1.5% MANGANESE STEEL FORGINGS – NORMALIZE / NORMALIZE & TEMPERED

1.0 GENERAL:

This specification governs the quality requirements of 1.5% Manganese Steel Forgings, Normalised.

2.0 APPLICATION:

Suitable for components requiring high strength and weldability.

3.0 CONDITION OF DELIVERY:

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

4.0 COMPLIANCE WITH NATIONAL STANDARDS:

There is no national standard covering this material.

5.0 DIMENSIONS AND TOLERANCES:

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

For finish machined drawings : 3 ± 1 mm

For rough machined drawings : ± 1 mm

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 over heated.

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

For sizes above 250mm 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 hardened and tempered to give 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;

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.

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 specified below :

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

Note:

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

11.0 T EST 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 receive no 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 the forging.

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 equivalent to the ruling section or 65 mm diameter, whichever is less and 610 mm long, 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 sample 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 12.5 mm 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. The test sample orientation shall be mentioned in the test certificate.

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 section of 800mm. Properties for thicker sections shall be subject to agreement between BHEL and the mainufacturer. Test methods are specified below:

12.1 Tensile test : 18:1608

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 ruiing section, mm			
		upto 100	>100 upto 250	> 250 upto 500	> 500 upto 800
Tensile strength N/mm^2	Longitudinal/ Transverse/ Radial/Tangential	600	560	540	520
Yield strength min, N/mm^2	Longitudinal/ Transverse/ Radial/Tangential	365	335	325	305
Elongation on 5.65 √So gauge length percent, min	Longitudinal	16	16	15	14
	Transverse	8	8	8	7
	Radial	10	10	10	8
	Tangential	12	12	12	10
*Hardness, Brinell,HB	—	174 - 223	156 – 212	150 – 205	145 - 200
Charpy Impact Value (2mm, U-Notch) min.,Joules	Longitudinal	39	39	39	35
	Transverse	20	20	20	18
	Radial	23	23	23	21
	Tangential	29	29	29	26

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

13.0 ULTRASONIC TEST:

Each forging shall be tested ultrasonically in accordance with BHEL standard AA 085 01 18 to ensure freedom frow internal defects. The norms of acceptance shall be as per Category 2 of the above standard.

14.0 ADDITIONAL TESTS:

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

i) Magnetic particie test.

ii) Any other tests.

Norms and 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 CERTIFICATES:

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 docuroents to facilitate quick clearance of the material.

The test certificate shall bear the following Information.

Dimensional Inspection.
Details of heat treatment.
Reduction ratio
Chemical composition including trace elements.
Results of mechanical tests.
Results of ultrasonic test.
Results of additional tests called for in the order/drawing.

17.0 PACKING AND MARKING:

Forgings shall be suitably packed to prevent corrosion and damage during transit. Machined surfaces shall be properly protected with anti-corrosive compounds. Each package or forging (when supplied separately) shall be legibly marked with the following Information:

AA 193 42 : 1.5% Manganese Steel Forgings – Normalised
BHEL Order No.
Consignment/Identification No.
Weight.
Batch No.
Supplier/s name

18.0 REFERRED STANDARDS (Latest Publications Including Amendments):

l. AA 085 01 18 2. IS: 1499 3. IS: 1500 4 IS: 1608

CORPORATE PURCHASE SPECIFICATION

ANNEXURE - 1: 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/mm²	Y.S. 0.5/0.2% Proof N/mm²	% Elongation $5.65\sqrt{So}$ 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.