

	PRODUCT STANDARD HYDRO TURBINE ENGINEERING	HT 00242
		Rev. 02
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<u>PURCHASE SPECIFICATION FOR FORGED</u> <u>ROUGH MACHINED MAIN SHAFT FOR HYDRO TURBINE</u>		

1. GENERAL

This specification governs the supply of rough machined carbon steel / 1.5% Manganese steel shaft forgings. This specification is supplemented by the following:-

- i) Material specification (referred in clause 4.1)
- ii) Non Destructive Testing (referred in clause 5.2)

2. CONDITION OF DELIVERY

Rough machined by forge master. The forgings shall be heat treated as per material specification to achieve the mechanical properties specified.

3. DIMENSIONS & TOLERANCES

The dimensions & tolerances shall be as specified in the drawings enclosed with purchase order.

4. TECHNICAL REQUIREMENTS

4.1 **Material:**

As specified in the drawing.

4.2 **Manufacturing**

Forgings shall be manufactured from steel produced by open hearth, electric or such other processes as may be agreed to between BHEL & the manufacturer.

The steel for this forging shall be vacuum degassed to protect it from harmful effects of hydrogen and other gases. **The steel shall be fully killed.** Sufficient discard shall be made from each ingot to ensure freedom from pipe, segregation and other defects. The amount of hot working & finishing temperature shall be such as to ensure complete soundness and adequate uniformity of structure & mechanical properties after heat treatment. The forgings shall not be over heated.

The minimum reduction ratio when forgings are made out of ingots shall be 4:1 for all ruling sections unless otherwise agreed between BHEL & vendor before placement of purchase order.

Rev. No.	Date of Rev.	Remarks	Approved		
02	17.10.2015	Completely reviewed	 J.S.Hanspal, AGM (HOD)-HTE		
			Prepared	Checked	Date of issue
			 Omeshwar Daheekar	 A.Mandal	26.10.2007
Saved in server as no. 42009900242					

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<u>PURCHASE SPECIFICATION FOR FORGED</u> ROUGH MACHINED MAIN SHAFT FOR HYDRO TURBINE		

4.3 General

The shaft shall be free from stresses of any kind and perfectly true and straight after delivery to BHEL (Bhopal) works. The shaft shall be sound and free from defects such as cracks, flakes, seams, segregation, harmful non-metallic inclusions etc. **No patching or welding is permitted.**

4.3.1 Solid shafts:

In addition to the conditions specified in this specification, all solid shafts shall comply with the following:

If ultrasonic or any other non-destructive method of inspection detects the presence of significant faults in the region of the shaft center line, then such faults are to be removed by boring a hole concentric with the outside diameter of the shaft. The maximum size of the hole bored for this purpose shall not exceed 0.2 of the smallest outside diameter. The bore shall be machined to a surface finish of 3.2 micron or better.

If any segregation or other defects present can be removed by further machining or local chambering of the bore then the forge master before proceeding, shall submit his proposal for such machining of chambering, illustrated by a sketch, to BHEL (Bhopal) for approval. The bore shall be treated against corrosion as specified in clause 4.3.3.

4.3.2 Shaft with central bore:

When called for in the drawing, a through hole shall be bored by the forge master in the center of the shaft to the dimensions & tolerances stated in the drawing. The bore shall be concentric with the outside diameter of the rough machined forging throughout its entire length and shall have a surface finish as stated in the drawing so that any defects which may exist shall be readily seen by visual inspection.

Should any segregation or other defects present can be removed by further machining or local chambering of the bore, then the forge master, before proceeding, shall submit to BHEL (Bhopal) his proposals (illustrated by a sketch) for such machining or chambering for approval if deemed to be permissible.

4.3.3 Treatment of the bore against corrosion:

Immediately after the bore has been passed as satisfactory, it shall be treated with anti-corrosion compound (Ref. Clause 10). It shall then be hermetically sealed by means of steel cover plates

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<u>PURCHASE SPECIFICATION FOR FORGED</u> ROUGH MACHINED MAIN SHAFT FOR HYDRO TURBINE		

fixed in position with any rubber based adhesive. The cover plates shall be thick enough to resist buckling and flat enough to make effective sealing (refer sketch). The bore must be bright, smooth and clean on receipt at BHEL (Bhopal) works.

When called for in the drawing the forge master shall carry out a dimensional check of the bore and shall record on a diagram the actual diameters of the bore and their positions relative to one end of the shaft (refer sketch). The diagram shall be submitted to BHEL (Bhopal) together with the certificates called for in this specification.

5. **TESTING**

5.1 **Material testing**

Test pieces: Test pieces shall be as specified in the material specification, except when otherwise started in the drawing or in the purchase order. Test pieces to be forged integral & to be cut from heat treated forging by cold process only and shall receive no further heat treatment. They shall be cut only in the presence of BHEL or BHEL appointed inspection agency or BHEL's customer and stamped with hard punching (painting not permitted)

Test pieces shall be cylindrical in shape.

- Radial test piece shall be taken from one end of the forging.
- Tangential test piece shall be taken from the other end of the forging.

Test piece shall be cut as given below:

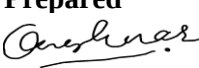
- For solid forgings:** At a distance of 1/3 th radius or 1/6 th diameter from the outer surface.
- For hollow forgings:** Midway between the inner and outer surface of the wall thickness.

Along with each shaft 1 set of test samples duly stamped with hard punching of heat no. and drawing no. /PO no. to be dispatched to BHEL Bhopal. This is a must.

5.2 **Non-destructive testing**

Shall comply with BHEL Corporate Standard AA 085 01 01(latest revision).

- Each forging shall be 100% ultrasonically tested and 100% magnetic particle tested in accordance with BHEL's standard AA 0850101.

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<u>PURCHASE SPECIFICATION FOR FORGED</u> <u>ROUGH MACHINED MAIN SHAFT FOR HYDRO TURBINE</u>		

- b. Borescopic test for central hole shall be carried out as per AA 0850101 before application of anti-corrosion compound.

6 IDENTIFICATION

Each forging shall be identified with the corresponding chemical analysis & mechanical tests by being clearly stamped with the **Heat Number** which shall be located as shown in the sketch.

7 TEST CERTIFICATES

Six copies of the forge master's works test certificate and shall contain the following information:

HT 00242 (latest Rev. No.)
 BHEL's purchase order No.
 Drawing No. (latest Rev. No.)
 Material specification No.
 Forging identification No.
 Dimensional record
 Chemical composition including trace elements (called for in material spec.)
 Mechanical properties (called for in material spec.), orientation of test sample to be also mentioned
 Details of heat treatment
 Results of magnetic particles tests
 Results of ultrasonic testing
 Results of borescopic examination of bore
 Reduction ratio

8 INSPECTION AT VENDOR'S WORKS

The final inspection at the forge master's works shall be carried out in the presence of BHEL's representative. The representative shall have free access at all times to all parts of the vendor's works where the material is being manufactured and shall be at liberty to inspect the manufacturing at any stage, using any non-destructive method and have the right to reject any material which does not conform to this specification.

Any inspection which the BHEL's representative has carried out shall in no way relieve the forge master of his responsibility for examining, testing and furnishing of certificates completed as specified.

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<u>PURCHASE SPECIFICATION FOR FORGED</u> <u>ROUGH MACHINED MAIN SHAFT FOR HYDRO TURBINE</u>		

9 REJECTION & REPLACEMENT

In the event of any forging proving defective in the course of preparation, machining, testing or erection, such forging shall be rejected, notwithstanding any previous certification of satisfactory testing and/or inspection.

The vendor shall undertake to replace the rejected forging at his own cost and the rejected forging shall be sent back to the vendor after fulfilling the commercial terms and conditions.

10 APPROVED ANTI-CORROSION COMPOUNDS

The composition of anti-corrosive compounds shall be based on either of the following :

- Mineral oil & inhibitive pigments with suitable additives.
- Synthetic resin inhibitive pigment (Zinc Chromate) with suitable additives.
- Lanolin & suitable additives dissolved in appropriate solvent blends.
- Wool felt & other corrosion inhibitors.

The compound shall be capable of withstanding tropical climate for a period of at least six months without any damage.

11 PACKING

Each forging shall be properly protected with anti-corrosive compound. Forgings shall be suitably packed to prevent corrosion and damage during transit.

12 DOCUMENTS TO BE SUBMITTED ALONG WITH OFFER

QA plan and manufacturing process chart comprising of manufacturing sequence, heat treatment cycle with stage wise test schedule.

NOTE: WITHOUT ABOVE DOCUMENTS, THE OFFER OF VENDOR SHALL NOT BE EVALUATED.

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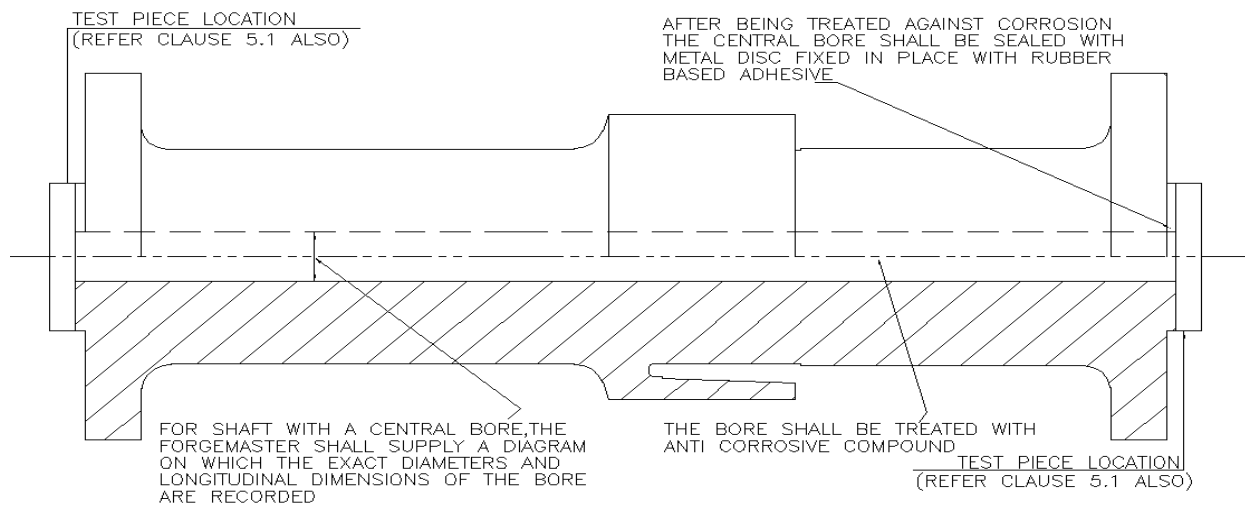
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Page 6 of 6

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