



**BEML LIMITED**  
**BANGALORE**  
**R & D CENTER**

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

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## 1. Introduction

### 1.1. General

This document describes the 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 <sup>2</sup>
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 <sup>3</sup>
Suspended particulate matter in atmosphere	360 - 540 mg/m <sup>3</sup>
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

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.

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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 <sub>2</sub> level in atmosphere	6.7 – 80 micro g/m <sup>3</sup>
NO <sub>x</sub> level in atmosphere	16 – 80 micro g/m <sup>3</sup>
Respirator Suspended Particles Matter in atmosphere (RSPM)	49 – 120 micro g/m <sup>3</sup>
Total Suspended particulate matter in atmosphere (TSPM)	111 – 360 micro g/m <sup>3</sup>
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 <sub>2</sub> level in atmosphere	6.7 - 80 micro g/m <sup>3</sup>
NO <sub>x</sub> level in atmosphere	16 - 80 micro g/m <sup>3</sup>
Respiratory Suspended Particles Matter in atmosphere (RSPM)	49 - 120 micro g/m <sup>3</sup>
Total Suspended Particles Matter in atmosphere (TSPM)	111 - 360 micro g/m <sup>3</sup>
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.

## 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 Supplier 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 drawing requirement and as per this PTS. The Supplier shall be responsible and shall ensure that the rubber items supplied meet the environmental condition 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 6.

### 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 6.

#### 5.1. Submission of Documents

The Supplier shall submit the technical specification, 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 along with technical offer.

#### 5.3. Packing

Supplier shall pack properly in order to ensure that no damages occur 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 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 drawing, this PTS and Purchase order. The physical and mechanical properties shall generally conform to Table-4 below and fire performance to clause 6.2.

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 <sup>3</sup>	1000 - 1250				ASTM D1817

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Accelerated ageing	Max. Hardness change $\pm 5$ 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-4: Physical & Mechanical Properties

## 6.2. Fire Safety

The Fire Safety requirements shall be met, but not be limited to the requirement of BS 6853 (1999) Category 1a.

The minor usage material of mass less than 100g is unclassified in respect of fire performance.

### 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 requirement:

Property	Test Procedure	Criteria
Flammability	BS 476 Pt 6 BS 476 Pt7	i1 < 6, I < 12 Class 1
Smoke	BS 6853 Annex D Panel test	Ao (ON) < 2.6 Ao (OFF) < 3.9
Toxic Fume	BS 6853 Annex B	R < 1.0

Table-5

**Minor use materials ((100g < Interior < 500g, 400g < Exterior < 2000g)**

Property	Location Int/Ext	Test Procedure	Criteria
Flammability	Interior/Exterior	BS EN ISO 4589-3 ; 1996, annex A or BS ISO 4582-2	FT > 3000C OI > 34% (V/V)

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Smoke	Interior	BS 6853 Annex D Small scale test	Ao < 0.017
	Exterior	BS 6853 Annex D Small scale test	Ao < 0.029
Toxic Fume	Interior	BS 6853 Annex B	R < 1.0
	Exterior	BS 6853 Annex B	R < 1.7

Table-6

The preferred method is determination of flammability temperature (FT) but oxygen index (OI) should be used where the behavior of the material at temperature makes it unsuitable for FT testing.

**6.2.2.** Alternately, the supplier may offer products meeting equivalent FST (fire, Smoke & Toxicity) requirements as per ASTM or other international standards for BEML consideration. Specification details and test reports for the same shall be submitted along with the offer.

### **6.3. Heat Release Rate**

The Heat Release Rate by Cone Calorimeter Method to ISO 5660-1 or ASTM 1354 shall be performed as a type test.

HP: heat flux 50 kW/m<sup>2</sup>, HS: heat flux 25 kW/m<sup>2</sup>, V: heat flux 35 kW/m<sup>2</sup>

### **6.4. 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.

## **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 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.

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### 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	Type test	Routine test
1)	Visual inspection	•	•
2)	Dimensional inspection	•	•
3)	Hardness	•	•
4)	Tensile Strength	•	
5)	% Elongation	•	
6)	Tensile Set	•	
7)	Compression Set	•	
8)	Tear Strength	•	
9)	Density	•	•
10)	Accelerated ageing	•	
11)	Outdoor exposure resistance	•	
12)	Low temperature resistance	•	
13)	Staining test	•	
14)	Ozone resistance	•	
15)	Fire Safety	•	
16)	Heat Release Rate	•	

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#### **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. Type test reports & Fire safety test reports.
4. A4 size samples of Silicone/ EPDM/ Nitrile / Neoprene.
5. Compatibility test report of self adhesive with the stainless steel /FRP.
6. Clause-wise comments against the PTS Doc No. GR/TD/1766.