specified in table-4. Gel Coat or Top coat not to be removed prior to testing of FRP Panels.

PROPERTIES REQUIRED OF THE FRP PANEL

SN	Properties	Specified Value	Evaluation Standard
1	Specific gravity	1.5-1.8	ASTM-D792
2	Tensile strength (N/MM²)-min	100	IS: 1998
3	Tensile modulus (N/MM²)-min	8000	-do-
4	% age elongation at break % min	1.0	-do-
5	Inter laminar shear strength- min (N/mm²)	7.5	BS:4994
6	Hardness Barcol-min	40	ASTM –D-2583-81
7	Cross breaking strength (N/MM²)-min	120	IS: 1998
8	Izod strength (joule/mtr.)	550	IS: 1998
9	Fiber content by weight (w/w) -min (%)	30	IS: 13411 ANNEXURE-A
10	Water absorption-max	0.5 %	ASTM D-570
11	Critical oxygen index	28% min.	ASTM-D-2863
12	Resistance to stains for (a) Acetone (for solid surface) (b) Black Tea	Should not show any visible change on the surface	IS:2046
13	Crack & Bluster test (ink test)	Shall not show any crack in the surface coat.	ICF/MD spec. 107 (rev-2) annex B
14	Fire Resistance	R1-HL3	EN45545-2
15	Fire Characteristics	V0	UL-94

Table 4: Properties required of the FRP Cured Panel

9.2 In addition above testing as per Table-4, the following tests should also be carried out on the final product made up as per drawing/spec mentioned in the purchase order:

SN	Properties	Required Value
1	Thickness	As per values specified in drawing at various cross-section
2	Fiber content by weight on solid (w/w)-min (%)	Values as specified in Table-1
3	Water absorption on solid specimen only	Values as specified in Table-1

Table 5: Properties required of the FRP Test Panel

Rest of the inspection shall be carried out as per drawing/spec.

Note: The required number of layers for glass reinforcement needs to select such a way to obtain required thickness as per mention in PO drawing and the final FRP properties as per mention in Table -4.

9.3 Fire properties/requirements shall be tested in end-use condition.

10 Surface finish of FRP components:

a. The FRP components shall be painted as per colour scheme issued. The vendor shall also advise the repairing method of FRP panels for maintenance at Depots.

b. **Painting:**

- The items shall be thoroughly cleaned and ground before painting to achieve an excellent painted surface. Surface should be clean, grease free. The paint system used should primarily be suitable for application by spraying. It may also be applied by brush for touching up small areas.

- All Interior area of lavatories of all AC & Non-AC coaches shall be painted with 2-component polyurethane-based primer (DFT-30-35 µm) and 2-component polyurethane based direct gloss Anti-graffiti paint (DFT- 50-70 µm), and the surface finish shall be as per colour Scheme issued.

- All areas of AC & Non-AC coaches shall be painted with 2-component polyurethane-based primer (DFT-30-35 µm) and 2-component polyurethane based Anti-Graffiti paint system with Matt finish (DFT- 50-70 µm), and the surface shall be matt & smooth.

c. The surface of FRP components painted with Anti-Graffiti coating shall meet the parameters as laid down in Table-6 as described below:

Sr.	Characteristics	Requirements	Test Method
1	Gloss at 60° angle of incidence	> 80 (For glossy and gel coated panels) 16-30 (For matt Finish)	Gloss Meter
2	Scratch hardness (1.5 kg load)	No such scratch so as to show on base surface	IS: 101-88(Part 5 Sec.2)
3.	Durability Test: accelerated weathering test	Rating: Chalking:10 Checking 10 Cracking 10 Flaking 10 Spotting 10 Blistering 10 Corrosion No Corrosion Color change AE < 1.0 **Gloss**: The film shall have minimum gloss retention of 90% of its critical value.	ASTM G154
4.	Anti-Graffiti Properties	Graffiti resistance score (Average) 7.6 (Min) without Not- cleanable OR shadow OR gloss loss.	ASTM-D-6578/ D6578M-13 (2018)

Table 6: Properties required of Anti-Graffiti Painted Surface of FRP Components

d. There should be no damage to the surface in terms of cracks or deep scratches on the surface in course of assembly.

11 Quality Assurance, Tests & Documents:

The following table provides an overview of the system for quality assurance.

Requirement Description	Requirement Detail	Remarks
Quality Assurance plan	The manufacturer shall have a detailed quality assurance plan. The Plan shall be submitted for approval by RCF/KXH. The QAP document shall clearly document the following and control the test record formats. 1.control over outsourced products and processes 2.Testing of raw material and establishing its traceability 3.Sampling Plan 4.Type Tests	The QAP shall be submitted in PDF soft copy digitally signed by the head of Quality department of the manufacturer for approval.

	5.Routine Tests 6.Acceptance tests 7. Raw Materials	
Type Tests	These tests shall be done on a sample lot. These tests are to be repeated after every 36 months. However, also in case of initial approval, change of design and change of manufacturing process or raw material, these tests shall be repeated. • Fire Resistance as EN 45545-2 • Durability Test: accelerated weathering test exposure	The records of the type tests shall be maintained by the manufacturer and shall be made available upon demand. These records shall be traceable and verifiable.
Routine Tests	These tests are required to verify the functional working of the system. These may require simulated inputs for testing the operation under full range of inputs. These tests shall be done by the manufacturer during manufacturing and record maintained for inspection. These tests are to be repeated after every 12 months or as specified. • Tensile strength (N/MM²)-min • Tensile modulus (N/MM²)-min • % age elongation at break % min • Inter laminar shear strength- min (N/mm²) • Cross breaking strength (N/MM²)-min • Izod strength (joule/mtr.) • Anti-graffiti Test	The records of the routine tests shall be maintained by the manufacturer and shall be made available upon demand. These records shall be traceable and verifiable.
Acceptance tests	These tests shall be done on all or samples of lot for bulk supply. Sampling shall be done as per IS:2500 • Fire characteristics as per UL-94 • Dimensional check • Visual Checks • Specific gravity • Glass content by weight (w/w)- min (%) • Hardness Barcol-min For surface finish (Para 8.0) as per applicable specification:	The records of the acceptance tests shall be enclosed along with the supply consignment. These records shall be traceable and verifiable.

	• Gloss • Color • Finish • DFT • Scratch resistance These tests shall normally consist of routine tests and additionally specified in the contract.	

Table 7: Quality Assurance, Tests & Documents

11.1 All the testing shall be conducted by NABL accredited Lab for that particular test. The fire-retardant tests as per EN 45545 -2 shall be conducted by either NABL accredited Lab for these tests or Testing lab accredited as per ISO/IEC-17025 to perform/ conduct fire test as per EN45545-2 (Proof of same shall be submitted).

12 Marking:

Before dispatch, each assembly shall be legibly marked with indelible marking ink /paint showing the following details:

- Manufacturer's name with address
- PO details with PO No. & date
- Batch No.
- Serial No. of item/product
- Month and year of manufacturing

13 Nomenclature of the store

- Month and year of manufacturing

Note 1: The markings shall not compromise the lifecycle or performance of the components.

Note 2: Incase it is not possible to put all the above information on the item due to constraints of shape and size, the information shall be reduced in the reverse order of the list above.

Note 3: It shall be ensured that the markings are readable for the expected lifecycle of the components.