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**GOVERNMENT OF INDIA  
MINISTRY OF RAILWAYS**

**SPECIFICATION OF  
POLYAMIDE SELF LUBRICATING BUSH FOR  
COMPENSATING & EQUALIZER BEAM PIN IN  
WAG7 ELECTRIC LOCOMOTIVES**

**SPECIFICATION No. RDSO/2007/EL/SPEC/0056 (Rev.'1')**

**Issued on 06.07.2015**

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### Status of Revision




S. N.	Date of Revision	Page No.	Revision	Reasons for Revision
1.	---	All	0	First Issue.
2.	---	1, 3, 4, 5, 6, & 7	1	<ul style="list-style-type: none"> <li>- Rectification of Typographical error</li> <li>- Specification changed as per ISO format</li> <li>- Correction in parameters &amp; their values of raw &amp; finished materials</li> <li>- Edition in testing facilities</li> <li>- Added clause of qualification &amp; training</li> <li>- Deletion of warranty clause</li> <li>- Correction in inspection, marking &amp; packing and field trial clause</li> </ul>

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**1.0 BRIEF BACKGROUND:**

- 1.1 Presently metallic pins and bushes in equalizer and compensating beam of WAG7 locomotives are being used as per IS: 1875. The following problems with metallic pins and bushes have been experienced:
- Excessive fast wear of bushes cause wear of pins too by eating away the parent material of pin and equalizer / compensating beam. The replacement of bushes is required frequently (within 1 year) and pins are also required to be replaced.
  - Relative movement between pins and bushes are not found smooth which leads to rotation of bush itself in its position causing ovality in the holes of compensating, equalizer and links of WAG7 locos.
- 1.2 Later on, greasing between pins and bushes has been tried by providing greasing holes and grease nipples in the pins along with a groove in the bush. But this arrangement has been proved as ineffective.
- 1.3 The existing arrangement is not only ineffective but also very difficult to maintain as it requires large manpower as well as costly materials for keeping the whole suspension arrangement in healthy working condition. The premature and intermittent need for replacement of compensating beam, equalizer beam and links in WAG7 locos is adding to the cost of maintenance of locos.
- 1.4 Of late, trials have been conducted with the bushes made of non-metallic High Density Polymer (HDP) having self-lubricating properties. The polyamide self lubricating material of the bushes have the property of high wear resistance, thermal stability, good mechanical resistance against shocks and vibration. Hence, the life of the bushes is expected to be 4-5 years i.e. required to be replaced only during IOH of the locomotives.
- 1.5 Fitment of this bush is push fit and easier too.

**2.0 SCOPE OF SPECIFICATION:**

- 2.1 The specification deals with the polyamide self-lubricating bush made out of combination of high density polymers, catalyst, activator and lubricating agents, manufactured with controlled centrifugal casting method to get required properties to serve the useful life without failures. It covers the manufacturing process, various properties of raw materials/finished product, minimum manufacturing and testing facilities required and other criteria to be met with by the manufacturers.

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### 3.0 PROPERTIES OF RAW/FINISHED MATERIALS, TESTING METHODS & SCHEDULES:

S N	Parameter	Test method	Unit	Value	Routine	Acceptance	Prototype
1	Tensile strength at yield	ASTM D 638	Mpa	70(min.)	✓	✓	✓
2	Compressive strength at 5% nominal strain	ASTM D 695	Mpa	85 (Min.)	x	✓	✓
3	Compression Set at 80°C±1°C for 24 (+0/-2) hrs.	ASTM D 395	%	45 (Max.)	x	✓	✓
4	Flexure modulus	ASTM D 790	Mpa	3000 (Min.)	x	✓	✓
5	Specific gravity	ASTM D 792		1.1 (Min.)	✓	✓	✓
6	Izod impact strength (Notch)	ASTM D 256	J/m	25 (min.)	x	✓	✓
7	Shore hardness	ASTM D 2240	D-scale	60 (Min.)	✓	✓	✓
8	Melting point	ASTM D 3418	°C	200 (min.)	x	✓	✓
9	Water absorption at 23°C after 24 hrs. immersion in water	ASTM D 570	%	0.5 (Max.)	x	x	✓
10	Coefficient of friction (Dynamic)	ASTM D 1894	-	As given in clause 6.0	x	✓	✓
11	Wear rate	ASTM G 99	µm/km	12 (Max.)	x	✓	✓
12	Dimensional checks	-	-	As per relevant drawing	✓	✓	✓

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**4.0 MANUFACTURING PROCESS:**



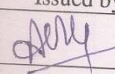
- 4.1 The raw materials required like polymer granules can be purchased from any renowned indigenous manufacturers but the additives like catalyst, activators and lubricating agents (MOS2) should be imported. The hollow tubes (stock shape) to be made by the centrifugal casting methods only and the final machining will be done on CNC lathe machine to finish the size of different bushes as given in drawing.
- 4.2 While making the stock shape, 1.0 to 1.5 mm excess thickness should be kept as a machining allowance to ensure the removal of voids, pin holes and surface cracks at the time of machining.
- 4.3 All bushes shall be smooth, free from air bubble, surface cracks, pin holes and voids. Sharp edges and burrs to be removed.

**5.0 WEAR RATE MEASUREMENT:**

- 5.1 Measurement of wear rate (wear resistance) to ensure the required minimum wear during application, accelerated wear resistance test should be conducted on the test samples manufactured from the same compound as of the stocks (in this case tube). Manufacturers shall make the test sample for wear resistance for every lot of casting and carry out tests internally and submit the test report to the inspecting agency. Manufacturer shall preserve the test samples and produce at the time of inspection. The testing shall be done as per the following tests conditions and to be carried out on friction & wear monitor of adequate capabilities.
- a) Pressure: 3 MPa
  - b) Pin (specimen diameter): 6mm
  - c) Sliding velocity: 0.33 m/s
  - d) Surface roughness of the C35 steel  
Mating surface:  $R_a = 0.70 - 0.90 \mu m$
  - e) Total distance run: 28 km
  - f) Normal environment (air, 23°C/50% RH)
  - g) Un-lubricated operation
- 5.2 The wear rate of the materials shall not be more than 12 micro meter per km in the above mentioned test conditions.

**6.0 TEST FOR DYNAMIC COEFFICIENT OF FRICTION:**

- 6.1 Manufacturers shall make the test sample for dynamic coefficient of friction testing for every lot of casting and carry out tests internally and submit the test report to the inspecting agency. The test samples should be preserved & produced at the

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time of inspection. The testing shall be done as per the following tests conditions and to be carried out on friction & wear monitor of adequate capabilities.




- a) Pressure: 3 MPa
- b) Sliding velocity: 0.33 m/s
- c) Surface roughness of the C35 steel  
Mating surface:  $Ra=0.70 - 0.90 \mu m$
- d) Total distance run: 28 km
- e) Normal environment (air,  $23^{\circ}C/50\%$  RH)
- f) Un-lubricated operation

- 6.2 The dynamic coefficient friction shall be 0.2 to 0.35 under the standard test conditions as mentioned above.

7.0 **MACHINERY AND PLANTS:**

Either the manufacturers of polyamide bushes shall have the following machinery and plants in their manufacturing premises or they can purchase the hollow tubes (stock shape) with the approval of RDSO for manufacturing of polyamide bushes.

- 7.1 Centrifugal casting machine with adequate chemical process & handling machine: The machine shall be capable for manufacturing tube length of minimum 1000 mm and up to the outside dia of 300 mm at the speed of 500-2000 rpm. The machine shall have heating arrangement at 3 to 4 locations for uniform heating. The machine shall have facilities for recording of vital parameters like temperatures and rotational speed.
- 7.2 Manufacturers shall have sufficient number of CNC lathe machine for machining of the bush.
- 7.3 Manufactures shall have dust and damp free covered area sufficient to store raw materials and manufacturing and testing machines.
- 7.4 Manufacturers shall have temperature controlled mixing plant for making activated monomer melt. Manufacturers shall have electronic weighing machine for mixing of catalyst, activator, and lubricator while making monomer melt.
- 7.5 All the machinery plants and testing equipments shall be up to date with respect to their calibration from any NABL accredited approved lab/agency and they should be in working condition without bypassing any sub system of the plants/machines.
- 7.6 Firms shall have 'GO' & 'NO GO' gauges for the bushes as per the drawing. These gauges should be calibrated every 1 year and shall be made available for 100% checking and testing at the time of inspection.

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## 8.0 TESTING FACILITIES:

8.1 Manufacturers shall have at least the following in-house facilities for carrying out various tests specified in clause no. 3.

- Tensile Testing Machine of adequate capacity
- Izod impact testing machine of adequate capacity
- Equipment for humidity control of Laboratory
- Shore 'd' hardness tester
- Melting point apparatus
- Weighing balance with specific gravity determination kit
- Equipment to test compression set as per ASTM D 395
- Equipment for water absorption test at 23<sup>o</sup>c for 24 hrs.
- All gauges required for checking of dimensions of bush
- Dies/moulds for preparation of various test specimens for the relevant tests.
- Wear and friction monitor for carrying out wear resistance and dynamic coefficient friction test. Monitor shall be capable of carrying out these tests as per schedule given.

8.2 Firms not having facility for wear resistance test shall arrange for this test at any NABL accredited laboratory or some overseas laboratory of international repute.



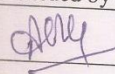
## 9.0 RECORDS AND DOCUMENTATION:

9.1 Firms should have valid ISO 9000 series (Latest version) certification for manufacturing of polyamide based materials.

9.2 Firms should have a Quality Manual giving details of quality assurance programme, test schedules, control over manufacturing and monitoring of critical parameters.

9.3 Manufacturers shall submit quality manuals at the time of inspection of materials.

9.4 Records of raw materials and its testing shall be maintained and made available at the time of inspection.

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#### 10.0 QUALIFICATION & TRAINING:

- 10.1 Training needs for all personnel should be identified. Regular training should be organized covering personnel identified for a particular period.
- 10.2 The inspection/Quality control section shall be headed by a graduate Engineer with at least 5 years experience or a Diploma holder with at least 10 years experience.
- 10.4 Laboratory and shift Engineers shall have a minimum qualification either a diploma or a degree in engineering (Plastic, Mechanical or Electrical).

#### 11.0 INSPECTION:

- 11.1 The inspecting agency will carry out the routine inspection of materials as mentioned in clause no. 3.0. Each of the bush/item should be closely inspected under magnifying glass arrangement for any blow holes, surface cracks, burrs and sharp edges. The inspecting agency may carry out acceptance test for a lot of every 2000 bushes or after a period of 06 months whichever is earlier.
- 11.2 The Prototype inspection as mentioned in clause no. 3.0 will be conducted by RDSO during prototype approval or if there are any quality issues, arising from failures in field or design review or design change, as may be required by RDSO. The firm shall make necessary arrangement for all the testing as and when required.

#### 12.0 MARKING & PACKING:

- 12.1 The finished product should be stored in damp and dust free environment.
- 12.2 Since the material is hygroscopic it should be packed in a sealed polythene bag with silica gel and not more than 10 number bushes shall be packed in one bag.
- 12.3 Marking on all bushes should be done as per relevant drawing of the bush.

#### 14.0 FIELD TRIALS:

- 14.1 After completion of successfully prototype inspection, field trials for minimum 2 loco sets of bushes shall be done for a minimum period of 18 months before the commencement of bulk supply by manufacturer.

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