	TECHNICAL DELIVERY CONDITION	Project: MRS1
Aggregate	CAB WINDOW ASSEMBLY	DOC No.: GR/TD/5131
BEML Enquiry/ RFQ Reference :		

Sl. No.	Technical Delivery Conditions	COMPLIED	NOT COMPLIED
1	Cab window assembly shall conform to the tender drawing requirements.	<input type="checkbox"/>	<input type="checkbox"/>
2	The aluminium extrusion shall confirm to the tender drawing requirements.	<input type="checkbox"/>	<input type="checkbox"/>
3	The firm shall submit material test certificate for chemical composition and mechanical properties for the extrusions as per ASTM B 221 along with each supplies.	<input type="checkbox"/>	<input type="checkbox"/>
4	Fabrication of the assembly shall be carried out by qualified welders. Welder qualification certificate and Welding Process Qualification (WPS & PQR) as per EN / ISO / DIN standard shall be submitted along with the technical bid.	<input type="checkbox"/>	<input type="checkbox"/>
5	Dimensional tolerance for the aluminium extrusion shall be as per IS 3965.	<input type="checkbox"/>	<input type="checkbox"/>
6	100% quantity of the extrusions shall be subjected to visual and dimensional inspection. Inspection reports shall be submitted along with supplies.	<input type="checkbox"/>	<input type="checkbox"/>
7	The cab window frame assemblies shall be fabricated using dedicated jigs and fixtures.	<input type="checkbox"/>	<input type="checkbox"/>
8	After fabrication, the finish products shall be of sound quality without any defects.	<input type="checkbox"/>	<input type="checkbox"/>
9	Hinge shall be selected as per the overall dimensions mentioned in the hinge drawing.	<input type="checkbox"/>	<input type="checkbox"/>
10	The accessories hinge and lock shall be from reputed OEM like M/s. Southco, M/s. Dirak, etc.,	<input type="checkbox"/>	<input type="checkbox"/>
11	The operation of lock and hinge shall be smooth and noise less. Locking and unlocking of lock shall be smooth and minimum effort.	<input type="checkbox"/>	<input type="checkbox"/>
12	Water tightness test shall be done in order to check the leakage from window. There shall not be any leakage from the window.	<input type="checkbox"/>	<input type="checkbox"/>
13	The rubber profile shall meet the EN 45545 HL3, R22 requirement.	<input type="checkbox"/>	<input type="checkbox"/>
14	Cab window frame shall be painted according to painting specification Doc. No. GR/TD/4390. The window colour shall be painted in black as per RAL 9005.	<input type="checkbox"/>	<input type="checkbox"/>
15	The supplier shall obtain sample approval and fitment trials for cab window from BEML before taking up mass production.	<input type="checkbox"/>	<input type="checkbox"/>
16	The assembly shall be packed to ensure that no damage will occur during transit & storing at BEML.	<input type="checkbox"/>	<input type="checkbox"/>
17	Inspection report for dimension and material for each part shall be submitted along with the each supplies.	<input type="checkbox"/>	<input type="checkbox"/>

Signature of the Bidder with Seal
(Name, Designation & Address)

Extract of Painting Specification GR/TD/4390

PAINTING SYSTEM REQUIREMENTS FOR PROTECTION OF PHENOLIC GFRP AND ALUMINIUM SUBSTRATES USED FOR INTERIORS & EXTERIORS OF MRS1 METRO CARS

Coating System

INTERIOR : EPOXY PRIMER / POLYURETHANE FINISH COAT

**EXTERIOR: EPOXY PRIMER / POLYURETHANE FINISH COAT/
POLYURETHANE CLEAR COAT**

C O N T E N T S

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2. PAINTING SYSTEM REQUIREMENTS

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2.2.2. Aluminium

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2.4. Application of **Finish Coat**

2.5 Application of **Clear Coat**

3. PERFORMANCE DATA

3.1 Mechanical Property

3.2 Fire Performance

1. INTRODUCTION

This painting System is applicable for Interior applications on Phenolic GFRP substrates like side wall, ceiling coving panel, Door coving panel, Infill strips, gangway cubicles, ceiling end panel & cab Interior panels and on aluminium substrates like Ceiling panel, diffuser and bulk head panels.

For Exterior application on Phenolic GFRP substrates like Cab mask and Cab skirt.

2. PAINTING SYSTEM REQUIREMENTS

The paint system shall be of epoxy primer and anti-graffiti polyurethane finish paints and shall be proven in railway Metro car application. The paint system shall be suitable for the environmental conditions of Mumbai specified at Attachment-1

The paint systems shall have excellent substrate and intercoat adhesion, outstanding long term corrosion protection, good resistance to oils and cleaning agents, very high order of abrasion, chip, impact and scratch resistance.

The paint system shall display a uniformity of colour throughout its service and shall not fade. The paint preparation and finish shall be such as to enable a satisfactory re-coat of part of the vehicle body in the event of localized repair.

The paints shall withstand frequent use of various cleaning products (alkaline or acid detergents, petroleum solvents, mechanical action of brushes) without losing their colour or noticeable deterioration of their surface aspect.

The paint system shall meet Fire safety requirement of EN45545-Part 2, HL3 condition for both Interior and Exterior applications.

Paint system used for Interior/Exterior applications shall have excellent UV and weather resistance characteristics.

Painted surfaces shall have a service life of at least 15 years.

The sub-contractor shall submit the details of the Proven Paint system he proposes to adopt and obtain BEML/DMRC approval. The details of the Railway project in which the proposed system is used for phenolic GFRP parts and its satisfactory performance in revenue service shall be submitted.

The supporting mechanical and fire performance test reports for adopted painting system shall be submitted.

2.1. Coating Thickness

a) The coating thickness for Interiors (GFRP and aluminium panels) is as below.

Process	Coats	Product name	Total D.F.T (µm)	Nominal value of DFT (µm)	Minimum value of DFT (µm)	Maximum value of DFT(µm)	Gloss level	Finish Colour
Putty	-	Polyester putty	-				Semi gloss (50±10)	White: RAL 9010 (for all Interior panels)
Primer	1 st Coat (1 or 2 layers)	Epoxy primer (Aluminium)	60 ±20	30	30	60		Yellow: RAL 1021 & Red : RAL 3028 (only for air diffuser)
		Epoxy primer (GFRP)		50	40	80		
Top coat	2 nd Coat (1 or 2 layers)	Polyurethane Top coat(Aluminium)	60 ±20	50	40	80		
		Polyurethane Top coat(GFRP)		50	40	80		

b) The coating thickness for Exteriors application -GFRP panels is as below.

Process	Coats	Product name	Total D.F.T (µm)	Nominal value of DFT (µm)	Minimum value of DFT (µm)	Maximum value of DFT(µm)	Gloss level	Finish Colour
Putty	-	Polyester putty	-				High Gloss (80±10)	Dark Blue: Pantone 287C & Jet Black : RAL 9005
Primer	1 st Coat (1 or 2 layers)	Epoxy primer	50 ±20	40	35	70		
Top coat	2 nd Coat (1 or 2 layers)	Polyurethane Top coat	45 ±15	30	30	60		
	3 rd Coat (1 or 2 layers)	Polyurethane Clear lacquer	45 ±15	30	30	60		

2.2. Surface Preparation

2.2.1. Substrate - Phenolic GFRP

2.2.1.1 Visual Examination

Initially all GFRP panels shall be visually examined for undulations, dry resins residues, cut marks, etc., If the undulations require more than 5% putty application, the panel shall be rejected.

2.2.1.2. Putty application at undulations and pin holes

Generally, Phenolic GFRP surfaces will have some surface pinhole/defects. To cover these pin holes and to hide the fibre grain structure of FRP panel surface and smoothen it, a very thin layer of putty is to be applied before and after primer application. These layers of putty have to be so thin that during sanding, precaution is to be taken not to excessively sand, otherwise fibre layer may get damaged. Two or more layers may be required, as thicker putty will shrink after drying.

The visually examined surfaces shall be thoroughly cleaned with pressurised air, cloth and acetone to remove any moisture, dust, oil, grease and other contaminants.

The degreased surface areas shall then be abraded with P120 sand paper for proper bonding of putty with surface. All dirt and resultant debris shall then be thoroughly removed.

Polyester putty shall be used to cover undulations and pin-holes and to smoothen the surface.

Before application of putty, room conditions shall be checked. The humidity of the room shall be <85%. If humidity of room is $\geq 85\%$, then oven heat or hot air blow the panel.

Polyester putty shall be two component fast curing unsaturated polyester filler. It has Base component and Activator component.

Dirt, dust or oil, if any, shall be completely removed before application of putty.

The proportions of Base and Activator (100:1~3% by wt) of the putty shall be transferred to a suitable mixing board and thoroughly mixed together to produce a homogeneous, streak free material.

After thorough mixing, the putty shall be applied into the surface defects using a stainless steel spatula and smoothed out.

The pot life of the putty is approx.10-15 minutes. Hence, the mixture has to be made in small quantities and immediately applied.

Allow for drying, drying can be natural drying in room temperature or forced drying in oven.

After drying, visually examine the panel surface for undulations and surface inaccuracies. If defects are found, another layer of putty has to be applied following the procedure outlined above. Otherwise proceed for 1st layer of putty application on entire surface.

2.2.1.3. 1st layer Putty application on entire surface of the panel

The panels shall be mechanically flattened/sanded using 220/320 grade paper to achieve a smooth and even surface.

All debris and dust from the flatting/sanding operation shall be removed by the use of compressed air.

A very thin layer of putty shall be applied on the entire surface of the panel to smoothen the surface.

Before application of putty, room conditions shall be checked. The humidity of the room shall be <85%. If humidity of room is $\geq 85\%$, then oven heat or hot air blow the panel.

Polyester putty shall be two component fast curing unsaturated polyester filler. It has Base component and Activator component.

The proportions of Base and Activator (100:1~3% by wt) of the putty shall be transferred to a suitable mixing board and thoroughly mixed together to produce a homogeneous, streak free material.

After thorough mixing, the putty shall be applied into the surface defects using a stainless steel spatula and smoothed out.

The pot life of the putty is approx.10-15 minutes. Hence, the mixture has to be made in small quantities and immediately applied and

Allow for drying, drying can be natural drying in room temperature or forced drying in oven.

2.2.2. Substrate - Aluminium

All surface areas shall be thoroughly degreased and then lightly flash blasted or mechanically abraded with Scotch brite pads to achieve a uniformly etched surface.

All dirt and resultant debris must be thoroughly removed and surfaces which have been contaminated during abrading stage shall be degreased again using Thinner/Cleaning Solvent prior to application of the primer.

2.3. Application of Primer (In 2 layers)

2.3.1. Application of First coat of Primer

After surface preparation as at 2.2 above, the panels shall be mechanically flattened/sanded using 220/320 grade paper to achieve a smooth and even surface.

All debris and dust from the flatting/sanding operation shall be removed by the use of compressed air.

Surfaces shall now be degreased, using thinner/ solvent, to remove any surface contamination resulting from the sanding operation.

Surfaces shall finally be solvent wiped using clean rags. Clean and dry surface shall be ensured prior to application of primer.

Before application of primer, room conditions shall be checked. The humidity of the room shall be <85%. If humidity of room is $\geq 85\%$, then oven heat or hot air blow the panel.

Epoxy Primer is a two component high performance epoxy coating, consisting of base component and activator component. It provides excellent anti-corrosion and adhesion to steel, aluminium and other materials.

Before application, the following procedures must be observed.

The base component shall be thoroughly stirred until a uniform colour is produced. The activator shall then be added to the base component and then again thoroughly stirred for at least five minutes to produce a homogeneous mixture. The base and hardener have to be mixed thoroughly half an hour prior to application.

Finally, the mixture of base and activator shall then be thinned with the appropriate amount of thinner. The thinned material shall then be thoroughly stirred before application . The mixture shall be used within the pot life of mixture .

NOTE: If only part quantities of the base and activator are to be used, care must be taken to maintain the volume mixing ratio as well as total compliance with the above mixing procedures.

Primer shall be applied by spray to produce a smooth uniform film with appropriate number of passes to achieve a desired dry film thickness (DFT).

Allow for drying, Touch dry shall be achieved in dust free environment.

Sanding of FRP panels for next layer of PU paint should not be done before hard dry.

The DFT shall be measured using a paint coating thickness Gauge for aluminium substrate and for the GFRP a metallic painted panel shall be prepared daily and it's DFT shall be checked and this shall be kept as reference to verify the GFRP panel DFT which is painted under similar conditions

2.3.2: 2nd layer Putty application on defective portions of the FRP panel

The primed FRP panels shall be visually inspected. Check the surface for cracks, undulations, peel off, pin holes etc.

If defects are found, apply 2nd layer of putty over the defective portions following the procedure at 2.2.1.2

If no defects found, apply 2nd coat of epoxy primer

2.3.3 : Putty application on Aluminium panels

A thin layer of putty shall be applied at corners and edges of Aluminium panels (ceiling panels & bulkhead) to ensure evenness at the interface regions of the panels.

2.3.4: 2nd coat Epoxy primer application on entire surface

Apply 2nd coat of primer following the procedure at 2.3.1.

After primer application, visually inspect the FRP surface and check for cracks, undulations, peel off, pin holes etc., If defects are found, reject the item. Otherwise PU finish painting shall be done.

If a defect is found after applying primer and the piece is to be used, all the primer layer should be removed first and process shall be re-started from the putty application stage.

2.4. Finish PU Coat Application

After primer application as at 2.3 above, the panels shall be mechanically flattened/sanded using 400 grade sand paper to achieve a smooth and even surface. Curve profiles shall be manually sanded.

All debris and dust from the flatting/sanding operation shall be removed by the use of compressed air.

Surfaces shall now be degreased, using thinner/ solvent, to remove any surface contamination resulting from the sanding operation.

Surfaces shall finally be solvent wiped using clean rags .Clean and dry surface shall be ensured prior to application of Finish paint.

Before application of finish paint, room conditions shall be checked. The humidity of the room shall be <85%. If humidity of room is $\geq 85\%$, then oven heat or hot air blow the panel.

Finish Coat is a two component, Polyurethane resin based finish paint with excellent color and gloss retention, workability and durability. The coating shall be two pack system consisting of a base component and an activator component.

The base component shall be thoroughly stirred until a uniform colour is produced. The activator shall then be added to the base component and then again thoroughly stirred for at least five minutes to produce a homogeneous mixture. The mixing ratio of base : activator by volume, shall be declared by supplier.

Finally, the mixture of base and activator shall then be thinned with the appropriate amount of The thinned material shall then be thoroughly stirred before application.

Finish coat shall be applied by spray to produce a smooth uniform film with appropriate number of passes to achieve a desired dry film thickness (DFT)

Allow for drying. Touch dry shall be achieved in dust free environment.

Sanding of FRP panels for next layer of PU paint should not be done before hard dry.

The DFT shall be measured using a paint coating thickness Gauge for aluminium substrate and for the GFRP a metallic painted panel shall be prepared daily and its DFT shall be checked and this shall be kept as reference to verify the GFRP panel DFT which is painted under similar conditions

The 1st coat finish painted FRP panels shall be visually inspected. Check the surface for cracks, undulations, peel off, pin holes etc. If defects are found, panel shall be rejected. If no defects found, apply 2nd coat of finish paint (for Interior application) .

If no defects found, apply 2nd coat of Clear finish coat as detailed at 2.5 (For Exterior application)

If a defect is found after applying PU paint, and the panel is to be used, the entire paint and primer layer should be removed first and process shall be re-started from the putty application stage.

2.5. Application of Polyurethane Clear Finish Coat

Polyurethane Clear finish coat is a two component coating consisting of a base component and activator component.

Before application, the following procedures must be observed.

The base component shall be thoroughly stirred and then the activator shall be added to the base component and again thoroughly stirred for at least two minutes to produce a homogeneous mixture.

NOTE: If only part quantities of the base and activator are to be used, care must be taken to maintain the volume mixing ratio as well as total compliance with the above mixing procedures.

Finally, the mixture of base and activator shall then be thinned **Polyurethane Thinner** and then again stirred thoroughly.

Polyurethane Clear finish coat shall be applied by spray to produce a smooth uniform film with the appropriate number of passes to achieve a desired dry film thickness (DFT). The DFT will be measured using Paint coating thickness gauge.

If a defect is found after applying PU clear coat paint, and the panel is to be used, all the paint and primer layer should be removed first and process shall be re-started from the putty application stage.

Visual Inspection of painted panels : The panels shall be inspected under illumination of 800 lux minimum. The panels shall be free from defects like orange peel, pin holes, finger prints, air bubbles, shade difference, roughness, undulation, paint flow, scratch marks, etc., If defects are found, panel shall be rejected. The gloss level shall be measured using a Gloss meter

3 PERFORMANCE DATA

3.1 Mechanical Property

The paint system shall comply with following mechanical property requirements.

Property	Test result	Standard
Chip Resistance	Class 2	BS AU 148 Part 15
Scratch Resistance	No failure	BS 3900 Part E2, BS EN ISO 1518:2001
Impact test (Falling ball)	No failure	BS 3900 Part E7
Abrasion resistance	Max 29 mg	ASTM D 4060 CS10 wheel 500 cycles – 1000 gm load
Adhesion	5B	ASTM D 3359 (Method B)
Gloss Level	Semi-gloss	BS 3900 D5, EN ISO 2813:2000
Film Hardness	H	ASTM D 3363
Anti-graffiti	Level 5	ASTM D 6578
Acid & Alkali Resistance	No defect	ISO 2812-3
Accelerated Weathering Test (QUV x 500 hrs)	Gloss (60°)>90% DE < 2	ASTM G155

3.2 Fire Performance

The paint system shall comply to fire safety requirements of EN 45545 -HL3 requirements, but not limited to the following requirements.

Requirement set	Property	Test method reference	Parameter unit and	Criteria For HL3
R1	Lateral flame spread	T02 ISO 5658-2	CFE (kW/m ²)	Minimum 20
	Heat release rate	T03.01 ISO 56601-:50 kWm ⁻²	MARHE (kW/m ²)	Maximum 60
	Smoke generation	T10.01 EN ISO 5659-2: 50kWm ⁻²	D _s (4) (dimensionless)	Maximum 150
	Smoke generation	T10.02 EN ISO 5659-2: 50kWm ⁻²	VOF ₄ min	Maximum 300
	Toxicity	T11.01 EN ISO 5659-2: 50kWm ⁻²	CIT _G dimensionless	Maximum 0.75
R17	Lateral flame spread	T02 ISO 5658-2	CFE (kW/m ²)	Minimum 13
	Heat release rate	T03.01 ISO 5660-1: 50kW/m ²	MARHE (kW/m ²)	Maximum 60
	Smoke generation	T10.04 EN ISO 5659-2: 50kW/m ²	D _s max dimensionless	Maximum 300
	Toxicity	T11.01 EN ISO 5659-2: 50kW/m ²	CIT _G dimensionless	Maximum 1.5

Mumbai Climatic & Environmental Conditions

The car shall operate reliably and safely under the climatic and environmental conditions of Mumbai. Accordingly, the GFRP/aluminium painted panels shall be designed to operate with satisfactory performance under the following conditions.

Description	Limiting Values
Maximum ambient temperature (See note below)	36 °C
Minimum temperature	14.3 °C
Humidity	≥ 95% RH
Rainfall	The annual precipitation is 2,078 mm with 34%(709mm) falling in the month of July.
Atmosphere during hot season	Extremely dusty including bird feathers
Maximum wind speed	150 km/h
Vibration and Shocks	The sub-systems & their mounting arrangements shall be designed to withstand satisfactorily the vibration and shocks encountered in service as specified in IEC 61373 and IEC 60571.
SO ₂ level in atmosphere	80 – 120 mg/m ³
Suspended particulate matter in atmosphere (TSPM)	360 – 540 mg/m ³
Flood Proofing	The traction sub-systems mounted on the under-frame will be designed to permit propulsion of the train at 10 kmph through water up to a depth of 50mm above rail level. Traction sub-systems shall be made splash proof in accordance with International Standards
Life	The Metro car is designed for min. 35 years of life. Accordingly, the painted panels shall also not deteriorate in their performance for at least 15 years.

Note:

- 1) The temperature of the metal surfaces of the vehicles when exposed directly to the sun, for long periods of time, may be assumed to rise to 70 °C.
- 2) Any moisture condensation shall not lead to any malfunction or failure.
- 3) Adequate margin shall specially be built into the design particularly to take care of the higher ambient temperatures, high humidity, dusty and corrosive conditions, etc. prevailing in Mumbai area.



BEML LIMITED
BANGALORE
R & D CENTER

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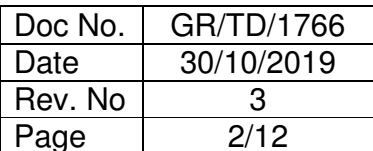
Date 30/10/2019

Rev. No 3

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**Procurement Technical Specification
of Rubber Profiles & Rubber Packing for
Metro Cars**

	Name	Date	Signature
Approved By	Gayatri. P.V	30 Oct 2019	
Reviewed By	Sunil Kumar. R	30 Oct 2019	
Prepared By	Sri Charan Akula	30 Oct 2019	

[illegible]

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1. Introduction

1.1. General

This document describes the technical requirements of Rubber profiles and Rubber packing used in the Metro cars.

The Supplier shall be responsible for all works required in this PTS with regard to manufacture, inspection and supply of Rubber profiles and Rubber packing and shall be responsible for supporting the BEML activities as contractor for manufacture of Metro Cars.

1.2. Climatic Conditions

The Metro Cars have to operate reliably and safely under the climatic & Environmental Conditions shown in the following tables for the respective cities and correspondingly the rubber profiles & rubber packing installed in the cars shall perform satisfactorily under the following conditions.

a) Metro Cars in Delhi shall operate reliably and safely under the climatic conditions shown in Table-1 below.

Description	Limiting Values
Maximum ambient temperature	47°C (Refer Note below)
Minimum temperature	3°C
Humidity	100% saturation during rainy season
Rainfall	Rain occurs generally from June to September. Average annual rainfall is approximately 650mm. maximum rainfall in any 24h period is 50mm.
Atmosphere during hot season	Extremely dusty
Maximum wind load	150 kg/m ²
Vibration & Shocks	The equipment, sub-systems & their mounting arrangements shall be designed to withstand satisfactorily the vibration and shocks encountered in service as specified in IEC61 373, IEC 60077 and IEC 60571
S02 level in atmosphere	80 - 120 mg/ m ³
Suspended particulate matter in atmosphere	360 - 540 mg/m ³
Life	The Metro cars are designed for min. 30 years life. Accordingly, the subject items shall also not deteriorate in their performance for 30 years in the Car Body

Table-1: Environment conditions for Delhi

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Note: The temperature of the metal surfaces of the vehicles when exposed directly to the sun, for long periods of time, may be assumed to rise to 70° C.

b) Metro Cars in Kolkata shall operate reliably and safely under the climatic conditions shown in Table-2 below.

Description	Limiting Values
Maximum ambient temperature (See note below)	35.2°C 45 °C (Inside Tunnel)
Minimum temperature	28.6°C
Humidity	60% (100% saturation during rainy season which may be as long as 6 months)
Rainfall	Average annual rainfall is approx. 1582 mm. Maximum recorded rainfall in any 24h period is 306 mm in month of August. Very heavy rain occurs along with high frequency of lightning discharges.
Atmosphere during hot season	Extremely dusty
Maximum wind speed	vehicle stopped on line: 160 km/h Vehicle Running: 130 km/h
SO ₂ level in atmosphere	6.7 – 80 micro g/m ³
NO _x level in atmosphere	16 – 80 micro g/m ³
Respirator Suspended Particles Matter in atmosphere (RSPM)	49 – 120 micro g/m ³
Total Suspended particulate matter in atmosphere (TSPM)	111 – 360 micro g/m ³
Altitude	100 m
Life	The Metro car is designed for min.35 year of life. Accordingly, the subject items shall also not deteriorate in their performance for 35 years

Table-2: Environment conditions for Kolkata

Note:

- 1) The temperature inside of an “inactive” metro train parked in the sun can easily exceed +60°C.
- 2) The rolling stock must be able to operate regardless of the external conditions. They must also be so designed as to avoid abnormal wear due to adverse weather. They can be parked outdoors regardless of the atmospheric conditions.

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c) Metro Cars in Bangalore shall operate reliably and safely under the climatic conditions shown in Table-3 below.

Description	Limiting Values
Maximum ambient temperature	42 °C
Minimum ambient temperature	8 °C
Humidity	92% saturation during rainy season
Rainfall	Rain occurs generally from May to October. Average annual rainfall is approximately 1065 mm. Maximum rainfall in any 24h period is 178mm.
Atmosphere during hot season	Extremely dusty
Maximum wind speed	Standstill exceptional: 160 km/h
SO ₂ level in atmosphere	6.7 - 80 micro g/m ³
NO _x level in atmosphere	16 - 80 micro g/m ³
Respiratory Suspended Particles Matter in atmosphere (RSPM)	49 - 120 micro g/m ³
Total Suspended Particles Matter in atmosphere (TSPM)	111 - 360 micro g/m ³
Altitude	1000 m
Life	The Metro car is designed for min.35 year of life. Accordingly, the subject items shall also not deteriorate in their performance for 35 years

Table-3: Environment conditions for Bangalore

Note:

- 1) The temperature inside of an “inactive” metro train parked in the sun can easily exceed +60 °C.
- 2) The rolling stock must be able to operate regardless of the external conditions. They must also be so designed as to avoid abnormal wear due to adverse weather. They can be parked outdoors regardless of the atmospheric conditions.

d) Metro Cars in Mumbai shall operate reliably and safely under the climatic conditions shown in Table-4 below.

Description	Limiting Values
Maximum ambient temperature (See note below)	36 °C
Minimum temperature	14.3 °C
Humidity	≥ 95% RH
Rainfall	The annual precipitation is 2,078 mm with 34%(709mm) falling in the month of July.

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Atmosphere during hot season	Extremely dusty including bird feathers
Maximum wind speed	150 km/h
Vibration and Shocks	The sub-systems & their mounting arrangements shall be designed to withstand satisfactorily the vibration and shocks encountered in service as specified in IEC 61373 and IEC 60571.
SO ₂ level in atmosphere	80 – 120 mg/m ³
Suspended particulate matter in atmosphere (TSPM)	360 – 540 mg/m ³
Flood Proofing	The traction sub-systems mounted on the under-frame will be designed to permit propulsion of the train at 10 kmph through water up to a depth of 50mm above rail level. Traction sub-systems shall be made splash proof in accordance with International Standards
Life	The Metro car is designed for min. 35 years of life. Accordingly, the subject items & accessories shall also not deteriorate in their performance for 35 years

Table 4: Environment conditions for Mumbai

Note:

- 1) The temperature of the metal surfaces of the vehicles when exposed directly to the sun, for long periods of time, may be assumed to rise to 70 °C.
- 2) Any moisture condensation shall not lead to any malfunction or failure.
- 3) Adequate margin shall specially be built into the design particularly to take care of the higher ambient temperatures, high humidity, dusty and corrosive conditions, etc. prevailing in Mumbai area.

2. Definitions

The following definitions are applicable to the PTS.

- “Customer” means the Order placing authority for the Mass Rapid Transport System (MRTS).
- “Customer’s Representative” means such person appointed by “Order placing authority” to act as Engineer for the MRTS.
- “BEML” means the Contractor for procuring the Rubber profiles and Rubber packing for Metro Project.
- “Supplier” means the OEM for supplying Rubber to BEML.
- “PTS” means BEML’s Procurement Technical Specification.

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3. General Requirements

The Supplier shall supply the rubber profiles & rubber packing as per tender drawing requirements and this PTS. The Supplier shall be responsible and shall ensure that the rubber items supplied meet the environmental conditions specified at Clause 1.2 and do not deteriorate / fail during the life time (35 years) of the cars.

3.1. Defining of unclear aspects

If any term or clause described in the specification is not clear, Supplier shall discuss those with Design Team in BEML, prior to making a contract, to confirm their definitions and opinions.

After making a contract, Supplier shall follow the definition and opinions of Design Team in BEML.

3.2. Responsibility of Supplier

Supplier shall have responsibility for manufacturing, defined performance testing with regard to rubber profiles and rubber packing.

4. Standards

Test and inspection standard applicable for the Rubber shall conform to the national and international standards as per the technical requirements at Clause 7.

5. Scope of supply

Generally the Rubber used as packing rubber/ profiles shall be of Silicon/ EPDM/ Nitrile/ Neoprene rubber and shall conform to the technical requirement at Clause 7.

5.1. Submission of Documents

The Supplier shall submit the technical specification, previous projects type test reports and fire safety test reports along with the offer.

Supplier shall submit the dimensional check sheets and routine test reports along with every batch of supplies.

5.2. Submission of samples

The supplier shall supply 2 nos. A4 size samples of each of the EPDM/ Silicon/ Nitrile/ Neoprene rubbers with material test certificate and test reports before bulk production.

5.3. Packing

Supplier shall pack properly in order to ensure that no damage occurs during transit.

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5.4. Quality Assurance Program

5.4.1. General

The supplier shall hold ISO 9001 certification and shall manufacture the product accordingly. The supplier shall submit a copy of ISO 9001 certification along with the offer. The supplier shall monitor and control the Quality systems as per ISO 9001 guidelines. BEML's and/or Customer's Representative may periodically conduct compliance audits of the supplier's Quality management system.

5.4.2. Quality assurance plan

The supplier shall develop and submit a Quality assurance plan (QAP) to BEML for review and approval based on ISO 9001 guidelines.

6. Technical Requirements

6.1. Technical Requirements for Rubber

The Rubbers supplied shall be to the highest quality and shall conform to the requirements specified in the drawings, this PTS and Purchase order. The physical and mechanical properties shall generally conform to Table-5 below and fire performance to clause 7.2.

Material Physical Properties	Silicone	EPDM	Neoprene	Nitrile	Test methods
Hardness, Shore "A"	70±5	85±5	80±5	80±5	ASTM D2240
Tensile Strength (Min), MPa	7	14	10	10	ASTM D412 Type A dumb-bell test
% Elongation (Min), %	200	100	150	150	ASTM D412 Type A dumb-bell test
Tensile Set (Max), %	20	15	20	20	ASTM D412 (A strain of 50% shall be applied. The straining period shall be 10 min, followed by relaxation for 10 min, prior to measurement)
Compression Set (Max), %	9	14	29	29	ASTM D395 (Type A the temperature of the test shall be 70°C for 22 hrs. The recovery time after compression shall be 60 min)
Tear Strength (min), kN/m	25	25	25	25	ASTM D624
Density, kg/m ³	1000 - 1250				ASTM D1817

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Accelerated ageing	Max. Hardness change ± 5 BS	ASTM D573 (Method B 100 \pm 1 °C for 3 days)
Outdoor exposure resistance	Shall not show cracks	ASTM D1171
Low temperature resistance	Shall not crack at -40 °C	ASTM D2137
Staining test (where applicable)	No staining	ASTM D925
Ozone resistance	Shall not show cracks with a rating greater than 1	ASTM 1149

Table-5: Physical & Mechanical Properties

6.2. Fire Safety

The Rubber Profiles & packing shall confirm to fire safety requirements as per EN 45545-HL3, R22 requirements.

6.2.1. Fire Performance Test Procedure and Criteria

The Fire Performance Test Procedure and Criteria shall be met, but not be limited to, the following requirements:

Property	Test Procedure	Parameter (units)	Criteria For HL3
Burning Behavior	T01 EN ISO 4589-2	Oxygen content (%)	Minimum 32
Smoke generation	T10.03 EN ISO 5659-2, 25kWm ⁻²	D _s Max (dimensionless)	Maximum 150
Toxicity	T12 NFX 70-100-1 and -2 600°C	CIT _{NLP} (dimensionless)	Maximum 0.75
Heat release rate	ISO 5660-1 50kWm ⁻²	MARHE kWm ⁻²	Maximum 60
	ISO 5660-1 25kWm ⁻²		Maximum 50

Table-6

6.3. Dimensional Tolerance

The dimensional tolerances shall conform to ISO 3302-1 for unspecified tolerances in the drawings. The dimensions shall conform to the most stringent grade of tolerance for each of the types (moldings/ extrusions/ sheets) specified in ISO 3302-1.

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7. Inspection & Testing

7.1. General

The Supplier shall perform all tests in accordance with the Standards specified in the drawing, this PTS and purchase order. BEML's and/or Customer's Representative have the right to witness any of these tests at any stage of test progress.

7.2. Visual inspection

The rubber items shall be uniform in quality and condition, clean, smooth and free from foreign matter and imperfections detrimental to the performance of the items.

7.3. Type Test & Routine Test

Type Test

Type tests shall be performed by the supplier under BEML and Customer Representative Participation.

Routine Tests

Routine test shall be performed by the supplier and during the test, the criteria shall be observed and results shall be recorded. Routine test reports shall be furnished along with the supplies.

The supplier shall perform, as a minimum, the following tests

Sl. No.	Description	Test Method	Type test	Routine test
1)	Visual inspection	-	•	•
2)	Dimensional inspection	-	•	•
3)	Hardness	ASTM D2240	•	•
4)	Tensile Strength	ASTM D412	•	
5)	% Elongation	ASTM D412	•	
6)	Tensile Set	ASTM D412	•	
7)	Compression Set	ASTM D395	•	
8)	Tear Strength	ASTM D624	•	
9)	Density	ASTM D1817	•	
10)	Accelerated ageing	ASTM D573	•	
11)	Outdoor exposure resistance	ASTM D1171	•	

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12)	Low temperature resistance	ASTM D2137	•	
13)	Staining test	ASTM D925	•	
14)	Ozone resistance	ASTM 1149	•	
15)	Peel Adhesion (wherever applicable)	EN 1939	•	
16)	Fire Safety	EN 45545 HL3	•	

7.4. First Article Inspection (FAI)

Before mass production, each type of EPDM/ Nitrile/ Silicon/ Neoprene rubber profiles and sheets shall be subjected to First Article Inspection by BEML and/or Customer's Representative. After clearance from BEML only, mass production shall be taken up. After formal approval has been given, no change in the compound or processing conditions shall be made without the consent of BEML.

8. Submittals with Technical Offer

The Supplier shall provide as a minimum, the following along with the technical offer:

1. Complete technical offer for rubber packing and rubber profiles.
2. Technical data sheet of EPDM, Silicone, Neoprene & Nitrile rubbers and the self adhesive.
3. Copy of Type test reports of earlier similar projects.
4. Clause-wise comments against the PTS Doc No. GR/TD/1766.
5. Fire safety test report copies of earlier similar projects.
6. Supporting documents for Qualification Criteria compliance.
7. Duly filled Vendor credential form along with supporting documents including QAP & ITP, company profile with infrastructure facilities, product range etc.,