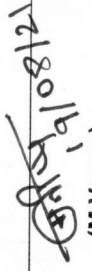
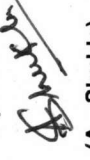


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<p align="center">COPYRIGHT AND CONFIDENTIAL</p> <p align="center">The information on this document is the property of BHARAT HEAVY ELECTRICALS LTD.</p> <p align="center">It must not be used directly or indirectly in any way detrimental to the interest of the company</p>	<p align="center"><u>SPECIFICATION OF ROTOR SHAFT (ROUGH MACHINED) FOR THREE PHASE TRACTION MOTOR TYPE 6FRA-6068 & 6FXA 7059.</u></p> <p>1.0 SCOPE:</p> <p>This specification covers the manufacture, testing, inspection, packing & supply of forged and rough machined rotor shaft for 3-phase Traction Motor type 6FRA-6068 & 6FXA-7059.</p> <p>1.1 The material shall comply with these delivery instructions in chemical composition, Mechanical properties and all other listed requirements.</p> <p>2.0 REQUIREMENTS:</p> <p>2.1 The material shall be fully killed, vacuum degassed and must be free of flaws and cracks. Gas content of the steel shall be as follows:- $H_2 = 2 \text{ ppm (max)}$ $O_2 = 25 \text{ ppm (max)}$ $N_2 = 70 \text{ ppm (max)}$ Trace elements like Cu, Al to be specified in the raw material test certificate. Radioactive contamination shall be certified.</p> <p>2.2 The material shall be delivered in Quenched and Tempered condition.</p> <p>3.0 SPECIFICATION</p> <p>3.1 The material of rotor shaft shall in general conform to DIN EN 10083-1, grade 30CrNiMo8 (material No.1.6580). The chemical composition shall be as specified in DIN EN-10083. The special requirements of this standard also applies.</p> <p>3.2 The mechanical properties of the material shall be as under :-</p> <table border="1" data-bbox="1422 252 1630 1134"> <tr> <td>R_m</td> <td>Tensile Strength</td> <td>880 to 1030 N/mm²</td> </tr> <tr> <td>$R_{e, R_{p0.2}}$</td> <td>Yield Strength</td> <td>735 N/mm² (min)</td> </tr> <tr> <td>Z</td> <td>Reduction in Area</td> <td>50 % (min)</td> </tr> <tr> <td>A</td> <td>Elongation</td> <td>12% (min)</td> </tr> <tr> <td>KV^p</td> <td>Impact strength</td> <td>45 J (min)</td> </tr> <tr> <td></td> <td>Hardness BHN</td> <td>270-320</td> </tr> </table>				R_m	Tensile Strength	880 to 1030 N/mm ²	$R_{e, R_{p0.2}}$	Yield Strength	735 N/mm ² (min)	Z	Reduction in Area	50 % (min)	A	Elongation	12% (min)	KV ^p	Impact strength	45 J (min)		Hardness BHN	270-320
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Revision : 06 Date: 19.08.2021	Distribution TXM QTM TME TSD	Qty. 1 1 1 1	Approved :  (M. Verma)	Prepared  (A. Shukla)	Checked:  (A. Jain)	Date: 19.08.2021																

	<div data-bbox="219 1216 295 1318" data-label="Image"></div> <div data-bbox="232 746 302 1120" data-label="Section-Header"> <p>PRODUCT STANDARD TME DIVISION, BHOPAL</p> </div> <div data-bbox="309 1212 331 1318" data-label="Text"> <p>TME/2015</p> </div> <div data-bbox="199 199 235 354" data-label="Text"> <p>TM10406</p> </div> <div data-bbox="244 221 280 333" data-label="Text"> <p>Rev 06</p> </div> <div data-bbox="288 150 324 406" data-label="Text"> <p>PAGE 02 OF 05</p> </div>
<p>COPYRIGHT AND CONFIDENTIAL</p> <p>The information on this document is the property of BHARAT HEAVY ELECTRICALS LIMITED</p> <p>It must not be used directly or indirectly in any way detrimental to the interest of the company</p>	<p>3.3 FORGINGS:</p> <p>The forging shall be done so that the forging ratio shall be (6)S*(ingot) or higher. Utmost attention shall be paid to the overheating so that there shall be no serious oxidation and decarburization.</p> <p>S* = Notation for solid forging. Forging ratio for solid forging = Original section / Reduced section = 6 (Minimum).</p> <p>The Mill test certificate for the ingot showing the cross section of the ingot to be furnished along with supplier test certificate. Supplier TC to show calculation as per above formulae to authenticate the desired ratio.</p> <p>4.0 DIMENSIONS:</p> <p>4.1 The dimension of Rotor shaft shall be furnished in the relevant drawing enclosed with the tender for proof machining after forging.</p> <p>4.2 Centre Hole: The rotor shaft shall be provided with center hole at both sides and the dimension and shape shall be as specified in the relevant drawing.</p> <p>5.0 HEAT TREATMENT</p> <p>Heat treatment shall be done as specified in DIN 10083-1. Heat treatment graph shall be produced at the time of inspection for verification. Soaking time at austenizing temperature shall be at the rate of ½ hour /inch basis minimum during hardening & 1 hour / inch during tempering. Heat treatment furnace should be calibrated once annually along with Thermocouple, Recorder and Indicators.</p> <p>6.0 Test And Test Method</p> <p>6.1 Test on material shall be conducted generally as specified in DIN 10083-1 for grade 30CrNiMo8 (material no. 1.6580). However, the no. of sample shall be double than the specified in the standard for various test.</p> <p>6.2 In addition to the test specified in the above standard, the following tests are also to be conducted (after proof machining).</p> <ul style="list-style-type: none"> (a) Visual/ Dimensional check: 100%. (b) Concentricity/ Straightness: 100%. (c) Grain Flow/ Structure: 1No. or 2% of each batch whichever is more. (d) Magnaflux Test: 100%. (Applicable for rough machined stepped bar and not for rough machined single diameter bar.) Magnaflux test to be done as per specification IS-3703. Supplier to ensure demagnetization of rough machined shaft after Magnaflux test. (e) Ultrasonic Test: 100%.

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<p align="center">COPYRIGHT AND CONFIDENTIAL</p> <p align="center">The information on this document is the property of BHARAT HEAVY ELECTRICALS LIMITED</p> <p align="center">It must not be used directly or indirectly in any way detrimental to the interest of the company</p>	<p>6.3 <u>ULTRASONIC TESTING</u></p> <p>Supplier shall carry out Ultrasonic test on 100% Proof Machined Shafts as per RDSO code of procedure MC-149, Rev-1/ May-2013. Test results and records to be shown to the inspecting authority as per PO. However, BHEL shall also carry out magnaflux test and ultrasonic test before using these shafts on the shop floor. If defect is noticed, that shaft has to be replaced by the firm.</p> <p>6.4 The following metallographic parameters should also be ensured:</p> <ul style="list-style-type: none"> • Average grain size (determined microscopically as per IS 4748-88) ASTM 6-B. • Inclusion rating (determined microscopically as per IS 4163-82). • Type A B C and D both thick & thin series < 2. • Free ferrite content of the Q & T steel shall not be more than 5%. <p>7.0 <u>SELECTION OF TEST SAMPLE</u></p> <p>7.1 AT SUPPLIER'S WORKS</p> <p>(a) One sample shall be taken from each heat for chemical analysis. One sample shall be taken per heat per heat treatment batch for testing of mechanical properties. Test pieces for mechanical tests shall be taken in the longitudinal direction of the products in accordance with Figure 1 of IS: 5517.</p> <p>General condition for selection and preparation of samples and test pieces shall be in accordance with IS: 3711.</p> <p>(b) TEST CERTIFICATES Test certificate in original from NABL approved lab shall be provided along with consignment, preferably in the test certificate format annexed to this specification (Annexure-1). Alternatively supplier can request for testing at BHEL Bhopal on chargeable basis.</p> <p>In addition, the supplier shall ensure to include one copy of the test certificate along with their dispatch documents.</p> <p>The test certificate shall bear the following information.</p> <p>BHEL Reference TM 10406 / DIN EN10083 Material No 1.6580. BHEL order No. Size and No.</p> <p>Results of Tests</p> <ol style="list-style-type: none"> 1. Chemical composition : Per Heat 2. Mechanical Tests : Per Heat Per Heat Treatment Batch 3. Ultrasonic Examination: All the bars supplied along with their identification number



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7.2 AT BHEL's WORKS

Three bars having additional length of 300mm other than specified length shall be provided along with each consignment per heat per heat treatment batch for material testing at BHEL. (Material testing may be done by BHEL, at its cost.)

For e.g.: If bar length is 925mm then one bar per heat per heat treatment batch shall be of (925+300) i.e. 1225 mm length.

The bar shall be properly identified and correlated with Heat and Heat treatment Batch No., Test certification No.

8.0 PACKING AND MARKING

The bars shall be suitably packed in bundles to prevent corrosion and damage during transit.

Bars shall be stamped TM 10406 and the cast number on the side near the end or on the end face.

A metal label shall be securely attached to each bundle and shall bear the following information.

TM 10406: Nickel Chromium Molybdenum steel bars – Hardened and tempered.

BHEL order No.

Consignment/ Identification Nos.

Cast No. / Melt No.

Heat treatment Batch No.

Size & Weight.

Supplier's Name.



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ANNEXURE-I: RECOMMENDED TEST CERTIFICATE FORMAT FOR FORGINGS

SUPPLIER'S NAME & ADDRESS TEST CERTIFICATE FOR FORGINGS																											
1. Customer: 2. TC No. & Date: 3. PO No.: 4. Process of Melting Ingot: 5. Deoxidisation Process: 6. Forging Method: 7. BHEL's Reference for Approval of Bloom 8. Discard: Top _____ % ; Bottom _____ %																											
9. Reduction Ratio } Ingot to Bloom 10. Batch No.: } Bloom to Blank 11. Heat / Melt No. 12. Spec. No.: 13. Test Bar Size & Nos. 14. Supplier of the ingot/ billet/ Bloom & TC reference																											
15. FORGINGS COVERED BY TEST CERTIFICATE																											
Sl. No.		Drawing No. & Item No.		Description		Quantity & Weight																					
16. GAS CONTENT (PPM)																											
Gas		H ₂		O ₂		N ₂		C		Si		Mn		S		P		Cr		Mo		Ni		Other trace elements like Al, Cu (Clause 6 of specn.)		Radioactive Contamination (Clause 6 of specn.)	
As Per Specn.		Min.																									
Actual Values																											
18. HEAT TREATMENT (To be accompanied by Recorder Chart)																											
Condition		Heating Rate, °C/hr.		Temp., °C		Soaking Time, Hrs.		Cooling Rate, °C/hr.		Cooling Medium																	
19. MECHANICAL PROPERTIES																											
As Per Specn.		Min.		Max.		T.S. N/mm ²		Y.S. 0.5/0.2% Proof N/mm ²		% Elongation 5.65 √So GL		% R.A.		Hardness BHN (Min.3 Values)		Impact Value Joules											
Actual Values																											
20. DIMENSIONAL INSPECTION																											
21. NON-DESTRUCTIVE TESTS																											
Nature o Test		Acceptance level		Instrument used		Range		Result		Any other detail																	
Ultrasonic																											
22. IDENTIFICATION OF FORGINGS AS PER PURCHASE SPEC.																											
We hereby certify that the items mentioned above have been tested and inspected in our presence and are found to be in accordance with drawings, specifications and purchase order.																											
SIGNATURE, NAME & SEAL OF THE INSPECTING OFFICER DATE:																											
SIGNATURE, NAME & SEAL OF THE CHIEF OF QUALITY CONTROL/ CHIEF METALLURGIST OF THE SUPPLIER DATE:																											
INSTRUCTIONS																											
a) Details of all heat treatment processes carried out should be furnished sequentially in 17. b) Test certificates are to be furnished as per Purchase order and specification, in A4 size preferably in transparent paper. c) All the entries including signature should be in black colour ink. d) If testing is done by outside agencies, the original TCs shall be furnished. e) The actual TC may run into more than one A4 size paper, if needed, to facilitate filing up of details.																											