



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

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|---------|------------|
| Doc No. | GR/TD/1744 |
| Date    | 06/01/2020 |
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Procurement Technical Specification  
of Glass Wool Insulation for  
Metro cars

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|             | Name               | Date       | Signature |
|-------------|--------------------|------------|-----------|
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## 1. Introduction

### 1.1. General

This document describes the technical requirements for Glass wool insulation to be supplied for Metro cars. The glass wool insulation will be applied on the side wall, roof, end walls, floor and on the air conditioning ducts of the Metro cars.

The Supplier shall be responsible for all works required in this PTS with regard to manufacture, inspection and supply of Glass wool insulation and shall be responsible for supporting 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 glass wool insulation 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 glass wool insulation 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<br>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<br>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 glass wool insulation 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 glass wool insulation 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<br>(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  |

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|   |  |
|---|--|
| 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 <sub>2</sub> level in atmosphere               | 80 – 120 mg/m <sup>3</sup>   |
| Suspended particulate matter in atmosphere (TSPM) | 360 – 540 mg/m <sup>3</sup>  |
| 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 and Abbreviations

The following definitions and abbreviations are applicable to the PTS.

- “Customer” means the Order placing authority of the Mass Rapid Transport System (MRTS)
- “Customer’s Representative” means such persons appointed by “MRTS Order placing authority” to act as Engineer for the MRTS
- “BEML” means the Contractor for procuring the Glass wool insulation for Metro Project.
- “Supplier” means the Supplier for supplying Glass wool insulation to BEML.
- “PTS” means BEML’s Procurement Technical Specification.

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### 3. General Requirements

The glass wool insulation is used in the following areas:

- Roof
- End wall
- Side wall
- Floor
- Air duct
- Ceiling panel
- Cab Mask

#### 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 and to perform defined performance testing with regard to glass wool insulation. The supplied glass wool insulation shall perform satisfactorily in the Indian environmental conditions specified at Clause 1.2.

### 4. Standards

Test and inspection standard applicable for the glass wool insulation shall conform to the National and International Standards as per the technical specification at Clause 6.1.

### 5. Scope of supply

The supplier shall supply glass wool insulation laminated with reinforced aluminium foil on one side. The Glass wool shall be made from fibers of glass intertwined using a binder into a texture similar to wool and calendered to required size slabs and shall conform to the technical requirements at Clause 6.

#### 5.1. Submission of Documents

The Supplier shall submit the following documents, as a minimum, along with the offer.

- ✓ Technical Specification in line with Clause 6.1

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- ✓ Previous projects Type Test Reports
- ✓ Fire safety test reports

The supplier shall submit the dimension check sheets and routine test reports along with every batch of supplies.

## 5.2. Packing

Supplier shall pack properly in order that in transit and after supply of the glass wool insulation to BEML works, no damage shall occur.

## 5.3. Quality Assurance Program

### 5.3.1. 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/ customer's representative may periodically conduct compliance audits of the supplier's Quality management system.

### 5.3.2. 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 Glass Wool insulation with Aluminium foil

The Glass wool shall generally conform to the requirements of I.S. 8183 with properties conforming to Table-5 and fire performance conforming to clause 6.2.

The properties of aluminum foil shall conform to Table-6 and fire performance as per clause 6.2.

| Characteristic                         | Test Method Standard | Unit              | Value        |
|--|----------------------|-------------------|--------------|
| <b>Physical Property</b>               |                      |                   |              |
| Type                                   |                      |                   | Glass wool   |
| Density                                | IS 3144              | Kg/m <sup>3</sup> | 24,32,48, 64 |
| Moisture absorption & Moisture content | IS 3144              | %                 | < 2          |
| Thermal conductivity                   | IS 3144              | W/(m.K)           | < 0.035      |

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|                                   |                |           |  |
|-----------------------------------|----------------|-----------|--|
| Hot shrinkage Temperature         | IS 3144        | °C        | >250   |
| Dimension                         | IS 3144        | mm        | Tolerance<br>Thickness : +3/-2<br>Width : +10/0<br>Length: +10/0 |
| Recovery after compression        | IS 8183 Cl.4.3 | %         | > 90   |
| Shot content                      | IS 3144        | % by mass | As per cl.4.4 of I.S:3144  |
| Sulphur content                   | IS 3144        | %         | < 0.6  |
| Fibre content(Diameter)           | IS 3144        | μ         | < 7  |
| Resistance to vibration & Jolting | IS 3144        | %         | As per cl. 4.11.3 & 4.11.4 of I.S:8183                           |

**Table-5 : Glass wool properties**

| <b>Facing Composition</b>  | <b>Description</b>    | <b>Values (English)</b>              | <b>Values (Metric)</b>          |
|----------------------------|-----------------------|--------------------------------------|---------------------------------|
| Foil                       | Aluminum              | 0.000276"                            | 7.0 micron                      |
| Adhesive                   | Water Base            | -                                    |                                 |
| Kraft                      |                       | 42 lbs / 3000 sq. ft                 | 70 g/sq.m                       |
| Reinforcing                | Tri-Way Fiberglass    | 2.0/inch (MD)<br>3.0/inch (XD)       | 8/100 mm (MD)<br>12/100 mm (XD) |
| Hot melt adhesive          | Thermoplastic         | 15.6 lbs/3000 sq.ft                  | 26 g/sq.m                       |
| <b>Physical Properties</b> | <b>Test Method</b>    | <b>Values (English)</b>              | <b>Values (Metric)</b>          |
| Basis Weight               | Scale                 | 25.5 lbs/1000 sq.ft                  | 125 g/sq.m                      |
| Permeance (WVTR)           | ASTM E-96 Procedure-A | 0.02 perm                            | 1.15 ng / N.s                   |
| Bursting Strength          | ASTM D-774            | 50 psi                               | 3.2 kg/sq.cm                    |
| Puncture Resistance        | ASTM C- 1136          | 23 beach units                       | 0.7 joules                      |
| Tensile Strength           | ASTM C1136            | 44 lbs/inch (MD)<br>13 lbs/inch (XD) | 7.6 kn/m (MD)<br>2.4 kn/m (XD)  |
| Caliper / Thickness        | Micrometer            | 0.0075 inch                          | 200 micron                      |

Physical properties based upon statistical averages, Weight / Thickness +/- 10%.

**Table-6 : Aluminium Foil properties**

|   |  |         |            |
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## 6.2. Fire Safety

The Glass wool insulation and Aluminium foil shall conform to fire safety requirements as per EN 45545-HL3, R1 requirement.

Fire safety test reports as per EN 45545 HL3 for Glass wool insulation supplied to previous projects shall be subjected along with technical offer.

### 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:

| Requirement | Property             | Test method reference                            | Parameter (units)                   | Criteria For HL3 |
|-------------|----------------------|--|-------------------------------------|------------------|
| R1          | Lateral flame spread | T02 ISO 5658-2                                   | CFE<br>kWm <sup>-2</sup>            | Minimum 20       |
|             | Heat release rate    | T03.01<br>ISO 5660-1:50kW/m <sup>2</sup>         | MARHE<br>(kW/m <sup>2</sup> )       | Maximum 60       |
|             | Smoke generation     | T10.01<br>EN ISO 5659- 2:<br>50kW/m <sup>2</sup> | D <sub>s</sub> (4)<br>dimensionless | Maximum 150      |
|             | Smoke generation     | T10.02<br>EN ISO 5659-2:<br>50kW/m <sup>2</sup>  | VOF <sub>4</sub><br>min             | Maximum 300      |
|             | Toxicity             | T11.01<br>EN ISO 5659-2:<br>50kW/m <sup>2</sup>  | CIT <sub>G</sub><br>dimensionless   | Maximum 0.75     |

**Table-7 : Fire performance requirements**

## 6.3. Noise Requirement

Noise Reduction Coefficient (NRC) of the insulation, measured as per ISO 354, shall be equal to or greater than 1.0.

## 7. Type test & Routine tests

The Glass wool insulation and aluminum foil shall be type and routine tested in accordance with relevant standards and specifications. All such tests shall be carried out at the supplier's cost, wherever performed, in the presence of and to the satisfaction of BEML and Customer, who reserves the right to witness any or all of the tests and to require submission of any or all test specifications and reports.

BEML and/or Customer representative reserve the right to reasonably call for additional tests, if necessary.

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The supplier shall carryout the following type tests and routine tests, as a minimum. Routine test reports shall be furnished along with the supplies.

| Sl. No. | Description                            | Type test | Routine test |
|---------|--|-----------|--------------|
|         | <b><u>Glass Wool Insulation</u></b>    |           |              |
| 1)      | Visual inspection                      | •         | •            |
| 2)      | Dimensional inspection                 | •         | •            |
| 3)      | Density                                | •         | •            |
| 4)      | Moisture absorption & Moisture content | •         |              |
| 5)      | Thermal conductivity                   | •         |              |
| 6)      | Hot shrinkage Temperature              | •         |              |
| 7)      | Dimension                              | •         |              |
| 8)      | Recovery after compression             | •         |              |
| 9)      | Shot content                           | •         |              |
| 10)     | Sulphur content                        | •         |              |
| 11)     | Fibre content(Diameter)                | •         |              |
| 12)     | Fire safety test reports               | •         |              |
|         | <b><u>For Aluminium foil</u></b>       |           |              |
| 1)      | Basis Weight                           | •         |              |
| 2)      | Permeance (WVTR)                       | •         |              |
| 3)      | Bursting Strength                      | •         |              |
| 4)      | Puncture Resistance                    | •         |              |
| 5)      | Tensile Strength                       | •         |              |
| 6)      | Caliper / Thickness                    | •         |              |

### 7.1. First Article Inspection (FAI)

Before mass production, glass wool insulation 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.

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## 8. Submittals with Technical Offer

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

1. Complete Technical Offer for Glass wool insulation.
2. Technical specification of Glass wool & Aluminium foil.
3. Clause-wise comments against the PTS Doc No. GR/TD/1744.
4. Type test reports of earlier similar projects for the properties as per Table-5 & Table-6
5. Fire performance test reports of earlier similar projects,
6. Supporting documents for Qualification Criteria compliance
7. Dully filled vendor credential form along with supporting documents and company profile with infrastructure facilities, product ranges etc.. for glass wool insulation and aluminium foil



## TECHNICAL OFFER SUBMITTALS CHECK SHEET

Project  
MRS1

|                               |                       |                         |
|-------------------------------|-----------------------|-------------------------|
| Aggregate                     | Glass wool Insulation | PTS DOC No.: GR/TD/1744 |
| BEML Enquiry/ RFQ Reference : |                       |                         |

| Sl. No. | DETAILS  | SUBMITTED                | NOT SUBMITTED            |
|---------|--|--------------------------|--------------------------|
| 1       | Complete Technical Offer for Glass wool insulation.  | <input type="checkbox"/> | <input type="checkbox"/> |
| 2       | Technical specification of Glass wool & Aluminium foil.  | <input type="checkbox"/> | <input type="checkbox"/> |
| 3       | Clause-wise comments against the PTS Doc No. GR/TD/1744.   | <input type="checkbox"/> | <input type="checkbox"/> |
| 4       | Type test reports of earlier similar projects for the properties as per Table-5 & Table-6  | <input type="checkbox"/> | <input type="checkbox"/> |
| 5       | Fire performance test reports of earlier similar projects,   | <input type="checkbox"/> | <input type="checkbox"/> |
| 6       | Supporting documents for Qualification Criteria compliance   | <input type="checkbox"/> | <input type="checkbox"/> |
| 7       | Dully filled vendor credential form along with supporting documents and company profile with infrastructure facilities, product ranges etc.. for glass wool insulation and aluminium foil. | <input type="checkbox"/> | <input type="checkbox"/> |

**Note : Incomplete submissions are liable for Rejection.**

-----  
Signature of the Bidder with Seal

Vendor Credentials - Glass wool Insulation

| Sl. No. | Product  | OEM & the manufacturing plant address | Grade & Technical Specification of Glass wool and aluminium foil | Project Name | Year of Supply | Qty. Supplied, (Sq.m) | Supplied to |
|---------|--|---------------------------------------|--|--------------|----------------|-----------------------|-------------|
| 1       | Glass wool insulation with reinforced aluminium foil |                                       |  |              |                |                       |             |
| 2       |  |                                       |  |              |                |                       |             |
| 3       |  |                                       |  |              |                |                       |             |
| 4       |  |                                       |  |              |                |                       |             |
| 5       |  |                                       |  |              |                |                       |             |
| 6       |  |                                       |  |              |                |                       |             |
| 7       |  |                                       |  |              |                |                       |             |
| 8       |  |                                       |  |              |                |                       |             |
| 9       |  |                                       |  |              |                |                       |             |
| 10      |  |                                       |  |              |                |                       |             |
| 11      |  |                                       |  |              |                |                       |             |