

		BHEL बी.एच.ई.एल. SPECIFICATION OF ALLOY STEEL FORGINGS-HARDENED AND TEMPERED FOR HYDROGENERATOR		HG 06004 Rev. 01 PAGE 1 OF 7	
गोपनीय एवं अधिकार सुरक्षित इस प्रपत्र पर दी गई जानकारी भारत हेवी इलेक्ट्रिकल्स लिमिटेड की संपत्ति है इसे प्रत्यक्ष या अप्रत्यक्ष रूप से कम्पनी के हितों को नुकसान पहुँचाने के लिए कदापि उपयोग नहीं किया जावे		ALLOY STEEL FORGINGS - HARDENED AND TEMPERED 1. GENERAL : This specification governs the quality of forged alloy steel forgings in Hardened & Tempered Condition. 2. APPLICATION : Pole end plates, shafts and other components for generators. 3. CONDITION OF DELIVERY : Forged, Hardened & Tempered in the "rough machined" condition. Forgings shall be commercially straight. 4. COMPLIANCE WITH BHEL / NATIONAL STANDARDS : There is no Indian Standard covering this type of material. 5. DIMENSIONS AND TOLERANCES : The dimensions and tolerances shall be as specified on the order/drawing, and shall not exceed these dimensions. A tolerance of 3 mm for finish has been provided in specifying the rough turned dimensions. Any forging which is bent to interfere with its finishing to desired sizes shall be rejected. 6. MANUFACTURES : Forgings shall be manufactured from steel produced by the open hearth, electric or such other process as may be agreed to between the BHEL and the supplier. 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. Forgings shall not be over heated.			
		Rev.01 Date: 29/09/2016 - Ref. of BHEL standard BP19389 is removed from Sr. No. 4 - Sr. No.11 ,Mechanical Properties UTS, elongation & Hardness updated ANUPAM KUMAR 29/09/16 P. CHAUDHURI 29/9/2016 14-07-2008 हाइड्रोजेनरेटर इंजीनियरिंग विभाग भारत हेवी इलेक्ट्रिकल्स लिमिटेड तैयारकर्ता अनुमोदनकर्ता जारी करने की दिनांक -Sd- -Sd- ANUPAM KUMAR P.CHAUDHURI 14-07-2008			

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The minimum reduction ratio when forgings are made out of ingots shall be 4:1.

The coupling or driven end of the shaft shall be indicated on the drawing. These ends shall correspond to the bottom of the ingot.

7. HEAT TREATMENT :

After forging and rough turning, the forgings shall be hardened & tempered. Forgings shall be free from uneven internal stresses, and shall have homogeneous grain structure.

Details of heat treatment shall be furnished to BHEL as and when called for.

8. FREEDOM FROM DEFECTS :

The forging shall be homogeneous, free from excessive hardness, slag spots, sand seams, blow holes, clinks, cracks or other imperfections.

9. CHEMICAL COMPOSITION :

The chemical composition of the material based on melt analysis shall comply with the following requirement.

Element	% Minimum	% Maximum
Carbon	0.19	0.25
Manganese	0.60	1.00
Silicon	-	0.35
Sulphur	-	0.03
Phosphorus	-	0.03
Nickel	0.35	0.75
Chromium	0.35	0.65
Molybdenum	0.15	0.25

Note : Carbon equivalent shall not be exceed 0.50 percent when calculated from the formula given below :

$$CE = C + \frac{Mn}{6} + \frac{Cr + Mo + V}{5} + \frac{Ni + Cu}{15}$$

10. TEST SAMPLES :

10.1 Unless otherwise specified on the order/drawing, test samples shall be taken from each cast and each heat treatment batch. Test samples should be cut from the heat treated forgings by cold process only and shall receive no further heat treatment.

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Test samples shall be taken from locations indicated on the drawing, leaving enough material, if required, for testing at purchaser's end, integral with the forging.

10.2 When integral test pieces are not called for and it is not possible to destroy the forgings, separate test samples as mentioned on the order/drawing shall be provided from the blooms and billets from which the forgings are made. They shall be forged to the ruling section of the main forgings and shall be heat treated similarly and simultaneously with the forgings they represent.

10.3 Test samples shall be cylindrical in shape.

(a) Longitudinal / Radial test piece shall be taken from one end of the forging.
Radial test piece may be taken from economic considerations.

(b) Tangential test piece shall be taken from other end of the forging.

(c) Test piece diameter shall be 10mm for HG 06004 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.

11. MECHANICAL PROPERTIES : (Longitudinal)

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 Mechanical properties

i)	Tensile strength (in any direction)	- 620 N/mm ² Min
ii)	Yield strength (in any direction)	- 462 N/mm ² Min
iii)	Elongation 5.65 " so gauge length long / Radial - 16 % min	Tangential - 16% min
iv)	Reduction in area	- 40% min.
v)	Hardness (Brinell) for reference only	190-260

Note: For an indication of the general quality of the steel, the broken test pieces shall show a fracture of uniform silky appearance free from granular black or brilliant specks, though this would not be criteria for rejection.

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12. MAGNETIC PROPERTIES: (For information only).

Magnetic Field Strength (H) A/m	Magnetic Induction (B) Minimum Tesla or Wb/m ²
3400	1.39
6200	1.55
10400	1.70
14800	1.76

One sample of size Ø 13 x 50 shall be taken from the each P.F. and shall be submitted to BHEL for testing for B/H-Magnetisation properties, irrespective of whether supplier has got facilities or not for the same.

13. NON-DESTRUCTIVE TESTING (OPTIONAL) :

When stated on the order/drawing, the forgings shall be ultrasonically tested to BHEL Corporate Standard AA 085 0101 for shafts and to AA 085 01 18 for other forgings. Acceptance Standard shall comply with category class mentioned in the standards & called for on the order/drawing.

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

14. 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.
- viii) Microstructure examination report.

In addition, the supplier shall ensure to enclose one copy of the test certificate along with their despatch document to facilitate quick clearance of material.

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ANNEXURE - I : RECOMMENDED TEST CERTIFICATE FORMAT FOR FORGINGS

Annexure - 1

Supplier's Name and Address

- | | |
|---|---|
| 1. Customer | 9. Reduction : ingot to Bloom |
| 2. TC No. & Date | Ratio Bloom to Blank |
| 3. PO No. | 10. Batch No. |
| 4. Process of Malting Ingot | 11. Heat / Melt No. |
| 5. Deoxidisation Process | 12. Spec. No. |
| 6. Forging Method | 13. Test Bar Size & Nos. |
| 7. BHEL's Reference for Approval of Bloom | 14. Supplier of the Ingot/billet/
Bloom and TC reference |
| 8. Discard : Top _____% Bottom _____% | |

15. FORGINGS COVERED BY TEST CERTIFICATE

15. FORGINGS COVERED BY TEST CERTIFICATE			
S.No.	Drawing No. & Item No.	Description	Quantity & Weight

16. CHEMICAL COMPOSITION (PERCENT)

[illegible]

17. HEAT TREATMENT

(To be accompanied by Recorder Chart, Whenever called for)

Condition	Heating Rate °C/hr	Temp °C	Soaking Time Hrs.	Cooling Rate °C/hr	Cooling Medium

18. MECHANICAL PROPERTIES

[illegible]

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