



TD219
Rev.00

PLANT PURCHASING SPECIFICATION HYDERABAD

HY 194 60

REV. NO. 03

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Ni-Cr-Mo-V ALLOY STEEL FORGINGS

1.0 GENERAL:

This specification governs the quality requirements of Ni-Cr-Mo-V alloy steel forgings.

2.0 APPLICATION:

Used for forgings for Gas Turbines components such as compressor wheel, stub shaft etc.

3.0 CONDITION OF DELIVERY:

Rough forged, heat treated and rough machined condition.

4.0 COMPLIANCE WITH NATIONAL STANDARDS:

This material does not comply with any national standards. However, this specification is based on Grades B10, B8, B11&B12 of B50 A420 Rev.A of M/s. GE of USA.

5.0 DIMENSIONS AND TOLERANCES:

5.1 Dimensions: The dimensions shall be as specified on the drawings.

5.2 Tolerances:

- Unless otherwise specified in the drawing, all rough machined surfaces shall have a machining allowance of 3 ± 1 mm per surface for final machining at BHEL.
- For rough machined forging drawings, necessary finish machining allowance is included in the dimensions. Hence extra allowance is not required. The tolerance shall be ± 1 mm on dimension, unless otherwise specified on the drawing.

6.0 QUALIFICATION TESTING:

The qualification of forgings shall be as per GT10047 and relevant part specification.

Revisions:

Note 3 added in clause no. 11.0

Issued :

STANDARDS ENGINEERING & IPR
COORDINATION DEPARTMENT

Rev.No. 03

Amd. No.

Reaffirmed

Prepared:

Approved:

Dt.of 1st Issue

Dt. FEB., 2010


Dt.

Year: 2021

MATLS. ENGG.

DGM (EC)

NOV 1991

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7.0 MANUFACTURE:

The steel shall be made by the basic electric arc furnace with either

- ladle refining and a vacuum treatment or
- consumable arc remelting by either Vacuum arc Remelting or Electroslag Remelting.

Note: The vacuum system shall have the capacity to maintain a vacuum of 2 torr or lesser, for the time required to bring the gas content down to the desired level.

8.0 HEAT TREATMENT:

8.1 Conditioning: This treatment is done to refine the structure and prevent flaking or other deleterious phenomena. The minimum treatment shall be a austenising in the temperature range of 870 - 970°C. The cooling rate following the austenising treatment shall be sufficient to ensure complete transformation from austenite.

8.2 Hardening: Austenitizing shall be done in a temperature range of 815°C to 870°C and subsequently the forgings shall be quenched uniformly to achieve the complete transformation.

8.3 Tempering: Tempering shall be done in a temperature range of 580°C to 680°C to achieve all the given properties and cooling from the tempering temperature shall be done at an optimum rate which prevents embrittlement and large residual stresses.

9.0 TEST SAMPLES:

9.1 Chemical Analysis: One sample shall be taken per melt for chemical analysis.

9.2 Mechanical Properties: Bore and Rim samples shall be tested for each production forging to check for uniformity of properties. For first piece qualification testing, relevant process specification may be referred to.

10.0 CHEMICAL ANALYSIS:

The chemical composition of the material shall be as follows:

Element		C	Mn	Si	P	S	Ni	Cr	Mo	Cu	V	Fe
Specified value	Min. %	0.25	0.20	-	-	-	2.50	1.30	0.20	-	0.07	Bal
	Max. %	0.33	0.80	0.35	0.012	0.010	3.50	2.00	0.70	0.35	0.15	
Aim content		0.29	0.40	-	LAP	LAP	2.80	1.60	0.55	LAP	0.11	-
Permissible Variation		±0.02	±0.03	+0.05	+0.008	+0.005	±0.05	±0.05	±0.03	-	+0.02	-

Note: 1) LAP — Low as possible.



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2) O₂, Ca & Al may be used to accomplish various phases of melting operations. If used the levels of Ca, Al & O₂ must be reduced to the required levels in the final forging.

3) Residual elements shall be as low as possible. Any deviation will be referred to Materials Engg Section. The max allowable limits shall be as follows.

Antimony, max.	- 0.003%
Arsenic, max.	- 0.020%
Tin, max.	- 0.015%
Aluminium, max.	- 0.025%
Calcium, max.	- 0.010%
O ₂ max.	- 75 ppm
H ₂ , max.	- 2 ppm
Nitrogen, max.	- 100 ppm

4) Silicon content of 0.12% max. shall be reported when Vacuum Carbon Deoxidation (VCD) process is used.

5) Both N₂ & H₂ levels are indicative of the effectiveness of the vacuum treatment. Therefore the supplier can report either measurement on a sample after vacuum processing operation.

11.0 MECHANICAL TESTS:

The mechanical properties of the material shall be as follows (property class shall be indicated in the drg.)

Property Class	Test location	Tensile strength N/mm ²	0.2 Yield Strength N/mm ² min.	%Elongation L=50mm min.	%Reduction in Area min.	Hardness BHN 3000kg load	FATT (°C) max
A	Surface	795-930	655	13	35	235-280	-73
	Deep Seated	795-930	655	13	35	235-280	-40
B	Surface	690-825	550	15	40	205-255	-73
	Deep Seated	690-825	550	15	40	205-255	-46
C	Surface	795-930	655	13	35	235-280	-73
	Deep Seated	795-930	655	13	35	235-280	-18
D	Surface	900-1035	760	12	30	265-320	-59
	Deep Seated	900-1035	760	12	30	265-320	-4

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- Note: 1. Unless otherwise specified tensile bars shall be tangentially oriented.
2. Strength values from single forging shall not vary by more 70 N/mm² and the BHN values shall vary by no more than 20 Brinell points.
3. The testing requirement for deep-seated Charpy V-notch properties only applies to First Piece Qualification (FPQ) and pilot lot forgings. In addition, this is also required of production forgings which are cut-up and tested for verification testing. For the FPQ and pilot lot forgings, the measured deep seated FATT values must be at least 25°F lower than the values show in the table above at the highest tensile strength value for the specification. It is the assumption of this specification that the deep seated FATT values would be achieved in 95% of the production forgings in the population, if tested. Since this property is not tested for production parts, it is assumed here that the 25°F margin at the highest tensile strength level used for a single FPQ forging is sufficient to insure that the production forgings meet or exceed this requirement. Production forgings that might be cut up for "Qualification Verification" programs are required to meet the specification's values for deep seated CVN toughness properties, but not the 25°F FATT margin.

12.0 MICROSTRUCTURE:

Samples taken in accordance with GT10047 shall exhibit a tempered bainitic / martensitic structure. A description of the structure including the grain size shall be reported in the test certificate.

13.0 NON DESTRUCTIVE TESTS:

Non destructive testing shall be carried out in accordance with the process specification GT 10047. Acceptance norms shall be as per applicable part specification and drawing.

14.0 RETESTS:

If any of the selected specimens fail to meet the specification due to some mechanical reasons, retesting shall be performed on double the number of specimens selected randomly from the same lot. All the retested samples meet the specified minimum requirements. In the event of failure due to heat treatment only two more reheat treatment cycles shall be permitted. However, retempering is not considered as a repeat heat treatment,

15.0 INSPECTION AT SUPPLIER'S WORKS:

BHEL representative shall have free access to all areas where the manufacture of forgings is carried out. All reasonable facilities shall be extended to them, including labour where necessary. BHEL representatives shall be given sufficient advance intimation to witness the various processes, tests etc. Punching, identification of test coupons and forgings and execution of various tests shall be done in the presence of BHEL representative.



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16.0 TEST CERTIFICATES:

Five copies of the test certificates shall be furnished bearing the following details.

- a) Material Specification No. HY19460 Rev.03
- b) BHEL Order No.
- c) Item Description
- d) Drg. No.
- e) Manufacturer's Name
- f) Melt Number
- g) Heat treatment details
- h) Results of all tests stipulated in this specification.

17.0 MARKING AND PACKING:

Each forging shall carry the following details:

- a) HY 19460 Rev.03
- b) BHEL Order No.
- c) Melt No.
- d) Serial No. of forging
- e) Drg No.
- f) Supplier's Name

The forgings shall be suitably packed to prevent any sort of damage during transit.