

	CORPORATE PURCHASE SPECIFICATION		AA 193 33		
			Rev. No. 09		
			PREFACE SHEET		
CARBON STEEL FORGINGS, CLASS 4 ↑ FOR INTERNAL USE ONLY REMOVE THIS PREFACE BEFORE ISSUE TO SUPPLIERS Comparable Standards: 1. INDIAN : IS: 2004 - 1991 Gr: Class 4 (45 C8) ↑ Suggested/Probable Suppliers and Grades: Refer plant vendors list. User Plant References: 1. BHOPAL 2. HEEP, HARDWAR 3. HYDERABAD 4. TIRUCHY : PS10211 : GOST 1050,Gr:45 : IS 2004, CI 4 & CSN 411600.0 : IS:2004, CLASS 4					
Revisions : 36 th MOM OF MRC+HTM			APPROVED : INTERPLANT MATERIAL RATIONALISATION COMMITTEE-MRC (FC&F+HTM)		
Rev. No. 09	Amd.No.	Reaffirmed	Prepared	Issued	Dt. of 1st Issue
Dt.:23.01.2007	Dt :	Year:04-11-2011	HARDWAR	Corp. R&D	JANUARY.1978



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CARBON STEEL FORGINGS, CLASS 4

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1.0 GENERAL:

This specification governs the quality requirements of Carbon Steel Forgings, class 4.

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2.0 APPLICATION:

Suitable for general engineering purposes.

3.0 CONDITION OF DELIVERY:

Normalised/Normalised and tempered.

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

4.0 COMPLIANCE WITH NATIONAL STANDARDS:

The forgings shall comply, in general with the requirement of the following National standards and also meet the requirements of this specification.

IS::2004: 1991(RA 2001) (RA-2006) } Carbon Steel Forgings For General Engineering

Gr: Class 4 (45C8), } Purposes.

↑

5.0 DIMENSIONS AND TOLERANCES:

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

For finish machined drawings : 3 ± 1 mm

For rough machined drawings : ± 1 mm

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**6.0 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.

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.

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

For sizes above 250 mm ruling section, the minimum reduction ratio shall be 3.5:1

Note: Raw material like Ingots/Blooms/Billets required for forgings should be procured from BHEL approved sources along with test certificate."

7.0 HEAT TREATMENT:

Forgings shall be normalised / normalised and tempered at suitable temperature to achieve the mechanical properties specified. ↑

Test pieces shall also be heat treated along with the forgings they represent.

8.0 FINISH:

As mentioned in the drawing.

9.0 FREEDOM FROM DEFECTS:

The forging shall be free from defects, such as cracks, fold, flakes, seams, segregation, nonmetallic inclusions and other defects which may affect the utility of the forging.

10.0 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	0.40	0.50	± 0.03
Silicon	0.15	0.35	± 0.03
Manganese	0.60	0.90	± 0.04
Sulphur	---	0.040	+ 0.005
Phosphorus	---	0.040	+ 0.005



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Notes:

1. 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	0.25
Molybdenum	0.05
Vanadium	0.05
Tin	0.05
Boron	0.0003

2. When steel is aluminium killed or killed with both aluminium and silicon, the requirements of minimum silicon content shall not apply. For aluminium killed steel the total aluminium content shall be within 0.02 to 0.05 percent.
3. $Mo \leq 0.15\%$, limiting to meeting conditions of $Cr + Mo + Ni = 0.5\%$.

11.0 TEST SAMPLES:

- 11.1 Unless otherwise specified in the order/drawing, test samples shall be taken from each melt and each heat treatment batch. Test samples should be cut from the heat treated forgings by cold process only and shall not have further heat treatment.

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

The samples shall be cylindrical or rectangular in shape and cut at a distance of 12.5mm below the heat treated surface.

- 11.2 When integral test pieces are not called for, a test sample, having similar reduction ratio and heat treatment, as the forgings it represents, shall be provided per heat, per heat treatment batch, for check testing at BHEL, along with the forgings. The samples shall be properly identified and correlated with the Heat/Heat treatment Batch No./ Test Certificate No. Test samples shall be taken, at a distance of 12.5mm below the heat-treated surface.
- 11.3 Test samples shall generally be taken in the longitudinal direction. However, for economic reasons or where the size/ configuration does not permit the same, test samples may be taken in the transverse or radial direction.

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12.0 MECHANICAL PROPERTIES:

The test pieces, after being heat treated as per clause 7.0 above, shall show the following properties upto a limiting ruling section of 800 mm. Properties for thicker sections shall be subject to agreement between BHEL and the manufacturer. Test methods are specified below:

- 12.1 Tensile test : IS:1608
- 12.2 Hardness test (Brinell) : IS:1500
- 12.3 Charpy Impact Value (2mm U-Notch) : IS:1499

This test applicable for forgings of sizes above 16mm only.

Property	Sample (See Cl.11.3)	Limiting ruling section, mm			
		Upto & incl 100	>100 & upto 300	> 300 & upto 500	>500 & upto 800
Tensile strength N/mm ²	Longitudinal/ Transverse/ Radial/Tangential	620	620	530	530
Yield strength min, N/mm ²	Longitudinal/ Transverse/ Radial/Tangential	320	320	275	275
Elongation on 5.65 $\sqrt{S_0}$ gauge length percent, min	Longitudinal Transverse Radial Tangential	15 8 10 11	14 7 9 10	15 8 10 10	13 6 8 9
Reduction in area, percent min.	Longitudinal Transverse Radial Tangential	38 23 25 30	35 21 24 28	32 19 21 24	30 18 19 23
*Hardness, Brinell, HB	—	175-207	175-207	149-197	149-197
Charpy Impact Value (2mm, U-Notch) min., Joules	Longitudinal Transverse Radial Tangential	31 16 19 24	27 14 16 21	23 12 14 16	23 12 14 16

Note: 1. Unless otherwise stated on the order/drawing, small forgings of non-critical nature weighing less than 300kg shall be accepted on the basis of chemical composition and hardness.

* 2. Hardness test can be conducted only, when tensile test can not be performed.



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13.0 ULTRASONIC TESTS:

- 13.1 For forgings ordered by BHEL, Hyderabad: Unless other wise specified on the drawing, ultrasonic test shall be carried out as per BHEL standard AA 085 01 18 and norms of acceptance shall be as per category 2.
- 3.13.2 For forgings ordered by other units: If specified on the drawing/order, ultrasonic test shall be carried out as per BHEL standard AA 085 01 18 and norms of acceptance shall be as per category 2, unless otherwise specified.

14.0 ADDITIONAL TESTS:

If specified in the drawing/order, the following tests shall be conducted:

- 14.1 Bend Test (Longitudinal):
The test pieces (230mm long and 32 mm square with edges rounded off, where the dimensions permit) shall be capable of being bent cold by direct pressure without fracture, until the sides are parallel, round a mandrel having a diameter of 44 mm when tested as per IS:1599.
- 14.2 Magnetic particle test.
- 14.3 Any other tests: Norms of acceptance shall be as specified in the drawing/order.

15.0 SCOPE OF THIRD PARTY INSPECTION:

Wherever, separate quality plan is not attached, the scope of third party inspection shall be as follows:

1. Review of supplier's declared chemical composition.
2. Selection of test samples for mechanical tests and witness of mechanical tests.
3. Witness of Non-destructive tests as applicable.
4. Review of HT charts.
5. Dimensional inspection.

16.0 TEST CERTIFICATE:

Three copies of test certificates 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 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) Chemical composition including trace elements.
- iv) Results of mechanical tests.
- v) Results of Ultrasonic test
- vi) Details of heat treatment
- vii) Results of additional tests called for in the drawing/order.

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17.0 PACKING & MARKING:

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

Machined surfaces shall be properly protected with anticorrosive compounds.

Each package or forging (when supplied separately) shall be legibly marked with the following information:

AA 193 33 : Carbon Steel Forgings, Class 4 ↑

BHEL Order No.

Suppliers Name

Consignment/ Identification No.

Batch No.

Weight.

18.0 REFERRED STANDARDS (Latest publications Including Amendments):

1) AA 085 01 18	2) IS:1499	3) IS:1500	4) IS:1599
5) IS: 1608	6) IS: 2004		



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ANNEXURE-I: RECOMMENDED TEST CERTIFICATE FORMAT FOR FORGINGS

SUPPLIER'S NAME AND ADDRESS													
TEST CERTIFICATE FOR FORGINGS													
1. Customer:							9. Reduction Ratio } Ingot to Bloom Bloom to Blank						
2. TC No. & Date:							10. Batch No.:						
3. PO No.:							11. Heat/Melt No.						
4. Process of Melting Ingot:							12. Spec. No.						
5. Deoxidisation Process:							13. Test Bar Size & Nos.						
6. Forging Method:							14. Supplier of the ingot/billet/ Bloom and TC reference.						
7. BHEL's Reference for Approval of Bloom													
8. Discard: Top % Bottom %													
15. FORGINGS COVERED BY TEST CERTIFICATE													
S.No.		Drawing No. & Item No.			Description				Quantity & Weight				
16. CHEMICAL COMPOSITION (PERCENT)													
Element		C	Si	Mn	S	P							
As Per Specn.		Min.											
		Max.											
Actual Values													
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													
		T.S. N/mm ²	Y.S. 0.5/0.2% Proof N/mm ²	% Elongation 5.65√So GL	% R.A. Min.	Hardness BHN (Min. 3 values)	Impact Value Joules	Bend Test					
								Angle of bend	Dia of mandrel	Result			
As Per Specn.		Min.											
		Max.											
Actual Values													
19. SURFACE FINISH (When called for in the order/drg.)													
20. DIMENSIONAL INSPECTION													
21. NON-DESTRUCTIVE TESTS													
Nature of Test		Acceptance level		Instrument used		Range		Results		Any other detail			
Ultrasonic													
Radiographic													
Dye penetrant/ Magnetic Particle													
22. METALLOGRAPHIC EXAMINATION (To be conducted if called for and photo micrographs to be attached along with a report)													
Location of Sample		Etchant used		Magnification		Constituent observed		Relative %					
Microstructure		Macroetch		Inclusion Rating									
23. OTHER TESTS IF ANY (MICROSCOPIC, SULPHUR PRINTS, ETC)													
24. 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 block 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.													