



## PRODUCT STANDARD HYDROGENERATOR

HG 10035 REV.05

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### SPECIFICATION FOR SHAFT/THRUST COLLAR FORGINGS FOR HYDROGENERATORS

#### 1. GENERAL

1.1 Shaft/Thrust collar forgings for Hydrogenerators shall be procured in rough machined condition, as per requirements given in this specification and forging drawing made for individual project.

1.2 Comparable Standard for material : Generally to IS :4431 (latest version)

#### 2. CONDITION OF DELIVERY:

Normalised / Normalised & Tempered

Rough machining of the forgings shall be carried out unless otherwise specified on the order/drawing.

#### 3. DIMENSIONS AND TOLERANCES:

The dimensions and tolerances shall be as specified on the order/drawing. Wherever these are not specified, the machining allowances and tolerances shall be as specified below:

For rough machined drawings : +2/-0 on outside diameter and +0/-2 on inside diameter

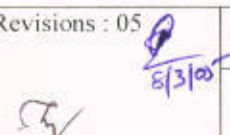
#### 4. MANUFACTURE:

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

The steel for this forging shall be vacuum degassed to protect the forgings 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 and finishing temperature shall be such as to ensure complete soundness and adequate uniformity of structure and mechanical properties after heat treatment. The forgings shall not be overheated.

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

## 5. HEAT TREATMENT:

Forgings shall be normalised at suitable temperature to give the mechanical properties specified.

## 6 FINISH:

As mentioned in the drawing.

## 7 FREEDOM FROM DEFECTS:

Forgings shall be free from defects such as cracks, flakes, seams, segregation, harmful non-metallic inclusions and other defects which may affect the utility of the forgings.

## 8. CHEMICAL COMPOSITION:

The melt analysis of steel and permissible variation in the composition of the forgings from the melt analysis shall be as follows:

Element	Melt analysis, Percent		Permissible variation, Percent
	Min.	Max.	
Carbon	0.24	0.32	± 0.02
Silicon	0.10	0.35	± 0.03
Manganese	1.30	1.70	± 0.10
Sulphur	--	0.035	+ 0.006
Phosphorus	--	0.035	+ 0.006

### Notes:

Elements not quoted above shall not be added to the steel, other than for the purpose of finishing the heat and shall not exceed the following limits:

Element	Percent, Max.
Nickel	0.30
Chromium	0.30
Copper	0.30
Molybdenum	0.15
Vanadium	0.05
Tin	0.05



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### 9. TEST SAMPLES:

9.1 Test samples should be cut from the heat treated forgings by cold process only and shall receive no further heat treatment.

Test samples shall be cylindrical in shape.

- (a) Radial test piece shall be taken from one end of the forging.
- (b) Tangential test piece shall be taken from other end of the forging.
- (c) Test piece diameter shall be 16mm min. (as per IS-1608:1995, amd. No. 1, May 2002, table 5).

Test piece shall be cut as below:

- (i) For solid forgings : at a distance of one-third radius or one-sixth diagonal from the outer surface.
- (ii) For hollow forgings : midway between the inner and outer surface of the wall thickness.

### 10 MECHANICAL PROPERTIES:

The test pieces, shall show the following properties for all ruling sections. Test methods are specified below:

- 10.1 Tensile test : IS:1608
- 10.2 Hardness test (Brinell) : IS:1500
- 10.3 Charpy Impact Value (2mm U-Notch): IS:1499
- 10.4 Mechanical properties

- |      |   |  |
|------|---|--|
| i.   | Tensile strength (in any direction)       | 560 N/mm <sup>2</sup> Min                    |
| ii.  | Yield strength (in any direction)         | 335 N/mm <sup>2</sup> Min                    |
| iii. | Elongation 5.65 $\sqrt{}$ so gauge length | Radial – 10% min<br>Tangential – 12 % Min    |
| iv.  | Charpy impact value (2 mm U notch)        | Radial – 23 joules<br>Tangential - 29 joules |
| v.   | Hardness (Brinell) for reference only     | 156 – 212                                    |

### 11. N.D.T.

11.1 Each forging shall be tested ultrasonically in accordance with BHEL Standard No. AA0850101 after final completion of all operations on the forging. All transition zones shall be subject to magnetic particle test as per above standard, before application of antirust compound.

11.2 Boroscopic test for central hole in case of shaft forging shall be carried out to AA 0850101 before application of antirust compound



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### 12. TEST CERTIFICATES:

Three copies of test certificates shall be supplied unless otherwise stated on the order. In addition, the supplier shall ensure to enclose one copy of the test certificate along with their dispatch documents to facilitate quick clearance of the material.

The following details shall be furnished in the test certificate

- i) Reduction Ratio.
- ii) Dimensional Inspection.
- iii) Details of heat treatment.
- iv) Chemical composition including trace elements.
- v) Results of mechanical tests.
- vi) Results of ultrasonic test.

### 13. INSPECTION AT SUPPLIER'S WORKS :

Tests and inspection are to be conducted in the presence of purchaser's representative.

The representative shall have free access at all times while the work on the contract is being performed. All facilities without charge to be provided to purchaser during inspection including provision of test specimen and its testing. If necessary supplier shall make necessary arrangement for carrying out the test elsewhere.

### 14. REJECTION AND 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 supplier shall undertake to replace the rejected forgings at his own cost and the rejected forgings shall be sent back to the supplier after fulfilling the commercial terms and conditions.

### 15. PACKING AND MARKING:

The shaft forging shall be properly protected with anticorrosive compounds.

Forgings shall be suitably packed to prevent corrosion and damage during transit.

### 16. DOCUMENTS TO BE SUBMITTED ALONG WITH OFFER

Manufacturing process chart comprising of manufacturing sequence, forging sequence, heat treatment cycle with stage wise test schedule

**NOTE : WITHOUT THIS DOCUMENT, OFFER WILL BE CONSIDERED INCOMPLETE.**

Rev. 01 – Clause 2, 4, 7 & 13 – Modified. Clause 14, 15 & 16 added

Rev.02 – Clause 11.2 added.

Rev.05 – Clause 10.4(iii),(iv) updated (8<sup>th</sup> March,2005)

Rev.03 – Clause 1.2 modified

Rev.04 – Clause 9 modified (7<sup>th</sup> September, 2004)