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INDIAN RAILWAYS



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**SCHEDULE OF TECHNICAL REQUIREMENTS
FOR
SILICON FOAM AS A CUSHIOING MATERIAL FOR INDIAN RAILWAY
PASSENGER COACHES
(TENTATIVE)**

S. No.	Month/Year of Issue	Revision/ Amendment	Page No.	Reason for Amendment
1	May, 2014	-	-	First issue
2	Deceber, 2015	Amendment-1	7, 11	- Fire Worthiness Properties upgraded. - Heat Release Rate test specified in Table-1.

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Carriage Directorate
Research Designs and Standards Organization
Manak Nagar, Lucknow-226 011

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Amendment slip No. 1 of December, 2015 to STR No. RDSO/2013/CG-13 schedule of technical requirements for silicon foam as cushioning material for Indian Railway passenger coaches.

In Table-1 (Section-A) of Clause No. 2.7.1, the value and method of test of property at S. No. 12 amended & property at S. No. 14 added and shall be read as under:

TABLE-1

S. No.	Property	Value	Method of Test
12	Limiting Oxygen Index	Min. 35	IS: 13501
14	Heat Release Rate (MARHE i.e. Maximum Average Rate of Heat Emission in KW/m ²) as specified in EN 45545-2:2013	R21 (HL3)	ISO 5660-1: 25 KW/m ²

Section – A (New clause i.e. 3.1.4 added);

3.1.4 The test for Heat release rate (HRR) is type test. Heat Release Rate (HRR) test is to be done at every six months till 31.03.2016. Thereafter it will be the part of acceptance test.

Section – B (New Clouse i.e. 4.13 added);

4.13 The firm should have in-house testing facilities as per ISO 5660-1 for conducting test for Heat release rate (HRR) w.e.f. 01.01.2016. Till such time, firm should arrange testing at reputed laboratory as decided between IR/Inspecting Authority and manufacturer. The cost of testing will be borne by the manufacturer.

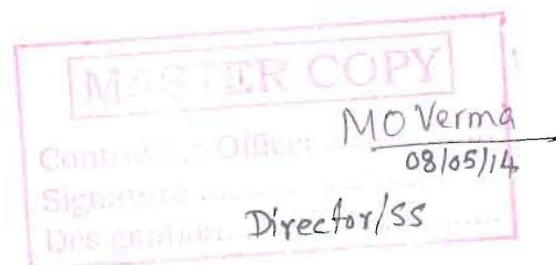


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INDIAN RAILWAYS



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SCHEDULE OF TECHNICAL REQUIREMENTS FOR SILICON FOAM AS A CUSHIONING MATERIAL FOR INDIAN RAILWAY PASSENGER COACHES (TENTATIVE)

S. No.	Month/Year of Issue	Revision/ Amendment	Page No.	Reason for Amendment
1	May 2014	-	-	First issue

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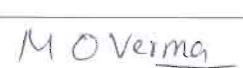
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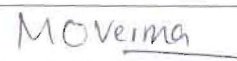
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**SCHEDULE OF TECHNICAL REQUIREMENTS
FOR
SILICON FOAM AS A CUSHIONING MATERIAL FOR INDIAN RAILWAY
PASSENGER COACHES**

0.0 FOREWARD

- 0.1 This schedule is intended to cover the technical requirements/provisions relating to materials, constructions and tests and does not include all the necessary provisions of the contracts.
- 0.2 This schedule draws reference to some of the relevant Naval, ISO, UIC and other IS specifications. Unless otherwise specified, the latest version of the relevant specifications shall be taken as references.
- 0.3 For the purpose of deciding whether a particular requirement of this schedule is complied with the final value observed or calculated, expressing the result of a test or analysis, shall be rounded off in accordance with the IS: 2-1960. The number of significant places retained in the rounded off value should be the same as that of specified value in this schedule.
- 0.4 In this schedule, due consideration has been given to the development in the field of polymeric materials and process technologies, serviceability requirements of the Indian Railways & the practices followed in advanced countries in this field.
- 0.5 This schedule consists of two sections i.e. Section-A and Section-B. Section-A covers the technical requirements, methods of sampling and tests of Silicon foam cushions for coaching stock and Section-B covers infrastructure requirements for manufacture, testing and quality control at the works of the manufacturers.

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SECTION - A

1.0 SCOPE

- 1.1 This schedule covers the technical requirements, method of tests and sampling for moulded & slab Silicon foam cushions for use in berths and seats of passenger coaches.

2.0 REQUIREMENT

Description of the Product

Silicone Rubber Foam blocks are produced by mixing the two liquid silicone compositions,

Part – A: Base Compound

Part-B: Cross-linker or curing agent.

Mixing of these two compositions leads to generation of hydrogen. While the two compositions cross-linked together to form a solid rubber, the mixture simultaneously expands due to hydrogen gas formation and produces small air bubbles with in the rubber which results into production of a cushioning foam material.

2.1 **General requirements**

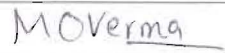
2.1.1 **Material:**

The material shall be uniform silicon rubber foam. The foam material is to be produced without the use of environmentally harmful foaming agent . Material should have a homogeneous open cellular foam structure and has to be well deaerated / vented, clean and physiologically unobjectionable.

2.2 **Construction, Workmanship and Finish:**

- 2.2.1 SLAB STOCK FOAMS - The foam shall be manufactured as block foam or continuous foam, which should be processed in the desired shape and size of the berth/seat for the use in Indian Railways. Alternatively the foam shall be manufactured as per clause 2.2.2.

- 2.2.2 COLD CURE MOULDED FOAM – The foam shall be manufactured as moulded in the required shape of seat/berth for the application in Indian Railways.

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2.3 Colour:

Unless otherwise specified, the colour of the Silicon foam shall be of natural white colour.

2.4 Dimensions & Tolerance:

The dimension and tolerance of the seat / berths shall be strictly as per the relevant drawing or as specified by the purchaser.

2.5 Ease of Handling

The product shall be user friendly and shall not cause any itches or skin irritation during handling.

2.6 FUNCTIONAL REQUIREMENTS:

The Silicon Foam should work satisfactorily under the following operating conditions of IR coaches:

2.6.1 Coach Dynamics:

Silicon Foam should provide adequate comfort during the vibrations and shocks normally encountered in service as indicated below:

- | | | |
|------|-----------------------------------|------|
| i) | Maximum vertical acceleration | 1.0g |
| ii) | Maximum longitudinal acceleration | 3.0g |
| iii) | Maximum transverse acceleration | 2.0g |

The vibrations are of sine wave form and the frequency vibration is between 1 Hz to 50 Hz.

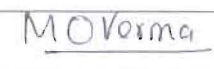
The amplitude 'a' expressed in millimeters is given as a function of f, by equations
 $a = 25/f$ for values of f from 1 Hz to 10 Hz.

$a = 250/f^2$ for values of f exceeding 10Hz and up to 50 Hz.

- 2.6.2 In the direction corresponding to the longitudinal movement of the vehicle, the Silicon Foam is subjected for 2 min. to 50 Hz Vibrations of such a value that the maximum acceleration is equal to 3g.

2.6.3 Coach-body displacement encountered under dynamic conditions.

- | | | |
|------|------------------------------------|---------|
| i) | Vertically- | ±100 mm |
| ii) | laterally - | ±55 mm |
| iii) | longitudinally- | ±10 mm |
| iv) | bogie rotation about center pivot- | ±4° |

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2.6.4 Ambient Conditions

- (i) Ambient temperature : -4° C to 50° C
Altitude : Sea level to 2500m
Max. temperature under Sun : 70° C
Relative humidity : 40% to 95%
- (ii) The rainfall is fairly heavy.
- (iii) During dry weather, the atmosphere is likely to be dusty.
- (iv) Temperature variations can be quite high in the same journey or short period of time.
- (v) Coaches operate in coastal areas with continued exposure to salt laden air.

2.6.5 Coach Inside Condition:

Inside condition of the coach may consider as under:

The ambient conditions may be similar as mentioned under para 2.6.4 above for Non-air-conditioned coaches. However in summer day the value of upper range of the temperature may go up. For AC coaches temperature may be maintained in the range of 20-27°C.

2.7 Physical Properties Required for Silicon Foam

- 2.7.1 Material properties for Silicon foam are given below which covers the performance parameters and tests to be conducted.

Table-1

SN	Property	Value	Method of test as per National/ International Standards
1	Density (Kg/m ³) maximum	135±10	IS:7888 Cl.4
2	Tensile Strength (Kg/cm ²) Minimum	0.5	IS:7888 Cl.5
3	Elongation at Break (%) Minimum	50	IS:7888 Cl.5
4	Indentation Hardness Index (Kgf)	10-20 @25% 15-25 @40%	IS:7888
5	Compression set (%) (50% at 70°C ±2 °C for 22 hrs.)	5% Max.	IS:7888 Cl.8
6	Humidity Ageing (%) Hardness Loss	<10%	ISO: 2440
7	Fatigue testing (%)		IS:7888 Cl.7
	Indentation stiffness loss(%)	<15%	
	Thickness loss	<5%	
	Cycles	100,000	
8	Tear Strength (Kg/cm ²) Minimum	0.5	ISO 8067

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9	Resilience (%) Minimum	50	ISO 8307
10	Resistance to Spread of Flame	Class A	UIC 564-2 Appendix 8
11	Deterioration of visibility Due to Smoke	Class A	UIC 564-2 Appendix 15
12	Limiting Oxygen Index	30 Min.	ISO 4589
13	Toxicity Index	<1	NCD 1409

2.8 Comfort and Life Performance Requirements

The flame resistant cushioning material shall conform to the comfort and life performance criteria listed below.

Table-2

S. No.	Properties	Specified Value	
		Pre-Fatigue	Post Fatigue
1	Comfort Factor	Min2.3@ 50mm	Min2.1@ 50mm
2	Thickness Loss (%)	--	5%Max
3	Stiffness Loss (%)	--	15%Max
4	Pressure Mapping		
	(a) Change in Max Pressure (kPa)	--	10%Max
	(b) Change in Pressure Gradient	--	10%Max
	(c) Change Max Pressure/Contact Area	--	10%Max

2.8.1 Determination of Comfort Factor

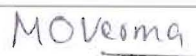
Comfort factor is the ratio of Indentation Hardness index at 65% compression divided by the Indentation Hardness index at 25% compression.

$$\text{Comfort Factor} = \frac{\text{Indentation Hardness (65\% Compression) Kgf}}{\text{Indentation Hardness (25\% Compression) Kgf}}$$

2.8.2 Test: Pressure Test for Sitting and Lying

Description of pressure mapping equipment:

Use pressure mapping equipment to monitor the Berths for changes. The equipment consists of a laptop and a pressure sensor map. The equipment shall measure pressure distribution, contact area, max pressure.

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2.8.3 Pressure Mapping Conditions

- a) Sample thickness: 50mm
- b) Sample size: 450mm x 450mm
- c) Test subject height: 1.7 ± 0.1 meters
- d) Test subject weight: 85 ± 5 kg
- e) Fatigue Test Method: IS:7888 Cl:7 100000 cycles

3.0 SAMPLING CRITERIA FOR CONFORMITY

3.1 Tests

3.1.1 The test shall constitute type and acceptance tests.

3.1.2 Type Tests

The type tests for all the requirements as laid down in this schedule are mandatory for product approval. Fatigue test and 'Comfort & Life Performance Requirement' tests are type tests. These type tests shall be carried out once in a six month. However RDSO/inspecting authority may draw the samples at its discretion as and when required and send the same for testing. A representative of Railways shall draw the samples once at time interval mentioned above and firm shall arrange testing at a reputed laboratory as decided between Railways and the manufacturer. The testing charges shall be borne by the manufacturer.

3.1.3 Acceptance Test

All tests mentioned under table-1 except 'Fatigue Testing' are acceptance test. Beside of this, following will also be acceptance test:

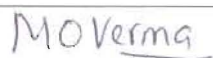
- a) Visual observation
- b) Dimensional check

3.1.4 The lot shall constitute a maximum of 500 nos. of cushion seat / berth / back rest / upper berth etc.

3.1.5 The number of pieces to be selected from the lot for acceptance test shall as under:

Visual observation	100% of the lot
Dimensional check	5% of the lot or 10 samples whichever is more.
For remaining tests	Three samples

3.1.6 Minimum one test specimen shall be prepared from each sample selected for tests, where the number of specimens is equal to the number of samples or exceeds the number of samples. In case number of test specimen is less than the number of samples, selection of the samples for preparation of specimen shall be at the discretion of the inspection authority.

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3.1.7 Each of the test samples undertaken for tests shall conform to the requirements as laid down in table 1. Should the samples fail to meet the requirements double the no. of samples from the same lot shall be drawn for retesting. Should any of the retest samples fail to comply with the requirements, the entire lot shall be rejected.

3.1.8 In case of non-compliance in regard to dimensional check [Clause 3.1.3(b)], the manufacturer may be given one chance to segregate the lot for dimensional conformity.

4. MARKING

4.1 Each piece along the length shall be legibly marked on the back at a distance of 1/2 mts. by hot stamping or indelible ink with the following details: -

- i) Manufacturer's name/initial/trade mark
- ii) Batch No.
- iii) Month & Year of manufacture

4.2 REJECTION MARKING

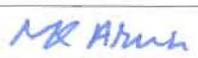
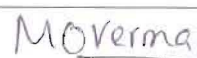
Any lot rejected by inspecting authority during inspection shall be permanently embossed by "REJECTED" so it cannot be re-offered and used in anywhere for Railway Purpose.

5. PACKING

The material shall be suitably packed by using biodegradable or recyclable packing material to avoid distortion, damage and to provide protection against fire hazard etc. during its transit and storage.

6. WARRANTY

The store supplied against an order shall be deemed to bear a warranty of the manufacturer against defective materials/workmanship and performance for period of 10.5 Years from the date of supply or 10 years of fitment of seats/berths whichever is earlier. The products shall be warranted against permanent set of the material during service. The sagging/reduction in thickness of seats and berths shall be less than 5% of original thickness. In case the material shows any defects/fails within warranty period, it shall be replaced by a new one without any cost within one month of receipt of information. The warranty for such material shall be 10 years from the date of replacement.

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SECTION-B

1. SCOPE

This section covers the infrastructural requirements for manufacture, testing & quality control of Silicon foam cushions used in coaching stock

2. REQUIREMENTS

All vendors seeking registration with RDSO shall comply all the requirements mentioned below.

3. PLANT, MACHINERY AND INFRASTRUCTURE REQUIREMENTS

3.1 The manufacturers shall have adequate space and a covered area with cemented floor to accommodate the following.

- a) Damp free space for storage of raw materials & finished goods
- b) Independent manufacturing area for Silicon foam cushions.
- c) Inspection area.

3.2 The firm should have following infrastructure:

- a) Mixing equipment
- b) Suitable Moulds to produce blocks as per the desired dimensions & density
- c) Heating Chamber
- d) Foam Contour cutting machine
- e) Complete manufacturing facility for seat & berth.

4. TESTING FACILITIES:

4.1 The testing lab should have facility for temperature and humidity control.

4.2 The firm should have all testing facilities for testing of parameters mentioned under table -1 & table -2 in Section A of this specification.

4.3 The firm should have suitable equipment for testing indentation hardness and load quotient.

4.4 The firm should have suitable fatigue tester for Durability or Fatigue test. In case, in-house testing facilities for the test is not available, the same may be carried out from any reputed laboratory as decided between Indian Railway/inspecting authority and manufacturer. The cost of testing will be borne by the manufacturer.

4.5 The firm should have suitable tensile testing equipment for testing tensile strength, tear strength and elongation.

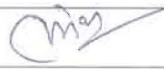
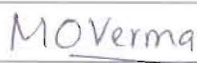
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- 4.6 The firm should have suitable hot air oven and the apparatus for keeping the samples for compression set test.
- 4.7 The firms should have suitable thermo-hygrostatic chamber for testing humidity ageing.
- 4.8 The firms should have chemical balance.
- 4.9 The firm should have testing facility for conducting test for Resistance to spread of flame as per Appendix-8 of UIC – 564-2 OR.
- 4.10 The firm should have in-house testing facilities for conducting tests for Limiting Oxygen Index, Deterioration of visibility due to smoke and toxicity.
- 4.11 The firm should have the following instruments.
- Vernier Calipers with Digital display
 - Dial/Digital soft material thickness Gauge
 - Measuring scale
 - Measuring tape
- 4.12 The firm should have arrangement for periodical calibration of all the gauges & instruments.

5. QUALITY CONTROL REQUIREMENTS

- 5.1 The firm should have acquired ISO: 9001- 2000 certification and the product for which the approval is sought should be broadly covered in the scope of the certification for manufacture and supply.
- 5.2 The Quality manual of the firm for ISO: 9001- 2000 should clearly indicate at any stage the control over manufacturing and testing of the said railway product.
- 5.3 There should be a system to ensure the traceability of the product from raw material stage to finished product stage. The system should also facilitate to identify the raw material composition from the finish product stage.
- 5.4 It should be ensured that there is a Quality Assurance Plan for the product detailing the following various aspects:
- Organisation chart
 - Process flow chart
 - Stage inspection details from raw materials stage to finish product stage
 - Various parameters to be checked and level of acceptance of such parameters indicated and method to ensure control over them.
 - Disposal system of rejected raw material and components.

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- 5.5 There should be at least one full time technologist having a minimum bachelor's degree in relevant field with experience of at least 5 years or a person with diploma in relevant field with 12 years experience. He should be free from day-to-day production, testing and quality control responsibilities. He should be mainly responsible for development of a product, analysis of products, control over raw material, and corrective action in case of difficulties in achieving the parameters.
- 5.6 Ensure that the incharge of the Quality Control Section is having a qualification of minimum bachelor's degree in the relevant field and has a minimum of 5 years experience. Alternatively he should be a diploma holder with minimum of 12 years experience. He should be actively involved in day-to-day activities of quality control / stage inspection / compliance of QAP etc.
- 5.7 The firm must ensure that proper analysis is being done on monthly basis to study the rejections at various internal stages and it is documented.
- 5.8 The firm should ensure that latest version of all the relevant specifications, IS standards are available with them.

6. DOCUMENTATION

Firm shall maintain following documents/records:

- 6.1 A well-documented Quality Plan.
- 6.2 Incoming raw material register with Test Certificates, references of suppliers and internal test results.
- 6.3 Stage inspection results including finished products results.
- 6.4 Records of internal rejection and its analysis vis-à-vis action plan.
- 6.5 Records of final products inspection by external agencies (like RDSO), Non –conformity reports and case analysis as well as action taken thereof.
- 6.6 Records for maintenance of dies/moulds.
- 6.7 Ensure that proper systems are available for dealing with customer complaint.

7. TRAINING

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

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