



BEML LIMITED
BANGALORE
R & D CENTER

Doc No. GR/TD/1766

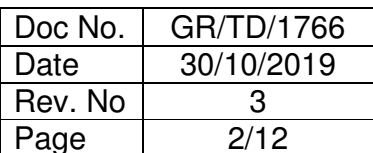
Date 30/10/2019

Rev. No 3

Page 1/12

**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]

| | | | |
|---|---|---------|------------|
|  | Procurement Technical Specification for Rubber Profiles & Rubber Packing | Doc No. | GR/TD/1766 |
| | | Date | 30/10/2019 |
| | | Rev. No | 3 |
| | | Page | 3/12 |

Table of Contents

| | | |
|-------------|--|-----------|
| 1. | Introduction | 4 |
| 1.1. | General..... | 4 |
| 1.2. | Climatic Conditions | 4 |
| 2. | Definitions | 7 |
| 3. | General Requirements..... | 8 |
| 3.1. | Defining of unclear aspects | 8 |
| 3.2. | Responsibility of Supplier | 8 |
| 4. | Standards | 8 |
| 5. | Scope of supply | 8 |
| 5.1. | Submission of Documents..... | 8 |
| 5.2. | Submission of samples | 8 |
| 5.3. | Packing | 8 |
| 5.4. | Quality Assurance Program..... | 9 |
| 6. | Technical Requirements..... | 9 |
| 6.1. | Technical Requirements for Rubber | 9 |
| 6.2. | Fire Safety..... | 10 |
| 6.3. | Dimensional Tolerance..... | 10 |
| 7. | Inspection & Testing..... | 11 |
| 7.1. | General..... | 11 |
| 7.2. | Visual inspection..... | 11 |
| 7.3. | Type Test & Routine Test | 11 |
| 7.4. | First Article Inspection (FAI) | 12 |
| 8. | Submittals with Technical Offer..... | 12 |

| | | | |
|---|---|---------|------------|
|  | Procurement Technical Specification for Rubber Profiles & Rubber Packing | Doc No. | GR/TD/1766 |
| | | Date | 30/10/2019 |
| | | Rev. No | 3 |
| | | Page | 4/12 |

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

| | | | |
|---|---|---------|------------|
|  | Procurement Technical Specification for Rubber Profiles & Rubber Packing | Doc No. | GR/TD/1766 |
| | | Date | 30/10/2019 |
| | | Rev. No | 3 |
| | | Page | 5/12 |

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.

| | | | |
|---|---|---------|------------|
|  | Procurement Technical Specification for Rubber Profiles & Rubber Packing | Doc No. | GR/TD/1766 |
| | | Date | 30/10/2019 |
| | | Rev. No | 3 |
| | | Page | 6/12 |

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. |

| | | | |
|---|---|---------|------------|
|  | Procurement Technical Specification for Rubber Profiles & Rubber Packing | Doc No. | GR/TD/1766 |
| | | Date | 30/10/2019 |
| | | Rev. No | 3 |
| | | Page | 7/12 |

| | |
|---|--|
| 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.

| | | | |
|---|---|---------|------------|
|  | Procurement Technical Specification for Rubber Profiles & Rubber Packing | Doc No. | GR/TD/1766 |
| | | Date | 30/10/2019 |
| | | Rev. No | 3 |
| | | Page | 8/12 |

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.

| | | | |
|---|---|---------|------------|
|  | Procurement Technical Specification for Rubber Profiles & Rubber Packing | Doc No. | GR/TD/1766 |
| | | Date | 30/10/2019 |
| | | Rev. No | 3 |
| | | Page | 9/12 |

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 |

| | | | |
|---|---|---------|------------|
|  | Procurement Technical Specification for Rubber Profiles & Rubber Packing | Doc No. | GR/TD/1766 |
| | | Date | 30/10/2019 |
| | | Rev. No | 3 |
| | | Page | 10/12 |

| | | |
|-------------------------------------|---|---|
| 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.

| | | | |
|---|---|---------|------------|
|  | Procurement Technical Specification for Rubber Profiles & Rubber Packing | Doc No. | GR/TD/1766 |
| | | Date | 30/10/2019 |
| | | Rev. No | 3 |
| | | Page | 11/12 |

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 | • | |

| | | | |
|---|---|---------|------------|
|  | Procurement Technical Specification for Rubber Profiles & Rubber Packing | Doc No. | GR/TD/1766 |
| | | Date | 30/10/2019 |
| | | Rev. No | 3 |
| | | Page | 12/12 |

| | | | | |
|-----|-------------------------------------|--------------|---|--|
| 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.,

| Vendor Credentials - Rubber Profiles | | | | | | | | |
|--------------------------------------|-----------------|---------------------------------------|-----------------------------------|---------------------|---------|----------------|---------------|-------------|
| Sl. No. | Product | OEM & the manufacturing plant address | Technical Specification of Rubber | Rubber Profile Dwg. | Project | Year of Supply | Qty. Supplied | Supplied to |
| 1 | Rubber Profiles | | | | | | | |
| 2 | | | | | | | | |
| 3 | | | | | | | | |
| 4 | | | | | | | | |
| 5 | | | | | | | | |
| 6 | | | | | | | | |
| 7 | | | | | | | | |
| 8 | | | | | | | | |
| 9 | | | | | | | | |
| 10 | | | | | | | | |
| 11 | | | | | | | | |