

TD219
Rev.00**PLANT PURCHASING
SPECIFICATION
HYDERABAD****HY 194 62**

REV. NO. 01

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Ni-Cr-Mo ALLOY STEEL FORGINGS**1.0 GENERAL :**

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

2.0 APPLICATION :

For GT compressor wheels.

3.0 CONDITION OF DELIVERY :

Forged and heat treated.

4.0 COMPLIANCE WITH NATIONAL STANDARDS :

This material does not comply with any national standard. This specification is in line with B50A633D of G.E., USA.

5.0 DIMENSIONS AND TOLERANCES :

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

5.2 Tolerances:

- a) For finish machined component drawings, the extra allowance of 3 ± 1 mm per surface shall be provided for finish machining at BHEL.
- b) 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 MANUFACTURE :

The material shall be made by the basic electric furnace process with either ladle refining + vacuum treatment or consumable electrode remelt (either VAR or ESR).

NOTE: The vacuum system shall have the capacity to produce a low pressure (2000 microns – 2 torr or less and maintain it for the time needed to reduce all dissolved gases to satisfactory levels. For vacuum systems that can have a blank off pressure measurement made the value must be 1 torr or less.

Revisions: General revision in line with B50A633-S13.


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Matls . Engg.

DGM (EC)

26th Sep.91

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7.0 HEAT TREATMENT:

7.1 Conditioning Heat Treatment: All forgings must be given this treatment which is designed to refine the structure and prevent flaking or other detrimental phenomena. This treatment is to be given before the final Quenching & Tempering. The minimum treatment shall be austenitizing in the 870-965°C temperature range. The cooling rate and the following austenitizing treatment shall be sufficient to ensure complete transformation from austenite.

7.2 Austenitizing in the 815-870°C temperature range.

7.3 Quenching in water to assure complete, uniform, transformation for sufficient time to get max. surface temperature of 150°C at any point on the forging, after removal from the water.

7.4 Tempering in the range 580°C-680°C for the time necessary to achieve all the required property and quality attributes throughout the forging. The cooling rate shall be so controlled as to minimise embrittlement and residual stresses. The average cooling rate between the tempering temperature and 200°C shall be that produced by cooling in still air.

8.0 FINISH:

The surface finish of the forgings shall be as given in the ordering drawing.

9.0 FREEDOM FROM DEFECTS:

The forging shall be free from cracks, seams, laps and all defects that are detrimental to the application of the forgings.

10.0 TEST SAMPLES:

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

10.2 Mechanical Properties: The no. and locations of the samples shall be as given in the drawing or Process Specification.

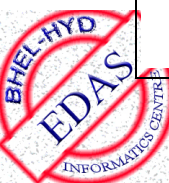
11.2 CHEMICAL ANALYSIS: The steel shall have the following chemical composition.

| Element | C | Mn | Si | P | S | Ni | Cr | Mo | Cu | V | Fe |
|-----------------------|-----------|-----------|-----------|------------|------------|-----------|-----------|-----------|-------|-----------|------|
| Min. % | 0.27 | 0.20 | - | - | - | 1.90 | 0.90 | 0.20 | - | 0.05 | Bal. |
| Max. % | 0.33 | 0.80 | 0.35 | 0.012 | 0.010 | 3.00 | 2.00 | 0.70 | 0.35 | 0.15 | - |
| Aim | 0.30 | 0.40 | - | LAP* | LAP* | 2.25 | 1.25 | 0.40 | LAP* | - | - |
| Permissible Variation | ± 0.02 | ± 0.03 | + 0.05 | + 0.005 | + 0.005 | ± 0.05 | ± 0.05 | ± 0.03 | 0.010 | + 0.02 | - |

*LAP : LOW AS POSSIBLE.

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NOTE: (1) The residual elements shall be as follows. These elements shall be as low as possible.

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


- (2) Silicon content of 0.12% max. required when VCD process is used.
 (3) All residual elements and impurities shall be as low as possible.
 (4) Both N2 and H2 levels are indicative of the effectiveness of the vacuum treatment. Therefore the supplier can report either H2 or N2 measurement on a sample obtained after vacuum processing operation.
 (5) It is recognised the oxygen, calcium and aluminium may be used to accomplish various phases of the melting operations. If used, however, the levels of these elements must be reduced to the required respective levels in the final forging.

12.0 MECHANICAL PROPERTIES:

12.1 The production samples shall comply with the following properties:

| Property Class | Tensile Strength N/mm ² (Ksi) | 0.2 Yield strength Min.N/mm ² (Ksi) | % Elongation l = 50mm | % reduction in Area min. | Hardness BHN |
|-------------------|--|--|--------------------------|--------------------------------|-----------------|
| Class 1 (D8) | 690-830 (100-120) | 585 (85) | 15 | 40 | 205-255 |
| Class 2 (D10) | 795-895 (115-130) | 655 (95) | 13 | 35 | 235-280 |
| Class 3 (D12)* | 895-1000 (130-145) | 760 (110) | 12 | 30 | 265-310 |

- NOTE:** 1. Orientation of the tensile bars shall be tangential.
2. Tensile values from a single forging shall not vary more than 70 N/mm² (10 Ksi) within the forging. For forgings that require only one tensile test or only hardness testing, the Brinell hardness test values made on that forging shall vary not more than 20 Brinell points.
3. *class 3 (D12) are to be used for section sizes 50mm or less.

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12.2 Charpy V-notch Impact Tests:

| | Class 1 (D8) | Class 2(D10) | Class 3 (D12) |
|------------------------------|--------------|--------------|---------------|
| A. FATT °C (°F) Max. | | | |
| Surface | - 73 (-100) | - 73 (-100) | - 73 (100) |
| Deep Seated | - 46 (-50) | - 40 (-40) | - 32 (-25) |
| B. RT Impact tests | | | |
| Surface Energy | # | # | # |
| J (ft – lb) | # | # | # |
| Surface fibrocity(%) | # | # | # |
| C. –10 (-100°F) Impact tests | | | |
| Surface Energy J | # | # | # |
| (ft – lb) | # | # | # |
| Surface Fibrocity (%) | >50 | >50 | >50 |

For information purposes.

Note: 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 for production forgings which are cut up and tested for verification testing. For the FPQ & pilot lot forgings, the measured deep seated FATT values must be at least 15°C (25°F) lower than the values shown 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 15°C (25°F) margin at the highest tensile strength level used for a single FPQ forging is sufficient to ensure that the production forgings meet or exceed this requirement. Production forgings that might be cut up for qualification verification program are required to meet the specifications values for deep seated CVN toughness properties, but not the 15°C (25°F) FATT margin.

13.0 METALLOGRAPHY:

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

14.0 RETESTS:

If any specimen fails to meet the requirements due to some mechanical reason, another specimen may be taken from the extra test material. The vendor may plan for extra test material in case of retests. In the event of failure due to heat treatment, only 2 more reheat treatments shall be permitted. However a retempering is not considered as a heat treatment.

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15.0 INSPECTION ATLSUPPLIER'S WORKS:

BHEL representatives shall have free access to all areas where the manufacture of forgings is carried out. All reasonable facilities shall be extended to him 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.

16.0 TEST CERTIFICATES:

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

- (a) Material Specification No. HY 19462 Rev. 01.
- (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 19462 Rev.01
- (b) BHEL Order No.
- (c) Melt No.
- (d) Serial No. of forging
- (e) Drg. No.
- (f) Supplier's Name


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

NOTE: The marking shall be done as per GT 10047.

18.0 REJECTION AND REPLACEMENT:

In the event of the forging proving defective in the course of further processing at BHEL, the same shall be rejected notwithstanding any previous acceptance.

The supplier shall replace the forging at his own cost and the rejected forging shall be returned after all the commercial conditions are satisfied.

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| <p style="text-align: center;">Ni-Cr-Mo ALLOY STEEL FORGINGS</p> <p style="text-align: center;">Clause 12.2 Charpy V-notch Impact Tests :</p> <p style="text-align: center;">Read “-73°C (-100°F) Impact Tests” in place of existing “-10 (-100°F) Impact Tests” in the given table.</p> | | | | | |
| REF: Typographical error correction in clause 12.2. | AMD.NO. 01 | APPROVED MANAGER, STDS. ENGG. | ISSUED STDS. ENGG. | DATE 28.4.2001 | CUM. Sl.No. A 0340 |