

	CORPORATE PURCHASING SPECIFICATION	AA19358 Rev No.08 PREFACE SHEET															
1.5% NICKEL – CHROMIUM – MOLYBDENUM STEEL FORGINGS – HARDENED AND TEMPERED FOR INTERNAL USE ONLY REMOVE THIS PREFACE BEFORE ISSUE TO SUPPLIERS Equivalent/Comparable Standards: <table style="width: 100%; border: none;"> <tr> <td style="width: 35%;">1. INDIAN</td> <td style="width: 5%; text-align: center;">:</td> <td>IS: 4367 – 1991- up to 150 mm only Gr.:40Ni6Cr4Mo3, Hardened and Tempered</td> </tr> <tr> <td>2. BRITISH</td> <td style="text-align: center;">:</td> <td>BS 4670 – 1971, Gr.:818M40 Hardened and Tempered</td> </tr> </table> Suggested/Probable Suppliers and Grades: Refer plant vendors list. User Plants and Replaced Plant Specifications/References: <table style="width: 100%; border: none;"> <tr> <td style="width: 35%;">1. HEEP, HARDWAR</td> <td style="width: 5%; text-align: center;">:</td> <td>0500.7031, Gr: 34X H1M</td> </tr> <tr> <td>2. HPEP, HYDERABAD</td> <td style="text-align: center;">:</td> <td>HY 19369, TDC 003/71, TDC 200/76, BS 4670 Gr. 818M40, IS: 4367, UNI 40NiCrMo7</td> </tr> <tr> <td>3. HEP, BHOPAL</td> <td style="text-align: center;">:</td> <td>PS10524</td> </tr> </table>			1. INDIAN	:	IS: 4367 – 1991- up to 150 mm only Gr.:40Ni6Cr4Mo3, Hardened and Tempered	2. BRITISH	:	BS 4670 – 1971, Gr.:818M40 Hardened and Tempered	1. HEEP, HARDWAR	:	0500.7031, Gr: 34X H1M	2. HPEP, HYDERABAD	:	HY 19369, TDC 003/71, TDC 200/76, BS 4670 Gr. 818M40, IS: 4367, UNI 40NiCrMo7	3. HEP, BHOPAL	:	PS10524
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Revisions: Cl: 33.1.0, A.3 of MRC -FCF+HTM		APPROVED: INTERPLANT MATERIAL RATIONALISATION COMMITTEE – MRC(FCF+HTM)															
Rev No.08	Amd No.	Reaffirmed	Prepared	Issued	Dt. of 1 st Issue												
Dt:30-01-2008	Dt:	Year:2014	HEP, Bhopal	Corp.R&D	February, 1979												

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	CORPORATE PURCHASING SPECIFICATION	AA19358 Rev No. 08 PAGE 1 of 6				
1.5% NICKEL – CHROMIUM – MOLYBDENUM STEEL FORGINGS – HARDENED AND TEMPERED						
1.0 GENERAL: This specification governs the quality requirements of 1.5% Nickel – Chromium – Molybdenum Steel Forgings, Hardened and Tempered. The raw material for these forgings is covered by AA10559						
2.0 APPLICATION: Suitable for general engineering purposes.						
3.0 CONDITION OF DELIVERY: Hardened and tempered. Rough machining of the forgings shall be carried out, unless otherwise specified in 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: 4367 – 1991 : Alloy steel forgings for general industrial purpose. Gr: 40Ni6Cr4Mo3, H&T						
5.0 DIMENSIONS AND TOLERANCES: The dimensions and tolerances shall be as specified in BHEL order/drawing. Wherever these are not specified, the machining allowances and tolerances shall be as specified below. <table style="width: 100%; border: none;"> <tr> <td style="width: 40%;">For finish machined drawings</td> <td style="width: 60%;">: 3 ± 1 mm</td> </tr> <tr> <td>For rough machined drawings</td> <td>: ± 1 mm</td> </tr> </table>			For finish machined drawings	: 3 ± 1 mm	For rough machined drawings	: ± 1 mm
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 electric, arc furnace, there after refined by vacuum degassing or other process as may be agreed to between BHEL and the manufacturer.						
Revisions: Cl: 33.1.0, A.3 of MRC -FCF+HTM		APPROVED: INTERPLANT MATERIAL RATIONALISATION COMMITTEE – MRC(FCF+HTM)				
Rev No.08	Amd No.	Reaffirmed	Prepared	Issued	Dt. of 1 st Issue	
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CORPORATE PURCHASING SPECIFICATION



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.

Stress relieving of the forgings shall be done so that minimum residual stresses are leftover.

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	<u>Melt analysis</u> <u>percent</u>		<u>Permissible variation percent</u>	
	Min.	Max.	Upto 250 mm	>250 upto 500 mm
Carbon	0.35	0.45	± 0.02	± 0.04
Silicon	0.10	0.35	± 0.03	± 0.04
Manganese	0.40	0.70	± 0.04	± 0.06
Nickel	1.25	1.75	± 0.05	± 0.05
Chromium	0.90	1.30	± 0.05	± 0.06
Molybdenum	0.20	0.35	± 0.03	± 0.04
Sulphur	---	0.035	+ 0.005	+ 0.010
Phosphorus	---	0.035	+ 0.005	+ 0.010



CORPORATE PURCHASING SPECIFICATION

AA19358

Rev No.08

PAGE 3 of 6

Note:

- 1) Wherever necessary, more restricted ranges of chemical composition may be specified subject to mutual agreement between BHEL and the manufacturer.
- 2) 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
Copper	0.25
Vanadium	0.05
Tin	0.05

11.0 TEST SAMELES:

- 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 manufacturer. Test methods are specified below:

CORPORATE PURCHASING SPECIFICATION

**12.1 Tensile test:**

IS: 1608

12.2 Hardness test (Brinell):

IS: 1500

12.3 Charpy Impact Value:

IS: 1499

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

Property	Sample (See Cl: 11.3)	Limiting ruiing section, mm					
		Up to 30	>30 to 63	>63 to 100	>100 to 150	>150 to 250	>250 to 500
Tensile strength N/mm ²	Longitudinal/	1200	1100	1000	900	900	900
	Transverse/ Radial/Tangential	to 1350	to 1250	to 1150	to 1050	to 1050	to 1050
Yield strength min, N/mm ²	Longitudinal/ Transverse/ Radial/Tangential	1000	880	800	700	690	690
Elongation on $5.65\sqrt{S_0}$ gauge length percent, min	Longitudinal	10	11	13	13	13	13
	Transverse	5	6	7	7	7	7
	Radial	6	7	9	9	9	9
	Tangential	7	8	10	10	10	10
*Hardness Brinell,HB	----	355 to 399	325 to 370	295 to 341	266 to 311	262 to 311	262 to 311
Impact Value (ISO – U on 3 samples) min., Joules	Longitudinal	20	28	32	37	34	28
	Transverse	10	14	16	19	17	14
	Radial	12	17	19	22	20	17
	Tangential	15	21	24	28	26	21

* **Note:** Hardness test can be conducted only, when tensile test cannot be performed.**13.0 ULTRASONIC TEST:**

Each forging shall be tested ultrasonically in accordance with BHEL standard AA0850118 to ensure freedom from internal defects. The norms of acceptance shall be as per Category 2 of the above standard.



CORPORATE PURCHASING SPECIFICATION

AA19358

Rev No.08

PAGE 5 of 6

14.0 ADDITIONAL TESTS:

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

- i) Magnetic particle test.
- ii) Any other tests.

Norms and acceptance shall be as specified in the drawing/order.

15.0 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 documents 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.

16.0 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:

AA19358:1.5% Nickel – Chromium – Molybdenum Steel Forgings –Hardened and Tempered
BHEL Order No.:

Consignment/Identification No.:

Weight:

Melt. No.:

Batch No.

Supplier/s name

17.0 REFERRED STANDARDS (Latest publications including amendments):

1. AA0850118 2. IS: 1500 3. IS: 1608 4. IS: 1757 5. IS: 4367

AA19358

Rev No. 08

PAGE 6 of 6

CORPORATE PURCHASING SPECIFICATION



ANNEXURE - 1

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

As Per Specn.	Min.	Max.	T.S. N/mm ²	Y.S. 0.5/0.2% Proof N/mm ²	% Elongation 5.65√S ₀ GL	% R.A. Min.	Hardness BHN (Min. 3 values)	Impact Value Joules	Bend Test		
									Angle of bend	Dia of mandrel	Result
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

- Details of all heat treatment processes carried out should be furnished sequentially in 17.
- Test certificates are to be furnished as per Purchase order and specification, in A4 size preferably in transparent paper.
- All the entries including signature should be in block colour ink.
- If testing is done by outside agencies, the original TCs shall be furnished.
- The actual TC may run into more than one A4 size paper, if needed, to facilitate filling up of details.