



TME/2015

PRODUCT STANDARD  
TME DIVISION, BHOPAL

TM10406

Rev 02

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**SPECIFICATION OF ROTOR SHAFT (ROUGH MACHINED) FOR THREE  
PHASE TRACTION MOTOR TYPE 6FRA-6068 & 6FXA 7059.**

**1.0 SCOPE:**

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.

- 1.1 The material shall comply with these delivery instructions in chemical composition, Mechanical properties and all other listed requirements.

**2.0 REQUIREMENTS:**

- 2.1 The material shall be produced by electric arc furnace and shall be fully killed, vacuum degassed and bottom poured ingot and must be free of flaws and cracks.

Gas content of the steel shall be as follows:-

H<sub>2</sub> = 2 ppm (max)

O<sub>2</sub> = 25 ppm (max)

N<sub>2</sub> = 70 ppm (max)

Trace elements like Cu, Al to be specified in the raw material test certificate.

Radioactive contamination shall be certified.

- 2.2 The material shall be delivered in Quenched and Tempered condition.

**3.0 SPECIFICATION**

- 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 10083-1. The Special requirement of reproduced below:

- 3.2 The mechanical properties of the material shall be as under :-

|                                    |                   |                               |
|------------------------------------|-------------------|-------------------------------|
| R <sub>m</sub>                     | Tensile Strength  | 900 to 1100 N/mm <sup>2</sup> |
| R <sub>e</sub> , R <sub>p0.2</sub> | Yield Strength    | 700 N/mm <sup>2</sup> (min)   |
| Z                                  | Reduction in Area | 50 % (min)                    |
| A                                  | Elongation        | 12% (min)                     |
| KV <sup>b</sup>                    | Impact strength   | 45 J (min)                    |
|                                    | Hardness BHN      | 270-320                       |

Revision : 02

Date: 24/04/2019

Distribution

Qty.

Approved :

(M.Verma)

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Prepared

(A.Jain)

Checked:

(A.Sharma)

Date:

24.04.2019



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**3.3 FORGINGS:**

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.

S\* = Notation for solid forging.

Forging ratio for solid forging = Original section / Reduced section = 6 (Minimum).

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.

**4.0 DIMENSIONS:**

4.1 The dimension of Rotor shaft shall be furnished in the relevant drawing enclosed with the tender for proof machining after forging.

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.

**5.0 HEAT TREATMENT**

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 austenitizing 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.

**6.0 Test And Test Method**

6.1 Test on material shall be conducted generally as specified in DIN 10083-1, 1996 for grade 30CrNiMo8 (material no. 1.6580). However, the no. of sample shall be double than the specified in the standard for various test.

6.2 In addition to the test specified in the above standard, the following tests are also to be conducted (after proof machining).

- (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%.
- (e) Ultrasonic Test: 100%.



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**6.3 ULTRASONIC TESTING**

Supplier shall carry out Ultrasonic test on 100% Proof Machined Shafts as per RDSO code of procedure MC-149/ Spet'2010. 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.

**6.4** The following metallographic parameters should also be ensured:

- 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%.

**7.0 SELECTION OF TEST SAMPLE**

**7.1 AT SUPPLIER's WORKS**

- (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.

General condition for selection and preparation of samples and test pieces shall be in accordance with IS: 3711.

(b) **TEST CERTIFICATES**

Test certificates in original from **NABL approved laboratory** shall be supplied unless otherwise stated in the order, preferably in the test certificate format annexed to this specification (Annexure-1).

In addition, the supplier shall ensure to include one copy of the test certificate along with their dispatch documents to facilitate quick clearance of the material.

The test certificate shall bear the following information.

**BHEL Reference**

TM 10406 / DIN EN10083 Material No 1.6580.

BHEL order No.

Size and No.

**Results of Tests**

- |                            |                                                              |                                       |
|----------------------------|--------------------------------------------------------------|---------------------------------------|
| 1. Chemical composition    | : Per Heat                                                   | { From NABL approved<br>laboratory. } |
| 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

One bar 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.

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.

Alternatively, BHEL Bhopal may at their discretion and cost can destroy one shaft taken randomly per heat per heat treatment batch for testing.

## 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.

## 9.0 ACCEPTANCE OF THE CONSIGNMENT

9.1 The quality of the supplied material lies solely with the supplier and if at any stage any non-conformity in the supplied material is observed, the whole consignment is liable to be rejected.

9.2 The final acceptance of the consignment will be based on testing, inspection carried out at BHEL Bhopal.



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**ANNEXURE-I: RECOMMENDED TEST CERTIFICATE FORMAT FOR FORGINGS**

| SUPPLIER'S NAME & ADDRESS                                                                                                                                                           |      |                           |                        |                                             |                          |                                |                                    |                    |   |                                                                                                           |                      |                           |                                                       |                  |                                                |
|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------|---------------------------|------------------------|---------------------------------------------|--------------------------|--------------------------------|------------------------------------|--------------------|---|-----------------------------------------------------------------------------------------------------------|----------------------|---------------------------|-------------------------------------------------------|------------------|------------------------------------------------|
| TEST CERTIFICATE FOR FORGINGS                                                                                                                                                       |      |                           |                        |                                             |                          |                                |                                    |                    |   |                                                                                                           |                      |                           |                                                       |                  |                                                |
| 1. Customer:                                                                                                                                                                        |      |                           |                        |                                             | 9. Reduction Ratio       |                                |                                    |                    |   | } Ingot to Bloom<br>Bloom to Blank                                                                        |                      |                           |                                                       |                  |                                                |
| 2. TC No. & Date:                                                                                                                                                                   |      |                           |                        |                                             | 10. Batch No.:           |                                |                                    |                    |   |                                                                                                           |                      |                           |                                                       |                  |                                                |
| 3. PO No.:                                                                                                                                                                          |      |                           |                        |                                             | 11. Heat / Melt No.      |                                |                                    |                    |   | 12. Spec. No.:                                                                                            |                      |                           |                                                       |                  |                                                |
| 4. Process of Melting Ingot:                                                                                                                                                        |      |                           |                        |                                             | 13. Test Bar Size & Nos. |                                |                                    |                    |   | 14. Supplier of the ingot/ billet/ Bloom & TC reference                                                   |                      |                           |                                                       |                  |                                                |
| 5. Deoxidisation Process:                                                                                                                                                           |      |                           |                        |                                             |                          |                                |                                    |                    |   |                                                                                                           |                      |                           |                                                       |                  |                                                |
| 6. Forging Method:                                                                                                                                                                  |      |                           |                        |                                             |                          |                                |                                    |                    |   |                                                                                                           |                      |                           |                                                       |                  |                                                |
| 7. BHEL's Reference for Approval of Bloom                                                                                                                                           |      |                           |                        |                                             |                          |                                |                                    |                    |   |                                                                                                           |                      |                           |                                                       |                  |                                                |
| 8. Discard: Top _____ % ; Bottom _____ %                                                                                                                                            |      |                           |                        |                                             |                          |                                |                                    |                    |   |                                                                                                           |                      |                           |                                                       |                  |                                                |
| 15. FORGINGS COVERED BY TEST CERTIFICATE                                                                                                                                            |      |                           |                        |                                             |                          |                                |                                    |                    |   |                                                                                                           |                      |                           |                                                       |                  |                                                |
| Sl. No.                                                                                                                                                                             |      |                           | Drawing No. & Item No. |                                             |                          |                                | Description                        |                    |   |                                                                                                           | Quantity & Weight    |                           |                                                       |                  |                                                |
|                                                                                                                                                                                     |      |                           |                        |                                             |                          |                                |                                    |                    |   |                                                                                                           |                      |                           |                                                       |                  |                                                |
| 16. GAS CONTENT (PPM)                                                                                                                                                               |      |                           |                        |                                             |                          |                                | 17. CHEMICAL COMPOSITION (PERCENT) |                    |   |                                                                                                           |                      |                           |                                                       |                  |                                                |
| Gas                                                                                                                                                                                 |      | H <sub>2</sub>            | O <sub>2</sub>         | N <sub>2</sub>                              | 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. |                           |                        |                                             |                          |                                |                                    |                    |   |                                                                                                           |                      |                           |                                                       |                  |                                                |
|                                                                                                                                                                                     | Max. |                           |                        |                                             |                          |                                |                                    |                    |   |                                                                                                           |                      |                           |                                                       |                  |                                                |
| Actual Values                                                                                                                                                                       |      |                           |                        |                                             |                          |                                |                                    |                    |   |                                                                                                           |                      |                           |                                                       |                  |                                                |
| 18. HEAT TREATMENT<br>(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                                                                                                                                                           |      |                           |                        |                                             |                          |                                |                                    |                    |   |                                                                                                           |                      |                           |                                                       |                  |                                                |
|                                                                                                                                                                                     |      | T.S.<br>N/mm <sup>2</sup> |                        | Y.S.<br>0.5/0.2%<br>Proof N/mm <sup>2</sup> |                          | % Elongation<br>5.65 √So<br>GL |                                    | % R.A.             |   | Hardness<br>BHN (Min.3<br>Values)                                                                         |                      | Impact<br>Value<br>Joules |                                                       |                  |                                                |
| As Per Specn.                                                                                                                                                                       | Min. |                           |                        |                                             |                          |                                |                                    |                    |   |                                                                                                           |                      |                           |                                                       |                  |                                                |
|                                                                                                                                                                                     | Max. |                           |                        |                                             |                          |                                |                                    |                    |   |                                                                                                           |                      |                           |                                                       |                  |                                                |
| 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<br>INSPECTING OFFICER<br>DATE:                                                                                                                        |      |                           |                        |                                             |                          |                                |                                    |                    |   | SIGNATURE, NAME & SEAL OF THE<br>CHIEF OF QUALITY CONTROL/<br>CHIEF METALLURGIST OF THE SUPPLIER<br>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 filling up of details.                                                                          |      |                           |                        |                                             |                          |                                |                                    |                    |   |                                                                                                           |                      |                           |                                                       |                  |                                                |