



CORPORATE PURCHASE SPECIFICATION

AA 193 31

Rev. No. 11

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CARBON STEEL FORGINGS, CLASS 2

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1.0 GENERAL:

This specification governs the quality requirements of Carbon Steel Forgings, Class 2.

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2.0 APPLICATION:

Suitable for general engineering purposes and for use in welded constructions.

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 material shall comply with the following National standards and also meet the requirements of this specification.

IS::2004 – 1991 (RA -2006) } Carbon Steel Forgings For General Engineering
Gr: 2 (20C8), } Purposes.

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5.0 DIMENSIONS AND TOLERANCES:

The dimensions and tolerances shall be as specified on 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

REVISIONS :

36th MOM OF MRC (FCF+HTM)

APPROVED :

INTERPLANT MATERIAL RATIONALISATION
COMMITTEE-MRC (FCF+HTM)

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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 FREEDOM FROM DEFECTS:

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

8.0 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.

9.0 FINISH:

As mentioned in the drawing.

10.0 CHEMICAL COMPOSITION:

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

Element	Percent		Permissible variation , percent
	min.	max.	
Carbon	0.15	0.25	± 0.02
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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NOTE:

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:

<u>Element</u>	<u>Percent, max.</u>
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. Percent Cu + 10 X (percent Tin) shall not exceed 0.5%.
4. Carbon equivalent (Melt analysis) value (C.E.) = 0.42%, max.

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

5. $Mo \leq 0.15\%$, 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 heat treatment batch. 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 or rectangular in shape and cut at a distance of 12.5 mm 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 12.5 mm below heat treatment 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 : IS: 1608

12.2 Hardness Test (Brinell) : IS:1500

12.3 Charpy Impact Value (2mm U-Notch): IS:1499

The test is applicable for forgings of sizes above 16mm only.

Property	Sample (CI 11.3)	Limiting ruling section, mm		
		Upto & incl.100	> 100 & upto 400	> 400 & upto 800
Tensile strength, min, N/mm ²	Longitudinal Transverse/ Radial/ Tangential	430	390	370
Yield strength, min, N/mm ²	Longitudinal Transverse/ Radial/ Tangential	230	195	185
Elongation on 5.65√So gauge length percent, min.	Longitudinal Transverse/ Radial/ Tangential	24 12 16 18	23 11 15 17	21 9 13 15
* Hardness, Brinell, HB	----	120 – 167	111 – 156	111 - 156
Charpy Impact value (2mm U-Notch) min., joules	Longitudinal Transverse/ Radial/ Tangential	47 24 28 35	43 22 26 32	40 20 24 28

Note:


1. Unless otherwise stated on the order/drawing small forgings of non-critical nature weighing less than 300 kg 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.

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.

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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 on 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: <div><div>1. Review of supplier's declared chemical composition.</div><div>2. Selection of test samples for mechanical tests and witness of mechanical tests.</div><div>3. Witness of Non-destructive tests as applicable.</div><div>4. Review of HT charts.</div><div>5. Dimensional inspection.</div></div>		
16.0 TEST CERTIFICATES: Three copies of a test certificates shall be supplied, unless otherwise stated in the order, in the Test Certificate proforma annexed to this specification (Annexure -I). 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: Dimensional inspection. Details of heat treatment. Reduction ratio Chemical composition including trace elements. Results of mechanical tests. Results of Ultrasonic test Results of ultrasonic examination. Results of additional tests called for in the drawing/order.		
17.0 PACKING & MARKING: Forgings shall be suitably packed to prevent 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 31 - Carbon Steel Forgings, Class 2 (20C8). BHEL Order No. Suppliers Name Consignment/ Identification No. Batch No. Weight.		
18.0 REFERRED STANDARDS (Latest publications Including Amendments): <div><div>1) IS:1499</div><div>2) IS:1500</div><div>3) IS:1599</div><div>4) IS:1608</div><div>5) IS:2004</div><div>6) AA 085 01 18</div></div>		

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ANNEXURE-I: RECOMMENDED TEST CERTIFICATE FORMAT FOR FORGINGS

SUPPLIER'S NAME AND ADDRESS											
TEST CERTIFICATE FOR FORGINGS											
1. Customer: 2. TC No. & Date: 3. PO No.: 4. Process of Melting Ingot: 5. Deoxidisation Process: 6. Forging Method: 7. BHEL's Reference for Approval of Bloom 8. Discard: Top _____%; Bottom _____%	9. Reduction Ratio } Ingot to Bloom } Bloom to Blank 10. Batch No.: 11. Heat/Melt No. 12. Spec. No. 13. Test Bar Size & Nos. 14. Supplier of the ingot/billet/ Bloom and TC reference.										
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				
As Per Specn.	Min.						Angle of bend	Dia of mandrel	Result		
	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.											
<p>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.</p> <div style="display: flex; justify-content: space-between;"> <div style="width: 45%;"> <p>SIGNATURE, NAME & SEAL OF THE INSPECTING OFFICER DATE:</p> </div> <div style="width: 45%;"> <p>SIGNATURE, NAME & SEAL OF THE CHIEF OF QUALITY CONTROL/ CHIEF METALLURGIST OF THE SUPPLIER DATE:</p> </div> </div> <p>INSTRUCTIONS</p> <p>a) Details of all heat treatment processes carried out should be furnished sequentially in 17.</p> <p>b) Test certificates are to be furnished as per Purchase order and specification, in A4 size preferably in transparent paper.</p> <p>c) All the entries including signature should be in block colour ink.</p> <p>d) If testing is done by outside agencies, the original TCs shall be furnished.</p> <p>e) The actual TC may run into more than one A4 size paper, if needed, to facilitate filling up of details.</p>											