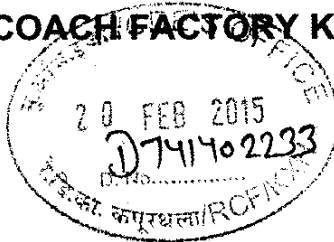


RAIL COACH FACTORY KAPURTHALA

MD22161



Dated : 20.02.2015

Sub: Issue of specification no. MDTS-133 Rev-'05', Technical Specification for hand lay-up FRP component for all passenger coaches

Please find enclosed a copy of specification no. MDTS-133 Rev-'05' of Technical Specification for hand lay-up FRP component for all passenger coaches, for information and necessary action at your end.


(Suraj Prakash)
Dy CME/D-1

CQM, CPLE, CWE (FUR), CMM/HSQ, CMM/TKJ, Dy. CMM/Fur/LHB, Dy CCMT, DY.CPLE-III

SSE / LIB. DESIGN

✓ SSE / Records

✓ SE / Design / RCF / TKJ

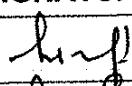


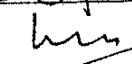
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NAME	DESIGNATION	SIGNATURE	DATE	LEVEL
Harish Kumar	SSE/Dev		2/2/15	Prepared
Joginder Singh	SME/D-1		18/2/15	Agreed
Suraj Prakash	Dy.CME/D1		19.02.15	Reviewed
Paramanand Singh	CDE		19.02.15	Approved

Issue/Rev	Details of Changes	Date
Rev. Nil	First Issue	29/03/2003
Rev01	Para 3.1 modified and Warranty's para added	29.03.2003
Rev02	Specification modified. Specification MDTS084 and MDTS-133 clubbed.	06.11.2006
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 MDTS-03 Rev-1 is withdrawn and MDTS-133 Rev-3 shall be applicable for all practical purposes wherever MDTS-03 Rev-1 has been referred in the past.	26/04/2011
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, 2.3.3 & 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.	17-09-2011
Rev-05	i. Para 3.2 modified	02.02.2015


Prepared By

(S)


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SECTION 'A'

SCHEDULE OF TECHNICAL REQUIREMENTS

1.0 FOREWORD & SCOPE: -

- 1.1 This schedule is intended to cover in two parts i.e. A&B. Section – A intends to cover the technical requirements/provisions relating to materials, constructions and tests and does not include all the necessary provisions of the contracts. The section B covers the infrastructural, testing and quality control facilities required to manufacture hand lay-up FRP components.

This schedule draws reference to some of the relevant specification. Latest version of these specifications shall be taken as reference.

- 1.2 Glass fibre reinforced plastic (FRP) panels are to be used for IR passenger coaches. These FRP components are to be produced by hand lay-up process and are required to meet the following objectives.

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

- 1.3 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.

- 1.4 Only suppliers with proven credentials who are supplying similar items for Railways/Bus Coach/Automotive/Air Bus shall be considered.

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

2.0 RAW MATERIAL TO BE USED: --

The materials to be used are plastics (polyester) on the basis of unsaturated polyester resin reinforced by glass fibres. The glass fibres are to be provided with sufficient polyester wetting and the polyester is to be cured completely. The laminates must not show any air pocket (air bubble). Moreover, fibre-free laminate section and bare glass fibres on the surface are not admissible.

The material parameters are to assure a safe functioning of the component under corresponding operating conditions. FRP items shall be manufactured using raw material as indicated below:

- 2.1 FRP items shall be manufactured using unsaturated polyester resin and E-glass Chopped strand mat (CSM), compatible with the polyester resin system.

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- 2.2 The unsaturated polyester resin used shall be pre-accelerated, high thixotropic laminating of low viscosity and medium reactivity. The resin shall be based on orthophthalic acid and standard glycol, dissolved in styrene and methlmethacrylate. This shall be free from Halogens and shall contain aluminium hydroxide as flame retardant additives. No filler shall be used except those required for obtaining fire retardant property in the resin system.
- 2.2.1 The resin shall be procured from a reputed manufacturer in sealed containers along with the test certificate. The heat distortion temperature of the resin shall not be less than 100° C and the percentage elongation of the resin shall not be less than 3 %. The properties of the un-cured resin shall be as under:

TABLE-1

SN	Properties	Specified Values	Evaluation Standard
1	Density at 20° C	1.5 g/ml	IS-6746-1994
2	Viscosity at 25° C Brookfield DV-II spindle 5 rpm 5	800-1500 MPa.s	IS-6746-1994
3	Styrene content	22-24 %	IS-6746-1994
4	Gel time at 25° C in 100 g cup	20-30 min	IS-6746 Annex-D

- 2.2.2 **Storage/Handling:** The products are required to be stored in closed container, in a cool place and shielded from sunlight. The gel and curing time of the product, in unopened original containers, shall not change when stored for at least 03 months in AC temperature controlled storage room.
- 2.2.3 The manufacturer's recommendation regarding storage must be clearly indicated on the packaging.
- 2.2.4 The packaging of the individual component should be such that the proper mixing ratio is achieved by using one or more complete packs of resin, hardener & accelerator to avoid wastage of the material.
- 2.3 Gel Coats: Gel coats are applied to the mould surface with a film thickness of approx. 0.6 to 0.8 mm, either by hand with a flat brush or by spraying with spraying equipments. Gel coat shall be pre-accelerated, in spray consistency made from polyester resin. The gel coat shall be based on isophthalic resin dissolved in styrene.
- 2.3.1 Ready mix granite finish filler system of a reputed brand, resulting in a solid surface of a shade mutually agreed between Railways & Vendor shall be procured from a reputed supplier. This filler system when used with natural colour resin for solid surface (Gel Coating) shall impart necessary fire retardant characteristics to FRP laminate as defined in table-3.
- 2.3.2 The gel coat shall be procured from a reputed manufacturer in sealed containers along with the test certificate. The properties of the uncured gel coat shall be as under:

TABLE-2


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SN	Properties	Specified Values	Evaluation Standard
1	Density at 20° C	1.1-1.3 g/ml	IS 6746-1994
2	Viscosity at 25° C Brookfield DV-II spindle 5 rpm 5	25000 to 30000 MPa.s	IS 6746-1994
3	Styrene content	32-34 %	IS 6746-1994
4	Gel time at 25° C in 100 g cup	08-14 min	IS 6746-1994

2.3.3 Storage/Handling: The products are required to be stored in closed container, in a cool place and shielded from sunlight. The gel and curing time of the product, in unopened original containers, shall not change when stored for at least 03 months in AC temperature controlled storage room.

2.3.4 The manufacturer recommendation regarding storage must be clearly indicated on the packaging.

2.3.5 The packaging of the individual component should be such that the proper mixing ratio is achieved by using one or more complete packs of resin, hardener and accelerator to avoid wastage of the material.

2.4 An appropriate pigment compatible with the resin approved by purchaser shall be used.

2.5 E-glass reinforcement: Layers of chopped strand mat of density 450 gm/ sq. meter to IS:11551 & woven roving of density 360 gm/ sq. meter to IS: 11273 shall be provided in required no's to achieve specified fibre content and overall thickness of the product & panel along with properties specified in para 3.1 & 3.2. Surface mat of density 30 gm/ sq. meter to BS: 3496 shall be provided on finished side of components. Continuous mat shall be used at the corners.

In Lavatory modules (made up by hand lay up process), some of the items are made of sandwich construction (outer portions are of FRP and inner hard cell PVC foam). The hard cell PVC foam shall be as per specification no. MDTs- 096. The details of the inner PVC foam shall be as per drawings indicated by the purchaser. In trough floor, granular corundum particles as per specification no. MDTs 092 shall be used.

In case of sandwiched construction components, 3D mat to specification no: MDTs- 115 shall be used in the middle of the component thickness as mentioned in the drawing.

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

3.0 PROPERTIES OF FRP PANEL:

3.1 The properties of the 03 mm thick FRP Panel (FRP Panel shall be prepared as per para 4.0 of this specification) shall be as per the values specified in table-3. Gel Coat shall be removed prior to testing of FRP Panels.

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TABLE-3

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/MM ²)-min	100	IS: 1998
3	Tensile modulus (N/MM ²)-min	8000	Do
4	% age elongation at break % min	1.0	Do
5	Inter laminar shear strength- min (N/mm ²)	7.5	BS:4994
6	Hardness Barcol-min	40	ASTM -D-2583-81
7	Cross breaking strength (N/MM ²)-min	120	IS: 1998
8	Izod strength (joule/mtr.)	550	IS: 1998
9	Resistance to Impact test	Should not show crack, crazing or pores on the tested surface	ICF/MD/Spec.-107 Annexure A
10	Glass content by weight (w/w)-min(%)	35	IS: 13411 ANNEXURE-A
11	Water absorption-max	0.5 %	ASTM D-570
12	Resistance to spread of flame	Class A or B	UIC 564-2 or Appendix-11
13	Critical oxygen index	28 % min	ASTM -D-2863
14	Toxicity	1.25 max.	NCD-1409
15	Smoke Density	Class A or B	UIC 564-2 or Appendix-15
16	Resistance to stains for (a) Acetone (for solid surface) (b) Black Tea	Should not show any visible change on the surface	IS:2046
17	Crack & Bluster test (ink test)	Shall not show any crack in the surface coat.	ICF/MD spec.107 (rev-2) annex B

3.2 In addition above testing as per Table-3, 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	Glass content by weight on solid (w/w)-min(%)	Values as specified in Table-3
3	Water absorption on solid specimen only	Values as specified in Table-3
4	Critical oxygen index on solid specimen only	Values as specified in Table-3
5	Smoke density on solid specimen only	Values as specified in Table-3

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

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4.0 FABRICATION: -

The FRP component shall be manufactured by hand lay-up process. For manufacturing of 3mm FRP panel, following minimum reinforcement layers shall be used:

3mm thickness- one finished solid surface (Gel Coat) of 0.6 to 0.8 mm thickness and surface mat, Chopped strand mat and woven roving as per para 2.5 to achieve properties as per Table-3. However two consecutive layers woven roving are not be used i.e. 2 layers of WR are not to be placed upon each other.

4.1 **Workmanship:** The surface shall be smooth and free from visual defects or any other surface defect such as delaminating, cavities and discontinuities etc. The finished surface shall be superior abrasion resistance properties.

4.2.1 All the layering of the specified glass fibre shall be done in continuous process to avoid undulation. For thicker FRP component (equal to or more than 5 mm thickness), pressure shall be applied on the modules for proper finish of the component.

4.2.2 Surface mat is to be used as outermost sandwiched layer in all the FRP components irrespective of the construction suggested in the drawing.

4.3 Geometry:

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

4.3.2 The thickness given in the drawing is minimum nominal thickness. However, the reinforcement content specified for each thickness must be provided with fibre layers of specified surface density as per clause 2.5. At Radius, continuous filament to be used. The minimum reinforcement layers for 3mm thick FRP laminate shall be as per Para 4.0 of this specification.

5.0 PAINTING OF THE COMPONENTS: -

The FRP components shall be painted as per MDTs-118 Rev.-01. The items shall be thoroughly cleaned and ground before painting to achieve an excellent painted surface. The gel coat shall be grounded suitably to provide good adhesion. The paint system used, should primarily be suitable for application by spraying. It may also be applied by brush for touching up small areas.

5.1 Surface preparation: Surface shall be clean, grease free. The surface shall be smoothened with emery paper. Polyester putty shall be applied on the surface wherever required and shall be sanded and smoothened with a proper grade emery paper.

5.2 Painting System:

5.2.1 Anti Graffiti paint system with glossy finish (for interior area of lavatories of all AC & Non-AC coaches).

Description	1 st coat	2 nd coat
Type of coating material	2-component polyurethane based primer (Table-I of	2-component polyurethane based direct gloss Anti-graffiti paint (Table 3 of

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	MDTS-118 Rev. 01)	MDTS-118 Rev. 01)
DFT	30-35 μ m	50-70 μ m

- 5.2.2 Anti Graffiti paint system with Matt finish (All areas of AC & Non-AC coaches except interior area of lavatories.)

Description	1 st coat	2 nd coat
Type of coating material	2-component polyurethane based primer (Table-I of MDTS-118 Rev. 01)	2-component polyurethane based matt Anti-graffiti paint (Table 5 of MDTS-118 Rev. 01)
DFT	30-35 μ m	50-70 μ m

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

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

Manufacturer's name
Nomenclature of the store
Month and year of manufacturing

- 8.0 **PACKING: -**

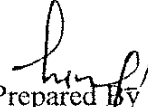
The FRP panels shall be packed in properly designed pallet to avoid damage to FRP panels. Suitable rubber packing/spacers shall be used for packing. The pallet shall be so designed that one complete coach material comes in one pallet and it shall be possible to check the quantity per coach. Complete detail of the packing shall be furnished on the pallet. The pallet shall be of disposal type.

9 Warranty:

The store supplied against an order shall be deemed to bear a warranty of 6 years from the date of fitment against defective materials/ workmanship and performance. If the stores supplied are found by the consignee to be so defective during warranty period, the same shall be replaced immediately with serviceable stores without any charges or cost.

10. Training:

The firm shall conduct training for user railways staff for repairs and preventive maintenance.


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SECTION-'B'**Requirements of infrastructure facilities to manufacture FRP components****1. SCOPE**

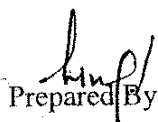
This section covers the infrastructural requirements for manufacture of FRP components of passenger coaches to be manufactured at RCF.

2. REQUIREMENTS

All vendors seeking registration with RCF must fulfill the requirements of this schedule.

3. PLANT, MACHINERY & INFRASTRUCTURE REQUIREMENTS

- 3.1 The manufacturer's 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 FRP components.
 - Finishing, Assembly and Inspection area with proper ventilation system and dust free area.
- 3.2 The firm shall have separate pattern making shop with all modern facilities for making the patterns of mirror finish surface. The firm shall have adequate facility of buffing and polishing of the pattern.
- 3.3 The firm shall have at least one ITI holder pattern maker with minimum of 5 years experience in the relevant field.
- 3.4 The mould/pattern up-keep shall be proper and the mould/pattern shall be cleaned after every production cycle.
- 3.5 The firm shall have adequate no's. of suitable tools, brushes, roller of different type, cutters required for manufacturing of FRP components, polishing files and buffing machine for de-flushing the moulded products.
- 3.6 The firm shall have at least one drilling machine with provision for drilling, different dia. holes and at least two portable hand grinders for finish grinding of components.
- 3.7 The firm shall have one number air compressor of suitable capacity with air dryer attachment.
- 3.8 The firm shall have system to ensure that moulds are checked at regular intervals. The firm shall have adequate mould handling facilities like chain pulleys or electric hoist or any other suitable method for movement of heavy moulds.


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- 3.9 Prior to release of patterns/moulds for production, it should be ensured that these are checked dimensionally in all respects. Proper records of patterns/moulds inspection checking showing the date of checking should be available.
- 3.10 The firm shall have at least one number patterns/moulds for each item along with minimum one number die for test laminates.
- 3.11 The firm shall have proper cutting facility for the FRP components with proper ventilation area. The cutting shop shall be clean and dust free.
- 3.12 The firm shall have one number oven (0 to 200 deg C) with digital temperature indicators fitted with control panel for post or pre-heating of moulds and spraying of moulds.
- 3.13 The firm shall have one no. Gel Coat System with AAC (air assist containment) gun gel coat pump.
- 3.14 The firm shall have separate paint booth with proper ventilation system and dust free environment for spraying of gel coat and painting of the components.
- 3.15 The painter shall have minimum 05 year experience and necessary training shall be imparted to technicians at different stage to update their skills.
- 3.16 Proper weighing facilities for measuring various raw material constituents should be available. One electronic weighing balance of minimum 10- mg accuracy and one mechanical weighing balance of 100 kg capacity with 0.2 % accuracy shall be available.
- 3.17 It must be ensured that the weighing machines are calibrated regularly and frequency of calibration should be specified.

4. TESTING FACILITIES

- 4.1 The firm shall have tensile testing machine of 2.5 MT capacity having a least count of 2 kg with adequate speed of testing required for FRP components.
- 4.2 The firm shall have test facilities for critical oxygen index, smoke density and toxicity index in house.
- 4.3 The firm shall have tie up with a reputed test house for conducting the resistance to spread of flame test.
- 4.4 The firm shall have hot plate for boiling water test of FRP.
- 4.5 The firm shall have one muffle furnace (800 °C) with digital temperature controller and indicator for glass content determination.
- 4.6 The firm shall have Barcol hardness tester (portable) range (0-100)
- 4.7 The firm shall have Izod impact testing machine for testing of FRP products.
- 4.8 The firm shall have electronic balance (least count – 0.001 gm) with density determination kit.
- 4.9 The firm shall have testing facility for resistance to impact test.
- 4.10 The firm shall have testing facility for water absorption percentage.
- 4.11 The firm shall have all measuring instruments like steel scales (300, 600 & 1000 mm) and vernier calipers (0-300 mm)

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- 4.12 The firm shall have all measuring and checking gauges for different components of the FRP components to ensure the dimensions as per drawings.
- 4.13 The firm shall have Digital Gloss Meter with 45° and 60° to measure gloss value of the surface of the FRP product.
- 4.14 The firm shall have at least one number of DFT meter.
- 4.15 The firm shall have at least one number flow cup B-4 (ford) for measuring the viscosity of resin.
- 4.16 The firm shall have at least 03 nos. of Silica Crucible of 4" size for glass content test and two numbers of glass desecrators. Other glassware like beakers, watch plate, funnel etc. should also be available.
- 4.17 The firm shall have necessary arrangement for measuring the gel time for resin like beakers, pipette, conical flask etc.
- 4.18 The firm shall have one number stopwatch.
- 4.19 The firm shall have one number lab stirrer for mixing the different chemical and fillers.
- 4.20 The firm shall have Test sample preparation facilities like vice, cutter, polishing files etc. for preparation of various samples for test for tensile strength, hardness, specific gravity etc.
- 4.21 Jigs & Fixtures for conducting load test, tensile test etc. should be available with the firm.
- 4.22 The firm shall have one digital oven (200°C) with digital temperature controller and indicator.

5. QUALITY CONTROL REQUIREMENTS

- 5.1 The firm shall have their own valid ISO: 9000 series certification for the product for which the approval is sought.
- 5.2 There should be the system to ensure the traceability of the product beginning with raw material stage to finish product stage.
- 5.3 There should be the system to ensure 'first-in first-out' for all raw materials and intermediate stages to finish products.
- 5.4 It should be ensured that there is a Quality Assurance Plan for the product detailing the following various aspects: --
 - Organisation chart.
 - Process flow chart.
 - Stage inspection details from raw materials stage to finish product stage.
 - Various parameters to be checked and level of acceptance of such parameters indicated and method to ensure control over them.
 - Disposal system of rejected raw material and components.
- 5.5 The quality manual of the firm for ISO: 9000 should clearly indicate the control over manufacturing at every stage and testing of the said Railway Product.
- 5.6 There shall be at least one graduate degree holder person in relevant technology with field experience of at least 5 years or a diploma holder with experience of 10 years on thermosetting polymers for regular production and quality control.

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- 5.7 It should be ensured that proper analysis is being done on monthly basis to study the rejection at various stages of production and is documented.
- 5.8 Latest version of all the relevant specification IS, ASTM & RDSO standards and drawings with latest alterations should be available with the firm.

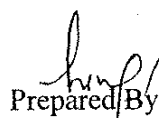
6. DOCUMENTATION

Firm shall maintain following documents/records:

- 6.1 A well documented Quality Plan.
- 6.2 Incoming raw material register with TC reference of supplier as well as internal test results.
- 6.3 Maintenances of stock register for use and balance of raw materials, bought out items.
- 6.4 Stage inspection results including finished product results.
- 6.5 Records of internal rejection and its analysis vis-à-vis action plan.
- 6.6 Records of final products inspection by external agencies (like RCF) NCR and case analysis as well as action taken thereof.
- 6.7 Records for maintenance of dies/moulds.
- 6.8 The firm shall ensure that proper systems are available for dealing with customer complaint.

7. TRAINING

- 7.1 Training needs should be identified for all concerned officials and regular training shall be organized and imparted on maintenance of machines, quality assurance, safety parameters etc.


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