



PLANT PURCHASING SPECIFICATION HYDERABAD

HY13098

REV. NO. 04

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NICKEL ALLOY BARS FOR HIGH TEMPERATURE FASTENERS, HEAT TREATED

(GR. Ni Cr 20 Ti Al)

1.0 SCOPE:

This specification governs the quality of NiCr20TiA1 bars for use upto 600°C.

2.0 APPLICATION:

For the manufacture of high temperature fasteners.

3.0 CONDITION OF DELIVERY:

Hot rolled/forged and heat treated.

4.0 REFERRED STANDARDS:

This specification is prepared taking reference from EN 10269-2013 for material Gr. Ni Cr20Ti A1 (Nimonic 80A) and also BHEL product specific technical requirements.

5.0 DIMENSIONS AND TOLERANCES:

5.1 **Sizes:** As stated in BHEL order.

5.2 **Tolerances:**

5.2.1 Tolerances for hot rolled bars shall be as follows:

The bars shall not vary from specified diameter or distance across flats by more than $\pm 2\frac{1}{2}\%$.

5.2.2 Tolerance for forged bars shall be as given below.

Diameter, mm		Tolerance, mm
Over	Upto & including	
50	125	+ 6.0, - 0.0 mm
125	175	+ 8.0, - 0.0 mm
175	-	+ 12.5, - 0.0 mm

Revision:
Modified Clause 6.0, 8.2, 9.0, 10.0, 11.0 & 13.2
Added new Clause 12.0, 13.2.1, 16.0, 16.1 & 17.4

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6.0 MANUFACTURE:

Material shall be melted in an vacuum induction melting / electro slag remelting (VIM / ESR) or by vacuum induction melting / vacuum arc remelting (VIM / VAR) process. The hot working shall be done in such a way that uniform fine grained microstructure is achieved.

Any other melting or refining process is acceptable subject to written mutual agreement between BHEL and manufacturer.

7.0 FREEDOM FROM DEFECTS:

The bars shall be free from defects such as cracks, flakes, seams, segregations and inclusions etc.

8.0 TEST SAMPLE:

8.1 **Chemical Analysis:** One sample for chemical analysis shall be taken from each melt.

8.2 **Mechanical Tests:** Mechanical properties shall be identified on the hardest and softest bar identified as per Clause 11.0 (iv).

9.0 CHEMICAL COMPOSITION (%):

Element	C	Si	Mn	P	S	B	Co	Fe	Cr	Al	Ti	Ni
Min.	0.04	-	-	-	-	-	-	-	18.0	1.00	1.80	-
Max.	0.10	0.30	1.00	0.010	0.010	0.008	1.00	1.50	21.0	1.80	2.70	Remainder

Note: 1) $Cu \leq 0.20\%$; $Ti + Al \geq 3.5\%$

2) Following values shall be aimed at

- (i) $Si \leq 0.25\%$
- (ii) $P \leq 0.005\%$
- (iii) $S \leq 0.005\%$

10.0 HEAT TREATMENT:

Following heat treatment cycle is suggested to achieve the mechanical properties specified in clause 11.0 of this specification.

- i) **Solution treatment:** heating to 1050-1080°C & soaking for 8 hrs (min), followed by air cooling.
- ii) **Stabilizing treatment:** heating to $845 \pm 10^\circ C$ & soaking for 24 hrs (min) followed by air cooling.
- iii) **Ageing:** heating to $700^\circ \pm 10^\circ C$ & soaking for 16 hrs (min) followed by air cooling.



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11.0 MECHANICAL PROPERTIES:

Tensile strength N/mm ²	0.2% proof stress N/mm ² min.	% elongation L = 5d min.	% reduction in area min.	Impact Strength (ISO-V) J min.	Hardness BHN min.
1000 - 1300	600	17	17	20	260

NOTE:

- (i) The tensile test shall be carried out according to ASTM A370 or any reputed national or international standard.
- (ii) The charpy impact test shall be carried out according to ASTM A370 or any reputed national or international standard. The test shall be performed on ISO-specimen of size 10 x 10 x 55 mm with a 2 mm V-notch.
- (iii) The minimum impact value specified above is the average of 3 specimens from a single location. Only one value of the three can be below the specified minimum, but in no case below 2/3rd of the same. All the three values shall be reported.
- (iv) Hardness test shall be performed on 10% of each melt, each heat treatment batch or on all bars if the total lot or batch size is less than 10 bars.
- (v) Mechanical test shall be performed in delivery condition after material been subjected to final heat treatment as per this specification.

12.0 METALLOGRAPHIC TEST:

The metallographic examination shall be carried out at the beginning and at the end of the hardest and the softest bars and 0 in each case in the corner and in the centre of cross section. A homogeneous microstructure with a grain size 3-6 according to ASTM E112 shall be achieved in the cross section.

13.0 NON DESTRUCTIVE TESTS:

Following NDT shall be performed in delivery condition:

- 13.1 **Visual Examination:** Visual & Verification inspection shall be done for all bars.
- 13.2 **Ultrasonic test:** 100% Ultrasonic inspection of all bars according to EN10308 Type 1a (table 1) or other agreed standard eg. AMS STD 2154 has to be carried out. The calibration block and the reference block have to be manufactured out of material with similar acoustic properties and similar surface conditions. The test has to be performed only by employees with level 2 certified according to EN 473 or SNT-TC-1A.
 - 13.2.1 Acceptance criteria for Ultrasonic test shall be quality class 3 according to EN10308 (table 3). The decision limit for loss of back wall echo is 3dB for all bar dimensions. The recording level is defined with $>1\text{mm } d_{eq}$. All indication $d_{eq} \leq 1\text{mm}$ are acceptable.

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13.3 **Dye Penetrant test:** 100% penetrant test of all the bars without face areas according to EN 571-1 or any equivalent international standard. Indications ≥ 5 mm are unacceptable. Indication free grinding excavations ≤ 1 mm are acceptable.

14.0 RETESTS:

As per EN10021.

15.0 INSPECTION AT SUPPLIER'S WORKS:

BHEL representative shall have free access at all times during work of the contract of BHEL is being performed, to all parts of the manufacturer's works. The supplier shall offer BHEL representative all reasonable facilities, without charge, to satisfy the later that the material is being furnished in accordance with this specification.

16.0 PROCESS QUALIFICATION:

A comprehensive Manufacturing Process Plan (MPP) and Quality plan including additional requirements (if any) duly approved by BHEL are mandatory before placement of order on a vendor who has not supplied the same material in the past.

The MPP shall include the stage wise detailed Manufacturing process (with control parameters at each stage) and Testing Plan (MTP) indicating the steel melting process, ingot dimensions, forging or rolling process, forging ratio, heat treatment plan, sketches showing test samples locations and stages of inspection, etc.

No process parameter changes are permitted without written approval of BHEL for subsequent supplies once the MPP referred above is frozen.

BHEL may incorporate additional tests in the Purchase order depending upon review of the capabilities / experience of the new vendor during first time supplies of this material to BHEL.

16.1 SHORT TERM CREEP RUPTURE TEST:

This clause is applicable for first time suppliers and shall be produced for clearance before dispatch of material to BHEL. One sample of each heat & heat treatment batch shall be subjected to a short time creep rupture test according to DIN EN 10291 with the following test parameters:

Test temperature	:	750 ⁰ C
Proof stress	:	310 MPa

The following values have to be reached:

Creep rupture time	:	≥ 100 h
Elongation	:	$\geq 4\%$
Reduction of area	:	$\geq 4\%$

If no creep rupture is occurred after 100h, the stress can be increased for further by 30MPa after 24h, until the creep rupture occurs.



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17.0 TEST CERTIFICATE:

Three copies of test certificate shall be supplied giving the following information.

17.1 BHEL References

- a) Purchase Order reference
- b) Material specification HY 13098 / Rev.04
- c) Size & quantity

17.2 Suppliers References

- a) Mill's Name
- b) Process of manufacture
- c) Melt No.
- d) Heat treatment cycles followed.

17.3 Test results

- a) Visual examination
- b) Chemical analysis
- c) Mechanical test results
- d) Ultrasonic test results
- e) Penetrant test results
- f) Metallography test results

17.4 Process Qualification Test results

- a) Short term creep rupture test, applicable for first time suppliers.

18.0 MARKING & PACKING:

Each bar above 63 mm dia/size shall be punched with the following information:

- a) BHEL Spec. No. HY 13098. / Rev. 04
- b) BHEL Order No.
- c) Melt No./Size
- d) Supplier trade mark

Bars upto 63 mm dia/size may be bundled together with a tag bearing the above information. The bars shall be suitably packed to avoid damage during transit.

19.0 REJECTION AND REPLACEMENT:

In the event of the bar proving defective in the course of further processing or testing at BHEL the bars shall be rejected notwithstanding any previous acceptance of the material. The supplier shall replace the rejected material at his own cost on priority and the rejected material shall be disposed off by mutual agreement between the supplier and BHEL.