



CORPORATE PURCHASE SPECIFICATION

AA 102 08

Rev. No. 07

PREFACE SHEET

HOT ROLLED / FORGED CARBON STEEL BARS, Gr : 40C8 - NORMALISED

FOR INTERNAL USE ONLY
 REMOVE THIS PREFACE BEFORE ISSUE TO SUPPLIERS

Comparable Standards:

1. INDIAN

IS : 1570, Part II, Section I - 1979

Gr: 40C8(c40) Normalised

Suggested/Probable Suppliers and Grades:

Refer Plant Vendors list

User Plant References:

1. BHOPAL	:	PS 10208
2. HEEP, HARDWAR	:	0500.007
		Gr: C40, Hot Rolled
3. HYDERABAD	:	HY 021 02 99
4. TIRUCHY	:	BM - CQ 35

Revisions :

CI 26.6.18 of MOM of MRC-S&GPS

APPROVED :

INTERPLANT MATERIAL RATIONALISATION
 COMMITTEE-MRC (S&GPS)

Rev. No. 07

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BHOPAL

Corp. R&D

AUGUST, 1976



CORPORATE PURCHASE SPECIFICATION

AA 102 08

Rev. No. 07

PAGE 1 OF 4

HOT ROLLED / FORGED CARBON STEEL BARS, Gr: 40 C8-NORMALISED

1.0 GENERAL

This specification governs the quality requirements of Hot Rolled / forged Carbon Steel Bars, Normalised.

2.0 APPLICATION

Production of machined parts for general engineering purposes.

3.0 CONDITION OF DELIVERY

Hot Rolled / forged and Normalised.

Note: Sizes upto 100mm in hot rolled
>100 to 180mm in hot rolled or forged
abov 180mm in forged.

Bars shall be supplied in straight lengths with ends square and true.

4.0 COMPLIANCE WITH NATIONAL STANDARDS:

Material shall comply with the requirements of the following National Standards and also meet the requirements of this specification.

IS : 1570-Part II, Section 1-1979 : Schedule for wrought Steels-Carbon steels
Gr:40C8 (C40), Normalised : (Unalloyed Steels)

5.0 DIMENSION AND TOLERANCES

5.1 Sizes

Bars shall be supplied to the dimensions in BHEL order.

5.2 Length:

Unless otherwise specified, hot rolled bars shall be supplied in 3 to 6 metres length and forged bars shall be supplied in lengths of 1.5 to 3 metres

Revisions :
Cl 26.6.18 of MOM of MRC-S&GPS

APPROVED :
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AA 102 08	CORPORATE PURCHASE SPECIFICATION	
Rev. No. 07		
PAGE 2 OF 4		

5.2 Tolerances:

5.2.1 For Forged bars: The tolerances shall be as per Cl 5.2.2 for bars ≤ 100 mm.
The tolerances shall be +8 mm -0 mm for bars > 100 mm

5.2.2 Tolerances on hot rolled bars shall comply with those of Grade 2 of IS:3739: Dimensional Tolerances for Carbon and Alloy Constructional Steel Products, reproduced below:

5.2.2.1 Round Square Bars:

Nominal Size mm		Tolerances, mm	
Over	Up to & Including	Permissible deviation	Out of round / square
--	25	± 0.50	0.50
25	50	± 0.75	0.75
50	80	± 1.00	1.00
80	100	± 1.25	1.25
> 100		$\pm 1.6\%$ of diameter or width of side	75 % of total tolerance (+ and -)

5.2.2.2 Flats:

Nominal width, mm		On width	Tolerance, mm		
Over	Up to & Including		On thickness		
			6 to 13	Over 13 to 25 including	Over 25 to 50 including
--	50	± 1.0	± 0.5	± 0.8	± 1.0
50	100	± 2.0	± 0.5	± 1.0	± 1.5
100	150	± 3.0	---	---	± 2.0

5.2.3 Straightness:

Unless otherwise agreed to, the permissible deviation shall not exceed 5mm in any 1000mm length.

6.0 MANUFACTURE:

Material shall be manufactured from fully killed steel.



CORPORATE PURCHASE SPECIFICATION

AA 102 08

Rev. No. 07

PAGE 3 OF 4

7.0 FREEDOM FROM DEFECTS :

The bars shall be sound, straight and free from internal and surface defects such as seams, laps, cracks or any other defects which may impair the end use.

Bars shall be free from twists and bends.

8.0 HEAT TREATMENT :

The bars shall be normalised at a temperature of 830 - 860°C

9.0 CHEMICAL COMPOSITION :

The melt analysis of steel and the permissible variation in the composition of the material from the melt analysis shall be as specified below :

Element	<u>Melt analysis, percent</u>		Permissible Variation, percent
	Min.	Max.	
Carbon	0.35	0.45	± 0.02
Silicon	0.10	0.35	± 0.03
Manganese	0.60	0.90	± 0.04
Sulphur	---	0.035	+ 0.005
Phosphorus	---	0.035	+0.005

10.0 TEST SAMPLES :

10.1 One sample shall be taken from each melt for chemical analysis.

10.2 One sample shall be taken from each heat treatment batch for testing of mechanical properties. Test pieces for mechanical tests shall be taken in the longitudinal direction of the piece.

10.3 For ruling section upto & including 40mm, the test piece shall be machined coaxially from the test bars. For ruling section above 40mm the longitudinal axis shall be atleast 12.5 mm from surface of the test bars.

Test methods for determining mechanical properties shall be as per IS:1608 (For tensile test).


11.0 MECHANICAL PROPERTIES (IN NORMALISED CONDITION) :

Mechanical properties of the material shall be as follows:

Tensile strength : 580 - 680 N/mm²

Yield strength : 320 N/mm², min

Elongation on 5.65 √So : 18%, min.

AA 102 08	CORPORATE PURCHASE SPECIFICATION	
Rev. No. 07		
PAGE 4 OF 4		

12.0 ULTRASONIC TEST:

12.1 Each bar above 100 mm shall be tested ultrasonically in accordance with BHEL standard AA 085 01 18 to ensure freedom from internal defects. The norms of acceptance shall be as per category 2 of the above standard.

12.2 **Optional tests:** If specified on order, each bar > 40 to 100mm shall be tested ultrasonically in accordance with BHEL standard AA 085 01 18 to ensure freedom from internal defects and the norms of acceptance shall be as per category 2.

13.0 TEST CERTIFICATES :

Three copies of test certificates shall be supplied, unless otherwise stated on the order. In addition, the supplier shall ensure to enclose one copy of the test certificate along with their despatch documents to facilitate quick clearance of the material.

The test certificate shall bear the following information :

AA 102 08; Rev. No. 07: Hot rolled /forged carbon steel bars, Gr.:40 Normalised
BHEL order No,
Supplier's Reference :
Name
Identification No.
Melt No.
Details of heat treatment.
Results of Tests :
Results of Dimensional inspection.
Results of chemical analysis, mechanical tests & Ultrasonic test.

14.0 PACKING AND MARKING :

The material shall be suitably packed in bundles-hessian wrapped to prevent sagging, corrosion and damage during transit. A suitable clear temporary rust preventive shall be applied on all the bars. Each bar of 50 mm and above shall be stamped with AA 102 08, melt no, BHEL order no, at one end or on the end face.

Bars below 50mm shall be bundled together and tied with wire at 3 to 4 places along the length of the bars.

A metal label shall be securely attached to each bundle and shall bear the following information :

AA 102 08 : Hot Rolled / Forged Carbon Steel Bars, 40C8-Normalised.
BHEL Order No.
Consignment/Identification No.
Melt No.
Size and Weight.
Supplier's Name.

15.0 REFERRED STANDARDS (Latest Publications Including amendments):

1. IS : 1570 Part II	2. IS : 1608	3. IS : 3739	4. AA 085 01 18
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**PLANT PURCHASING
SPECIFICATION
HYDERABAD**

HY 10994

REV. NO: 03

PAGE 1 OF 5

PRECIPITATION HARDENING STAINLESS STEEL BARS (SOFTENED)

GR : 2S 144

1.0 GENERAL:

This specification governs the requirements of softened precipitation hardening stainless steel bars of grade 2 S 144.

2.0 APPLICATION :

For the manufacture of Impeller forgings meant for centrifugal compressors.

3.0 CONDITION OF DELIVERY :

Hot rolled/forged and softened condition.

4.0 COMPLIANCE WITH NATIONAL STANDARDS:

This specification is based on the BS Specification 2 S 144.

5.0 DIMENSIONS AND TOLERANCES:

5.1 Dimensions: The dimensions shall be as specified in the order .

5.2 Unless otherwise specified in the order, the hot rolled bars shall be supplied in random lengths of 3 to 6 meters with a maximum of 10% shorts down to 1 meter. Forged bars shall be supplied in random lengths of 1.5 to 3.0 meters.

5.3 Tolerances: The tolerances on cross sectional dimension shall be as follows.

5.3.1 Hot Rolled Bars :

Over	Size (mm)	Tolerance (mm)
	Upto & including	
--	25	± 0.50
25	50	± 0.75
50	80	± 1.00
80	100	± 1.25
100	125	± 1.50
125	150	± 2.00
150	-	± 1.60 % of size

5.3.2 Forged Bars : + 8 mm on size
- 0.0 mm

Revisions:

Modified clause 6.0

Issued :

**STANDARDS ENGINEERING
DEPARTMENT**

Rev.No. 03	Amd. No.	Reaffirmed	Prepared:	Approved:	Dt. of 1st issue:
Dt. MAR. 05	Dt.	Year :	Matls. Engg.	Mgr. / SED	17 .07.91

HY 10994	PLANT PURCHASING SPECIFICATION HYDERABAD	
REV. NO.03		
PAGE 2 OF 5		

6.0 MANUFACTURE:

- 6.1 The steel used shall be fully killed and shall be manufactured by basic electric process and shall subsequently be refined through ESR process. Any other process of steel melting & refining shall be mutually agreed upon.
- 6.2 The actual gas content shall be analysed and reported. Hydrogen content shall be less than 1.5 PPM. Sufficient discard shall be given from top and bottom of the ingot to ensure freedom from piping, segregation and other injurious defects.
- 6.3 Bars shall be made after giving sufficient reduction to each ingot ensuring that the cast structure is completely broken into fine grain structure. The reduction ratio shall not be less than 4:1 from the ingots.

7. HEAT TREATMENT:

- 7.1 Material shall be supplied in softened condition only. However, test samples shall be subjected to the following heat treatment.

- a) Solutionizing at 1000 -1050°C - for 30 mts min. followed by air cooling.
- b) Conditioning at 750 - 850°C - for 2 hrs min. followed by air cooling.
- c) Final ageing at 450 ± 10°C - for 2 hrs min. followed by air cooling

- 7.2 Softened Condition: Heating to 610 - 630°C for 2 hrs min. followed by air cooling.

8.0 FREEDOM FROM DEFECTS :

The bars shall be free from cracks, scabs, lamination, shrinkage and other harmful defects.

9.0 FINISH :

- 9.1 The surface of the bars shall be smooth without any laps, rolled in scabs etc. Dents, roll marks and scratches are permitted provided their depth does not exceed half the tolerance limits.
- 9.2 The edges of bars shall be cut square by sawing or shearing and no crop ends shall be permissible.

10.0 CHEMICAL COMPOSITION :

The analysis of the material shall be as follows :

Element		C	Si	Mn	Cr	Ni	Cu	Mo	Nb	S	P	H2 PPM
Melt-Analysis	Min.	--	--	--	13.20	5.00	1.20	1.20	0.10	--	--	--
	Max.	0.07	0.60	1.00	14.70	5.80	2.00	2.00	0.40	0.025	0.035	1.5
Variation Allowed in Product Analysis		+ 0.002	+ 0.05	+ 0.03	± 0.15	± 0.10	± 0.10	± 0.05	± 0.05	+ 0.005	+ 0.005	--



**PLANT PURCHASING
SPECIFICATION
HYDERABAD**

HY 10994

REV. NO.03

PAGE 3 OF 5

11.0 TEST SAMPLES:

- 11.1 One sample from each melt shall be subjected to chemical composition for check analysis.
- 11.2 One test sample for mechanical testing shall be taken from a bar representing each melt and size. Test samples shall be subjected to heat treatment as per clause –7 before mechanical testing. Supplier has got the option of upsetting the test coupon to a further 1.5 reduction ratio before heat treatment for the bars of sizes above 200 mm diameter.

12.0 MECHANICAL PROPERTIES:

- 12.1 Test samples shall be taken from heat treated test coupon in tangential direction for each melt and shall meet the following mechanical properties. The values obtained shall be reported in test certificate.

Tensile strength N/mm ²	0.2% Proof Stress N/mm ² (min.)	Elongation % min. L =5.65 √ So	Impact Strength , min.Charpy -‘U’ (5mm notch)
1130 - 1330	1030	12	20 J


NOTE: 1) The tensile tests shall be performed as per IS:1608 or any other reputed National Standard.

- 2) The charpy Impact test shall be performed on a 10 x 10 x 55 mm specimen with a 5mm ‘U’ Notch.
- 3) The minimum Impact value shown above is the average of three specimen from the same location. Only one value can be lower than the minimum value specified, but in no case less than 2/3rd of the same. All the three values shall be reported in test certificate.

- 12.2 10% of the bars or 10 bars minimum (whichever is higher) in softened condition shall be tested for hardness. Hardness shall be 331 BHN max. The hardness values for the tested bars shall be reported in test certificate.

13.0 ULTRASONIC TEST:

All bars more than 50 mm diameter shall be ultrasonically tested according to ASTM - A388 (or BHEL Standard AA 0850118) and following shall be the unacceptable defects.
(Category I of AA0850118 is acceptable)

HY 10994	PLANT PURCHASING SPECIFICATION HYDERABAD	
REV. NO.03		
PAGE 4 OF 5		



**PLANT PURCHASING
SPECIFICATION
HYDERABAD**

HY 10994

REV. NO.03

PAGE 5 OF 5

17.0 TEST CERTIFICATE:

17.1 The supplier shall furnish Five copies of test certificates (in English) to BHEL with the following details :

- a) Specification No. HY 10994 / Rev.03
- b) BHEL Order No.
- c) Size
- d) Process of manufacture.
- e) Melt No.
- f) Heat treatment details and batch no. along with HT charts duly endorsed by BHEL / BHEL appointed inspection agency.
- g) Results of chemical analysis and mechanical tests, including hardness of tested bars.
- h) Results of ultrasonic test.
- i) Inclusion content of steel.

17.2 The test certificates shall be signed by the chief of inspection / chief metallurgist of the Supplier and shall be attested by BHEL representative / BHEL appointed inspection agency.

18.0 PACKING AND MARKING :

18.1 Marking: All bars with cross sectional dimension greater than 50 mm shall be stamped with the following details:

- a) HY 10994 / Rev.03
- b) BHEL Order No.
- c) Melt No. & Heat Treatment Batch No.
- d) Size & Weight
- e) Supplier's trade mark

18.2 **Packing:** The bars shall be suitably packed to prevent corrosion and damage during transit. In case of overseas suppliers, the packing shall be seaworthy..

19.0 REJECTION AND REPLACEMENT:

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

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



PLANT PURCHASING SPECIFICATION HYDERABAD

HY10772

REV. NO. 04

PAGE 1 OF 4

AUSTENITIC STAINLESS STEEL BARS, ANNEALED TP 316L

1.0 GENERAL:

This specification governs the requirements of annealed, austenitic, low-carbon Stainless Steel bars of grade TP 316L.

2.0 APPLICATION :

For the manufacture of Labyrinth sealing Rings of compressors.

3.0 CONDITION OF DELIVERY :

Hot finished/cold finished/forged and solution annealed.

4.0 COMPLIANCE WITH STANDARDS:

This specification complies generally with
ASTM : A276-2004 : Stainless and heat-
Gr :TP 316L resisting steel bars and shapes.

5.0 DIMENSIONS AND TOLERANCES:

5.1 Dimensions: Dimensions shall be as specified in the order.

5.2 Tolerances: Tolerances shall be as per ASTM:A484 for hot / cold rolled bars.
Tolerances for forged bars shall be as follows.

<u>Diameter, mm</u>	<u>Tolerance, mm</u>
Above 50 to 125	+ 6.0
>125 to 175	+ 8.0
>175 ---	+ 12.5

Note: (FOR HOT ROLLED & FORGED BARS)

Insignificant surface defects in the form of dent and ripple marks are permissible provided their depth does not exceed half the tolerances on each size.

Revisions:

Revised in line with ASTM A276-04

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**STANDARDS ENGINEERING
DEPARTMENT**

Rev. No. 04

Amd. No.

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Prepared:

Approved:

Dt.of 1st Issue:

Dt. SEP. 2006

Dt.

Year:

STDS. ENGG.

SR.M (TC)

FEB. 1982

6.0 MANUFACTURE:

The steel shall be manufactured by Basic electric furnace process unless agreed upon mutually.

7.0 FREEDOM FROM DEFECTS:

The bars shall be free from cracks, scabs, lamination, shrinkage and other harmful defects.

8.0 HEAT TREATMENT:

The material shall be solution annealed by Quenching in oil/water and by fast cooling in Air from a temperature of not less than 1040° C.

9.0 TEST SAMPLE:

9.1 For Chemical Analysis: One test sample shall be taken from each melt for chemical analysis.

9.2 For Mechanical Properties: One sample per melt per heat treatment batch shall be tested for mechanical properties.

10.0 CHEMICAL COMPOSITION:

The melt analysis of the material shall be the follows:

Element	C	Mn	Si	Cr	Ni	Mo	S	P	N
% min.	-	-	-	16.00	10.00	2.00	-	-	-
% max.	0.03	2.00	1.00	18.00	14.00	3.00	0.030	0.045	0.10
Permissible variation	+0.005	+0.04	+0.05	±0.20	-0.10 +0.15	-0.05 +0.10	+0.005	+0.005	0.01

11.0 MECHANICAL PROPERTIES:

Tensile Strength, min N/mm ²	Yield Strength min N/mm ²	% Elongation l = 50mm min.	% Reduction in area of cross section min.
485	170	40	50



**PLANT PURCHASING
SPECIFICATION
HYDERABAD**

HY 10772

REV. NO. 04

PAGE 3 OF 4

12.0 NON-DESTRUCTIVE TESTS:

12.1 Ultrasonic Test: All bars above 50 mm dia/side shall be tested ultrasonically as per ASTM: A745 and the acceptance norm shall be as specified therein.

13.0 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.

14.0 TEST CERTIFICATE:

Three copies of test certificates shall be supplied, unless otherwise stated on the order. 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:

BHEL references:

HY10772 Rev.04
BHEL order no.

Supplier's references:

Name
Identification no.
Melt no.
Details of heat treatment


Results of tests:

Dimensional inspection
Results of chemical analysis, mechanical tests & UT (whenever applicable).

15.0 PACKING AND MARKING:

Bars shall be suitably oiled and packed in boxes to prevent corrosion and damage during transit.

Each bar and flat over 50 mm in diameter or width across flats shall be stamped with 'HY10772 Rev.04, melt no., BHEL order no. at one end or on the end face.

HY10772	PLANT PURCHASING SPECIFICATION <u>HYDERABAD</u>	
Rev. No. 04		
PAGE 4 OF 4		

Bar / flat upto and including 50 mm in diameter/width across flats shall be bundled together and tied with wire at 3 to 4 places along the length of the bars.

A metal label shall be securely attached to each bundle and shall bear the following information.

HY10772 Rev.04
BHEL order no.
Consignment/identification no.
Melt no.
Size and weight
Supplier's name

16.0 REJECTION & REPLACEMENT:

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

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



PLANT PURCHASING SPECIFICATION

HY10771

REV. NO: 03

PREFACE

MARTENSITIC STAINLESS STEEL BARS, ANNEALED

GRADE : 15 Cr 16 Ni 2

FOR INTERNAL USE ONLY
REMOVE THIS PREFACE
BEFORE ISSUE TO SUPPLIERS.

EQUIVALENT STANDARDS :

AMERICAN

ASTM : A 276

GR : TP 431 (S 43100)

BRITISH

BS : 970 - 1996 (Part I)

GR : 431 S 29 (Annealed)

SUPERSEDED PLANT REFERENCES:

This specification supersedes

BS : 1970 - 1995 ; Gr: En 57 (Annealed)

MAIN USERS:

PUMPS DIVISION (FP)

DIMENSIONAL STANDARDS:

HY 107 02 71 (Rounds)

Revisions:

Revised in line with IS:6603 - 2001.

Issued :

**STANDARDS ENGINEERING
DEPARTMENT**

Rev.No.03

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Prepared:

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Dt. JUL. 2002

Dt.

Year:

STDS. ENGG.

GM (ENGG.)

NOV. 1983



PLANT PURCHASING SPECIFICATION

HY10771

REV. NO: 03

PAGE 1 OF 5

MARTENSITIC STAINLESS STEEL BARS, ANNEALED

GRADE : 15 Cr 16 Ni 2

1.0 GENERAL:

This specification governs the requirements of annealed, high chromium and high tensile stainless steel bars.

2.0 APPLICATION :

For the manufacture of sealing rings of boiler feed pumps.

3.0 CONDITION OF DELIVERY :

Hot finished and annealed. The ends of bars shall be square and true. The bars shall be supplied in straight lengths.

4.0 COMPLIANCE WITH STANDARDS:

This specification complies, in general with

IS : 6603 - 2001 GRADE : 15 Cr 16 Ni 2 (Annealed)	}	Specification for stainless steel bars and flats.
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5.0 DIMENSIONS AND TOLERANCES:

5.1 Dimensions: As specified in the order. Unless otherwise specified, bars shall be supplied in random lengths 3 to 6 metre lengths.

5.2 Tolerances:

5.2.1 Tolerances for hot rolled bars shall be as follows:

Revisions: Revised in line with IS:6603 - 2001.			Issued : STANDARDS ENGINEERING DEPARTMENT		
Rev.No.03	Amd.No.	Reaffirmed	Prepared: STDS. ENGG.	Approved: GM (ENGG.)	Dt.of 1st Issue NOV. 1983
Dt. JUL. 2002	Dt.	Year:			

PLANT PURCHASING SPECIFICATION



Diameter or Width across flats, mm		Tolerance
Over	Upto & including	
--	25	+ 1.0 - 0
25	50	+ 1.5 - 0
50	80	+ 2.0 - 0
80	100	+2.5 - 0
100	125	+ 3.0 - 0
125	--	+ 2.5% of dia / width across flats

5.2.2 Tolerance for forged bars shall be as follows :

+ 8 mm on diameter / width across flats.
- 0 mm

6.0 MANUFACTURE:

The steel shall be manufactured by basic electric process. Any other process of steel manufacture shall be mutually agreed between the supplier and BHEL.

7.0 FREEDOM FROM DEFECTS:

The bars shall be free from pipes, cracks, scabs, laminations and other harmful defects. The surface shall be smooth without any laps, rolled-in scales etc. The edges of the bars shall be cut square by sawing or shearing and no crop ends shall be permissible.

8.0 HEAT TREATMENT:

8.1 Material shall be annealed at 750-800°C followed by air cooling.

8.2 Test samples shall be hardened at 980-1030°C followed by oil quenching. Double tempering shall be done at 640-680°C followed by 590-620°C.

9.0 TEST SAMPLES:

9.1 For chemical composition: Each melt shall be analysed for chemical composition.



PLANT PURCHASING SPECIFICATION

HY 10771

REV. NO: 03

PAGE 3 OF 5

- 9.2 For Mechanical Properties:** Bars of same size shall be divided into lots belonging to the same melt and heat treatment batch. One sample per lot shall be tested for mechanical properties.

The test specimens shall be concentric with the bars for sectional dimension upto 40mm. For diameters or widths across flats exceeding 40 mm, the specimen location shall be $1/3^{\text{rd}}$ the radius / section below the bar surface.

10.0 CHEMICAL COMPOSITION:

The melt analysis of the material shall be as follows:

Element		C	Mn	Si	Cr	Ni	S	P	Mo	Cu
Melt Analysis	%Min.	0.10	--	--	15.00	1.25	--	--	--	--
	%Max.	0.20	1.00	1.00	17.00	2.50	0.030	0.045	0.30	0.30
Permissible variation in product analysis		± 0.01	$+0.03$	$+0.05$	± 0.20	± 0.07	$+0.005$	$+0.010$	-	-

Note : (1) Elements not specified in the table shall not be added to the steel without prior approval of BHEL

11.0 MECHANICAL PROPERTIES:

11.1 Material in annealed condition :

The material in the annealed condition shall have a maximum Brinell Hardness of 262 BHN.

11.2 Test samples in heat treated condition :

The test sample after being heat treated as specified in cl. 8.2 shall show the following mechanical properties, upto a ruling section of 150 mm.

Tensile Strength, N/mm ²	0.2% Proof stress, min N/mm ²	Elongation % min $l = 5.65\sqrt{S_0}$	Hardness BHN	Impact Strength KCU (5 mm) J min. See Note (3)
830 - 1030	640	10	240 - 302	30

PLANT PURCHASING SPECIFICATION



Note: 1) The tensile test shall be carried out in accordance with IS: 1608 or any reputed National Standard.

2) The charpy impact test shall be performed in accordance with IS: 1499 or any reputed National Standard.

An impact test shall consist of three specimens from a single test location, the average value of which shall be as specified above.

Only one value of the three can be below the specified minimum but in no case below $2/3^{\text{rd}}$ of the specified minimum value.

All the three test results shall be reported in the test certificate.

3) The KCU values are applicable for sections ≥ 15 and ≤ 63 mm. The impact shall be proved on a section only in the range mentioned above.

11.3 Microstructural examination shall be done on heat treated sample. Maximum delta ferrite allowed is 10%.

12.0 NON-DESTRUCTIVE TEST :

12.1 Ultrasonic Test : Each bar above 50 mm shall be subjected to ultrasonic test as per ASTM: A 388 (BHEL standard AA0850118) and acceptance norms shall be class 2 of AA0850118.

13.0 RETESTS:

13.1 If any of the test specimen fails to meet the requirements specified in clause 11, the sample bar from which the test specimen was cut shall be rejected and two further sample bars from the same lot shall be taken for retests.

13.2 If the retests also fail, manufacturer is at liberty to heat treat the bars in question. However, not more than two reheat treatments are allowed.

13.3 If after reheat treatment, the mechanical properties are not complied with, the entire lot shall be rejected.

14.0 INSPECTION AT SUPPLIER'S WORKS:

The representative of BHEL shall have free access to the supplier's works at all times during the execution of the orders to satisfy himself that the material is produced as per the quality requirement of this specification. All reasonable facilities shall be extended to him, free of charge. He may witness sampling, testing and marking called for in this specification / order.



PLANT PURCHASING SPECIFICATION

HY 10771

REV. NO: 03

PAGE 5 OF 5

15.0 TEST CERTIFICATES:

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

- a) BHEL Order No.
- b) Specification No: HY 10771 / Rev. 03
- c) Supplier's Name
- d) Heat/Melt No.
- e) Size
- f) Results of Chemical Analysis
- g) Results of Mechanical Properties
- h) Results of ultrasonic test, if applicable.

16.0 PACKING AND MARKING:

16.1 Marking: All bars with cross-sectional dimension greater than 50 mm shall be stamped with the melt number and supplier's trade mark on both the end faces of the bars. Bars of sectional dimension 50mm and below shall be bundled as per each size and tag bearing the following details shall be securely attached to it.

- a) BHEL Specification No: HY 10771 / Rev.03
- b) BHEL Order No.
- c) Heat / Melt No
- d) Size & Wt. :
- e) supplier's trade mark

16.2 Packing: Bars shall be suitably packed to prevent damage during transit.

17.0 REJECTION AND REPLACEMENT:

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

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



PLANT PURCHASING SPECIFICATION

HY10770

REV. NO: 02

PAGE 1 OF 3

AUSTENITIC STAINLESS STEEL BARS, SOLUTION ANNEALED **(TP304)**

1.0 GENERAL:

This specification governs the requirement of solution annealed, austenitic Stainless steel bars of grade TP 304.

2.0 APPLICATION :

For the manufacture of components requiring general corrosion resistance and high temperature service..

3.0 CONDITION OF DELIVERY :

Hot rolled/forged and solution annealed.

4.0 COMPLIANCE WITH STANDARDS:

This specification complies with
ASTM : A276-1992 : Stainless and heat- resisting
TP 304 steel bars and shapes.

5.0 DIMENSIONS AND TOLERANCES:

5.1 Dimensions: The dimensions shall be as specified in the order. Unless otherwise specified, bars shall be supplied in 3 to 6 metre lengths.

5.2 Tolerances: As per ASTM. A 484.

6.0 MANUFACTURE:

The steel shall be manufactured by basic electric furnace, unless agreed upon mutually.

7.0 FREEDOM FROM DEFECTS:

The bars shall be free from cracks, scabs, lamination and other harmful defects. The surface shall be smooth without any laps or rolled-in scales. The edges of the bars shall be cut square by sawing or shearing and no crop ends shall be permissible.

Revisions: General Revision.			Issued : STANDARDS ENGINEERING DEPARTMENT		
Rev.No.02	Amd.No.	Reaffirmed	Prepared: Matls. Engg.	Approved: AGM (Engg.)	Dt.of 1st Issue DEC. 1982.
Dt.DEC.96	Dt.	Year:			

PLANT PURCHASING SPECIFICATION



8.0 HEAT TREATMENT:

The material shall be solution annealed by quenching in water / oil or cooling rapidly in air from a temperature of 1040° C min.

9.0 TEST SAMPLES:

9.1 For chemical analysis: Each melt shall be analysed for chemical composition.

9.2 For Mechanical Tests: Bars of same size and material specification shall be grouped into lots belonging to the same melt and heat treatment batch. One sample per lot shall be tested for mechanical properties.

The test specimens shall be concentric with the bars for sectional dimension upto 40mm. For diameters or widths across flats exceeding 40 mm, the specimen location shall be 1/3rd the radius/section below the bar surface.

10.0 CHEMICAL COMPOSITION:

The melt analysis of the material shall be as follows:

Element		C	Mn	Si	Cr	Ni	S	P	N
Melt Analysis	min	-	-	-	18.00	8.00	-	-	-
	max	0.08	2.00	1.00	20.00	10.50	0.030	0.045	0.10
Permissible variation in product analysis		+0.01	+0.04	+0.05	±0.20	-0.10 +0.15	+0.005	+0.010	+0.01

11.0 MECHANICAL PROPERTIES:

The material shall have the following mechanical properties.

Tensile Strength, min N/mm ²	Yield Strength, min N/mm ²	Elongation % min (l=4d & l=50mm)	Reduction in area % min
515	205	40	50

12.0 ULTRASONIC TESTING:

All forged bars shall be tested ultrasonically as per ASTM: A745 and the acceptance norm shall be as specified therein.



PLANT PURCHASING SPECIFICATION

HY 10770

REV. NO: 02

PAGE 3 OF 3

13.0 RETESTS:

If any of the test specimen fails to meet the requirements specified in cl. 11, the sample bar from which the test specimen was cut shall be rejected and two further sample bars from the same lot shall be taken for retest. If the retests also fail, the entire lot shall be rejected.

14.0 INSPECTION AT SUPPLIER'S WORKS:

The representative of BHEL shall have free access to the suppliers works at all times during the execution of the order, to satisfy himself that the material is produced as per the quality requirement of this specification. All reasonable facilities shall be extended to him, free of charge. He may also witness sampling, testing and marking called for in this specification.

15.0 TEST CERTIFICATES:

Five copies of the test certificate shall be furnished giving the following details..

- a) BHEL Order No.
- b) Specification No: HY 10770 / Rev. 02
- c) Supplier's Name
- d) Heat/Melt No.
- e) Size
- f) Results of Chemical Analysis
- g) Results of Mechanical Properties

16.0 PACKING AND MARKING:

16.1 Marking: All bars with cross-sectional dimension greater than 50 mm shall be stamped with the melt number, specification number and supplier's trade mark on both the end faces of the bars.

Bars of sectional dimension 50mm and below shall be bundled as per each size and a metal label shall be securely attached to each bundle.

- a) BHEL Specification No: HY 10770 / Rev.02
- b) BHEL Order No.
- c) Heat / Melt No
- d) Size & Wt. :
- e) supplier's trade mark

16.2 Packing: Bars shall be suitably packed to prevent damage during transit.

17.0 REJECTION AND REPLACEMENT:

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

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



AMENDMENT-NOTIFICATION

HY10770 REV.NO.02

PAGE 1 OF 1


AUSTENITIC STAINLESS STEEL BARS, SOLUTION ANNEALED


(GR. TP 304)

Add Clause 5.3 as follows:

5.3 Tolerances on forged bars shall be +8 mm on nominal diameter.
-0 mm

REF:	Amd.No.	APPROVED SR.MNGR. STDS.ENGG	ISSUED STDS. ENGG	DATE	CUM.Sr.No
	01			24 . 2 . 99	A 0277

	PLANT PURCHASING SPECIFICATION HYDERABAD	HY10767 Rev. No. 04 PAGE 1 OF 6
<u>STAINLESS STEEL BARS FOR HIGH TEMPERATURE SERVICE, HARDENED & TEMPERED</u> (GR: X22 Cr MoV121)		
<p>1.0 <u>GENERAL:</u></p> <p>This specification governs the requirements of hardened and tempered stainless steel bars of grade X22 Cr Mo V121.</p> <p>2.0 <u>APPLICATION :</u></p> <p>For the manufacture of steam turbine components suitable for temperatures from 400 - 550° C.</p> <p>3.0 <u>CONDITION OF DELIVERY :</u></p> <p>Hot rolled or forged for side/dia upto 160 mm. Bars above side/dia 160 mm shall be forged. The material shall be supplied in hardened and tempered condition.</p> <p>4.0 <u>COMPLIANCE WITH STANDARDS:</u></p> <p>This specification is based on TLV:9248//07, October, 2003 of M/s.Siemens, Germany. Assistance is also drawn from EN 10269 in preparation this specification.</p> <p>5.0 <u>DIMENSIONS AND TOLERANCES:</u></p> <p>5.1 <u>Dimensions:</u> As specified in the order. Unless otherwise specified in the order, the rolled bars shall be supplied in random lengths of 3 to 6 meters with a maximum of 10% shorts down to 1 metre & forged bars shall be supplied in random length of 1.5 to 3.0 metres.</p> <p>5.2 <u>Tolerance:</u></p> <p>5.2.1 <u>Hot rolled bars:</u> The bars shall not vary from specified diameter or distance across flats by more than $\pm 2\frac{1}{2}$ %.</p> <p>5.2.2 <u>Forged bars:</u> The tolerance on the forged bars shall be as follows:</p>		
Revisions: Revised in line with TLV9248/07 of October, 2003.		Issued : STANDARDS ENGINEERING DEPARTMENT
Rev. No. 04	Amd. No.	Reaffirmed:
Dt. FEB. 2006	Dt.	Year:
Prepared: Matls. Engg. Standards		Approved: Sr.Mngr. (QA&TS)
Date of 1st issue: JUL., 1981		

HY10767	PLANT PURCHASING SPECIFICATION HYDERABAD	
Rev. No. 04		
PAGE 2 OF 6		

<u>Diameter, mm</u>	<u>Tolerance, mm</u>
Above 50 to 125	+ 6.0
>125 to 175	+ 8.0
>175 ---	+ 12.5

Note: (FOR HOT ROLLED & FORGED BARS)
Insignificant surface defects in the form of dent and ripple marks are permissible provided their depth does not exceed half the tolerances on each size.

6.0 MANUFACTURE:

Steel shall be made by basic electric process and subsequently vacuum degassed. If any other process is employed, it shall be to mutual agreement between the supplier and BHEL.

Note: Raw material like ingots/blooms/billets required for forgings should be procured from BHEL approved sources alongwith test certificate.

7.0 HEAT TREATMENT:

The suggested heat treatment cycle shall be as follows:

7.1 Quench hardening: 1020 - 1070° C/air, oil or water.

7.2 Tempering: 680 - 740° C (min. 2 hrs).

Soak for a minimum of 2 hours and cool in air.

The details of the actual heat treatment cycle followed shall be furnished in the test certificate.

7.3 If bars need to be straightened after heat treatment, stress relieving is mandatory after completion of entire straightening process. stress relieving shall be carried out at 30 °C below the actual tempering temperature with a subsequent cooling rate.

8.0 FREEDOM FROM DEFECTS:

The bars shall be straight, sound and free from internal and surface defects viz., cracks, piping, scabs, laps, hairline cracks etc. The bars shall be free from twists and bends.

9.0 FINISH:

The surface of the bars shall be smooth without any laps, rolled in scales etc. Dents, roll marks and scratches are permitted provided their depth does not exceed half the tolerance limits specified in clause 5.



**PLANT PURCHASING
SPECIFICATION
HYDERABAD**

HY10767

Rev. No. 04

PAGE 3 OF 6

The edges of bars shall be cut square by sawing or shearing and no crop ends shall be permissible.

10.0 TEST SAMPLES:

10.1 For Chemical Analysis: One test sample for chemical analysis shall be taken from each melt.

10.2 For Mechanical Tests:

10.2.1 Two samples for lot, comprising of bars of same size, melt and heat treatment batch shall be taken for mechanical tests as follows.

Hardness shall be checked on 10% of the bars or 10 numbers of the bars, which ever is higher. When the lot consists of less than 10 bars, all the bars shall be tested. After checking the hardness in the above fashion, the softest and the hardest sample bars shall be taken from each lot for tensile and impact tests.

10.2.2 The specimens are to be taken in longitudinal direction according to EN10083-1. For bars with diameter (d) greater than 100 mm, the specimens shall be taken at a distance d/3 respectively. In this case transverse specimens are also allowed.

11.0 CHEMICAL COMPOSITION:

The melt analysis of the material shall be as follows:

Element	C	Si	Mn	Cr	Mo	V	Ni	P	S	Al
% min.	0.18	-	0.40	11.00	0.80	0.25	0.30	-	-	-
% max.	0.24	0.50	0.90	12.50	1.20	0.35	0.80	0.025	0.015	0.010
Permissible variation in product analysis	-0.01 +0.02	+0.05	±0.04	±0.15	±0.05	±0.03	±0.03	+0.005	+0.003	-

12.0 MECHANICAL PROPERTIES

The material shall be comply with following mechanical properties:

Tensile Strength N/mm ²	0.2% proof Stress N/mm ² Min.	%Elongation (L=5d) Min.		%Reduction in area of cross section, min.		Strength ISO-V notch J Min.		Hardness HB30
		L	T	L	T	L	T	
800-950	600	14	11	40	25	27	15	245-290

- NOTE:** 1) The tensile test shall be carried out in accordance with IS:1608 or any reputed National Standard.
- 2) The charpy impact test shall be performed in accordance with IS:1757 or any reputed National Standard. The specimen size shall be 10x10x55mm with a 2 mm V-Notch.

An impact test shall consist of three specimens from a single test location, the average value of which shall be specified above.

Only one value of the three can be below the specified minimum, but in no case below 2/3 of the specified minimum value.

All the three test results shall be reported in the test certificate.

13.0 RETESTS:

- 13.1** If any of the test specimen fails to meet the requirements specified in clause 12, the sample bar from which the test specimen was cut shall be rejected and two further sample bars from the same lot shall be taken for retest.
- 13.2** If either of the retests also fail, manufacturer is at liberty to reheat treat the bars in question. Not more than two reheat treatments are allowed. However retempering is not considered reheat treatment.
- 13.3** If after re-heat treatment, the mechanical properties are not complied with, the entire lot shall be rejected.



**PLANT PURCHASING
SPECIFICATION
HYDERABAD**

HY10767

Rev. No. 04

PAGE 5 OF 6

14.0 HIGH TEMPERATURE PROPERTIES:

The elevated temperature and Creep properties as mentioned in EN 10269 shall be guaranteed by the supplier in the test certificate.

15.0 METALLOGRAPHIC TEST:

15.1 The microstructure shall be studied on the fractured tensile or impact specimens. The microstructure shall show predominantly tempered martensite structure. Delta ferrite content shall not exceed 5%.

The average austenitic grain size of the steel shall be 5 or finer when tested as per ASTM E112 plate I.

15.2 Non-metallic Inclusions: The sample for testing shall be taken in longitudinal direction. When tested as per ASTM:E45, part III, the inclusion rating should not exceed the following norms:

‘A’ Sulphide type : Thin series 2

‘B’ or ‘D’ Globular type oxide : Thin series 2.

‘C’ Silicate type : Thin series 2.

However, any one of the above can be allowed upto 2.5, provided the other two do not exceed 2.

16.0 OUTER & INNER QUALITY / NDE :

16.1 Following NDE shall be performed in delivery condition:

- Verification test of all bars.
- Complete ultrasonic inspection (UT) of all bars according to EN10308 type 1a-1c (table 1).

16.2 Criteria for registration and decision: Regarding UT inspection quality class 4 according to EN10308 (table) shall be applied. The decision limit for loss of back wall echo is 3dB for all the bar dimensions. Every linear or surface-like inhomogeneity larger than 10 mm in any direction is not accepted.

17.0 INSPECTION AT SUPPLIER’S WORKS:

The representative of BHEL shall have free access to the supplier’s works at all times during the execution of the order, to satisfy himself that the material is produced as per the quality requirements of this specification. All reasonable facilities shall be extended to him, free of charge. He may also witness the sampling, testing and marking called for in this specification.

HY10767	PLANT PURCHASING SPECIFICATION HYDERABAD	
Rev. No. 04		
PAGE 6 OF 6		

18.0 TEST CERTIFICATE:

Five copies of the test certificate shall be furnished giving the following details:

- a) Specification No. HY 10767 Rev. 04
- b) BHEL Order No.
- c) Name of the supplier
- d) Melt No.
- e) Heat treatment batch no.
- f) Process of Manufacture
- g) Results of chemical analysis and mechanical tests including hardness tests.
- h) Results of Metallographic tests and Ultrasonic tests.
- i) Guarantee for high temperature properties as specified in clause 14.

19.0 PACKING AND MARKING:

19.1 Marking: All bars with cross-sectional size greater than 50mm shall be stamped with the melt number, specification number and supplier's trade mark on both the end faces of the bars.


Bars of sectional size 50mm and below shall be bundled as per each size and metal label bearing the following information shall be securely attached to each bundle.

- a) BHEL Order No.
- b) BHEL Specification No. HY10767 Rev. 04
- c) Melt No. & Heat Treatment batch No.
- d) Size & Weight
- e) Supplier's trade mark

19.2 Packing: The bars shall be suitably packed to prevent corrosion and damage during transit.

20.0 REJECTION:

In the event of any material proving defective during the course of further processing or testing, such material shall be rejected and the supplier shall make immediate arrangements to replace the same free of cost.

	PLANT PURCHASING SPECIFICATION HYDERABAD			HY 10763		
				REV. No: 04		
				PREFACE		
<div><div>ELECTRO SLAG REFINED (ESR) STAINLESS STEEL BARS FOR STEAM TURBINE BLADES, ANNEALED</div><div>(GRADE : X 20 Cr 13)</div></div>						
<div><div>For internal reference only</div><div>Remove this preface</div><div>Before issue to suppliers</div></div>						
<div><div>Main Users : Industrial Turbines</div><div>Steam Turbines</div></div>						
Revisions: Revisions: Brought in line with Siemens TLV /9238 / 01 /August, 1999.				Issued : STANDARDS ENGINEERING DEPARTMENT		
Rev.No.	Rev. Date:	Revised :	Prepared:	Approved:	Date:	
04	MAY,2003	Matls. Engg.	STDS. ENGG.	DGM (TS&MS)	July, '81	



**PLANT PURCHASING
SPECIFICATION
HYDERABAD**

HY 10763

REV. No: 04

PAGE 1 OF 6

**ELECTRO SLAG REFINED (ESR) STAINLESS STEEL BARS FOR
STEAM TURBINE BLADES, ANNEALED**

(GRADE: X 20 Cr 13)

1.0 GENERAL :

This specification governs the requirements of ESR hot rolled / forged and annealed Stainless steel bars of grade X20 Cr13, for steam turbine blades.

2.0 APPLICATION:

Round bars are used for forging of steam turbine moving blades suitable for operation upto 400°C. Flat bars are used for Labyrinth rings of steam turbines.

3.0 CONDITION OF DELIVERY :

Rounds/ flats shall be supplied in hot rolled or forged and soft annealed condition.

4.0 COMPLIANCE WITH STANDARDS :

This specification complies, in general, with TLV : 9238 / 01 /August, 1999 of M/s. Siemens, Germany.

5.0 DIMENSIONS AND TOLERANCES:

5.1 Dimensions: As specified in the order. Unless otherwise specified in the order, the bars shall be supplied in random lengths of 4 to 6 meters, with a maximum of 10% shorts down to 1 metre.

5.2 Tolerances for rolled bars and flats:

5.2.1 Round Bars : The tolerance on diameter shall be ± 1 mm.

5.2.2 Flat Bars : The tolerances on width and thickness of the flat bars shall be as follows

Revisions: Revisions: Brought in line with Siemens TLV /9238 / 01 /August, 1999.			Issued : STANDARDS ENGINEERING DEPARTMENT		
Rev.No.	Rev. Date:	Revised :	Prepared:	Approved:	Date:
04	MAY,2003	Matls. Engg.	STDS. ENGG.	DGM(TS&MS)	July, '81

PLANT PURCHASING SPECIFICATION HYDERABAD



Width across flats, mm		Tolerances
Over	Upto & including	
-	25	+ 1.0
25	50	+ 1.5
50	80	+ 2.0
80	100	+ 2.5
100	125	+ 3.0
125	-	+2.5% of dia width across flats.

- 5.3** Tolerances on forged bars/flats shall be + 8.0 mm
- 0.0 mm

6.0 MANUFACTURE:

The steel shall be manufactured by basic electric furnace process and subsequently subjected to Electro-Slag Refining (ESR) process. Any other method of steel melting shall be mutually agreed upon between the manufacturer and BHEL.

7.0 HEAT TREATMENT:

The recommended heat treatment cycle shall be as follows. The material shall be soft annealed in a furnace at 750- 800°C. However, the supplier may select suitable heat treatment cycle to achieve the specified hardness limit.

8.0 FREEDOM FROM DEFECTS:

The bars shall be free from cracks, scabs, seams and other harmful defects.

9.0 FINISH:

The surface of the bars shall be smooth without any laps, rolled in scales etc. Dents, roll marks and scratches are permitted provided their depth does not exceed half the tolerance limits specified in clause 5.

The edges of bars shall be cut square by sawing or shearing and no crop ends shall be permissible.



**PLANT PURCHASING
SPECIFICATION
HYDERABAD**

HY 10763

Rev. No.04

Page 3 of 6

10.0 CHEMICAL COMPOSITION:

The analysis of the material shall be as follows :

Element		C	Si	Mn	Cr	Ni	P	S
Melt Analysis	% min	0.17	0.10	0.30	12.50	0.30	--	--
	% max	0.22	0.60	0.80	14.00	0.80	0.030	0.020
Product Analysis	%	± 0.02	± 0.05	± 0.04	± 0.15	± 0.03	+0.005	+0.005

The tramp elements shall be within following limits.

Copper	=	0.20 max.
Tin	=	0.025 max.
Arsenic	=	0.010 max.
Antimony	=	0.010 max.
Aluminium	=	0.02 max.

The actual values shall be reported in the test certificate

11.0 SELECTION OF TEST SAMPLES:

11.1 For Chemical Analysis : One test sample for chemical analysis shall be taken from each melt.

11.2 For Mechanical Tests:

11.2.1 Hardness Test : Bars of same size shall be grouped into lots belonging to the same melt and heat treatment batch.

In case of bars with sectional dimensions more than 50mm, all the bars constituting the lot shall be tested for hardness.

In case of bars with sectional dimension less than or equal to 50 mm , hardness shall be checked on 10% of the bars or 10 numbers of bars whichever is higher.

11.2.2 Tensile and Impact Tests: One test sample shall be taken from the largest section of each melt for tensile and impact tests to be conducted in hardened & tempered condition.

PLANT PURCHASING SPECIFICATION HYDERABAD



The following heat treatment cycle is suggested to be carried out on the test samples :
Harden in air or oil at 950 - 1010 ° C
Temper at not less than 650 ° C
Soak for a minimum of 2 hours and cool in air.

The details of actual heat treatment followed shall be furnished in the test certificate.

11.3 LOCATION OF TEST SAMPLES : The test specimen shall be concentric with the bars for sectional dimension upto 40mm. For sectional dimensions exceeding 40mm the specimen location shall 1/3rd the bar thickness/radius below the bar surface. Specimens for impact testing shall have the length of the notch in the radial direction.

12.0 MECHANICAL PROPERTIES :

12.1 Material in Annealed Condition : When tested in accordance with IS:1500 or any reputed National Standard, the Brinell hardness on the bars shall not exceed 225 BHN.

12.2 Test Samples after Heat Treatment : Test samples after being heat treated as per clause 11.2.2 shall show the following mechanical properties at room temperature.

Tensile strength N/mm ²	0.2% Proof Stress N/mm ² Min.	% Elongation L= 5d Min.	Reduction of Area % Min.	Impact Strength ISO -V notch Joules (min.)	Brinell Hardness HB 30 Max.
800-950	600	15	50	20	280

NOTE: 1) The tensile test shall be carried out in accordance with IS:1608 or any reputed National Standard.

2) The Charpy Impact test shall be performed in accordance with IS:1757 or any reputed national standard. The specimen size shall be 10x10x55 mm with a 2mm ISO V-Notch.

An impact test shall consist of three specimens from a single test location, the average value of which shall be as specified above.

Only one value of the three can be below the specified minimum, but in no case below 2/3 of the specified minimum value.

All the three test results shall be reported in test certificate



**PLANT PURCHASING
SPECIFICATION
HYDERABAD**

HY 10763

Rev N0: 04

PAGE 5 OF 6

13.0 RETESTS:

13.1 If any of the test specimen fails to meet the requirements specified in clause 11, the sample bar from which the test specimen was cut shall be rejected and two further sample bars from the same lot shall be taken for retest.

13.2 If the retests also fail, manufacturer is at liberty to heat treat the bars in question. However, not more than two reheat treatments are allowed.

13.3 If after reheat treatment, the mechanical properties are not complied with, the entire lot shall be rejected.

14.0 METALLOGRAPHIC TESTS:

14.1 Microstructure: The micro structure shall be studied on the fractured tensile impact specimens. The microstructure shall have predominantly tempered martensite structure with grain No.5 or finer as per ASTM E112.

14.2 Non-metallic Inclusions : The sample for testing shall be taken in longitudinal direction. The rating of inclusions shall be tested as per ASTM.E45. Plate III and the inclusion rating should not exceed the following norms :

- ' A' Sulphide type : Thin series 2
- ' B' or 'D' Globular type oxide : Thin series 2
- ' C' Silicate type : Thin series 2.

However, any one of the above can be allowed upto 2.5, provided the other two do not exceed 2.

15.0 ULTRASONIC TEST :

Each bar above 50mm size/dia shall be tested ultrasonically in accordance with BHEL standard AA085 01 18 to ensure freedom from internal defects. The norms of acceptance shall be as per category 1 of the above standard.

16.0 INSPECTION AT SUPPLIER'S WORKS :

The representative of BHEL shall have free access to the supplier's works at all times during the execution of the order, to satisfy himself that the material is produced as per the quality requirements of this specification. All reasonable facilities shall be extended to him, free of charge. He may also witness the sampling, testing and marking called for in this specification.

**17.0 TEST CERTIFICATE :**

Five copies of the test certificate shall be furnished giving the following details :

- a) Specification No: HY 10763 Rev . 04
- b) BHEL Order No:
- c) Name of the supplier :
- d) Melt No.
- e) Heat treatment details
- f) Process of manufacture
- g) Results of chemical analysis and mechanical tests (clauses 10 & 12).
- h) Results of Metallographic and Ultrasonic tests.

18.0 PACKING & MARKING:

- 18.1 Marking:** All bars with cross-sectional size greater than 50 mm shall be stamped with the melt number, specification number and supplier's trade mark on both the end faces of the bars.


Bars of sectional size 50 mm and below shall be bundled as per each size and a metal label bearing the following information shall be securely attached to each bundle.

- a) BHEL Order No.
- b) BHEL Specification No. HY 10763 Rev.04
- c) Melt No. & Heat Treatment batch No.
- d) Size & Weight
- e) Supplier's trade mark.

- 18.2 Packing:** The bars shall be suitably packed to prevent corrosion and damage during transit.

19.0 REJECTION :

In the event of any material proving defective during the course of further processing or testing, such material shall be rejected and the supplier shall make immediate arrangements to replace the same at cost.

	PLANT PURCHASING SPECIFICATION HYDERABAD	HY10668			
		REV. No. 05			
		PREFACE			
<div><div><u>ELECTROSLAG REFINED, ALLOY STEEL BARS</u></div><div>(GRADE - V 15 Cr Mo 910 G)</div></div> <div><div>For internal use only.</div><div>Remove this preface</div><div>Before issue to suppliers.</div></div> <div>EQUIVALENT STANDARDS :</div> <div>ITALIAN : Gr : KMN - COGNE</div> <div>MAIN USERS : COMPRESSORS (TC)</div>					
Revisions: Upgradation of the technical requirement. Modified clauses 6.0, 8.0, 11.0 & 12.0.			Issued : STANDARDS ENGINEERING DEPARTMENT		
Rev. No. 05	Amd. No.	Reaffirmed	Prepared:	Approved:	Dt. of 1st Issue:
Dt. MAY, 05	Dt.	Year:	MATLS.ENGG.	SR.DGM (E&CC)	OCT. 1990



PLANT PURCHASING SPECIFICATION HYDERABAD

HY10668

REV. No. 05

PAGE 1 OF 5

ELECTROSLAG REFINED, ALLOY STEEL BARS

(GRADE - V 15 Cr Mo 910 G)

1.0 GENERAL:

This specification governs the quality requirements of ESR processed alloy steel bars of grade 15 Cr Mo 910 in annealed condition.

2.0 APPLICATION :

These bars are intended for upset forgings meant for welded type impellers of centrifugal compressors.

3.0 CONDITION OF DELIVERY :

The bars shall be supplied in hot rolled/forged, annealed condition.

4.0 COMPLIANCE WITH NATIONAL STANDARDS:

Presently there is no National Standard covering this material. This specification is based on Gr : KMN-COGNE of M/s. Cogne Nazionale, Italy.

5.0 DIMENSIONS AND TOLERANCES:

5.1 Dimensions: The dimensions shall be as specified in the order. Unless otherwise specified in the order, the hot rolled bars shall be supplied in random lengths of 3 to 6 meters with a maximum of 10% shorts down to 1 meter. Forged bars shall be supplied in random lengths of 1.5 to 3.0 meters.

5.2 Tolerances: The tolerances on cross sectional dimension shall be as follows.

5.2.1 Hot Rolled Bars :

Size (mm)		Tolerance (mm)
Over	Upto & including	
--	25	± 0.50
25	50	± 0.75
50	80	± 1.00
80	100	± 1.25
100	125	± 1.50
125	150	± 2.00
150	-	± 1.60 % of size

Revisions:

Upgradation of the technical requirement.
Modified clauses 6.0, 8.0, 11.0 & 12.0.

Issued :

**STANDARDS ENGINEERING
DEPARTMENT**

Rev. No. 05	Amd. No.	Reaffirmed	Prepared:	Approved:	Dt.of 1st Issue
Dt. MAY, 05	Dt.	Year:	MATLS. ENGG.	SR.DGM (E&CC)	OCT. 1990

HY10668	PLANT PURCHASING SPECIFICATION HYDERABAD	
Rev. No.05		
PAGE 2 OF 5		

5.2.2 Forged Bars : + 8 mm on size
- 0.0 mm

6.0 MANUFACTURE:

6.1 The steel shall be fully killed, manufactured from basic electric furnace and shall subsequently be refined through ESR process. Any other process of steel melting and refining shall be mutually agreed upon.

The actual gas content shall be analysed and reported. Hydrogen content shall be less than 1.50 ppm.

6.2 Sufficient discard shall be given from top and bottom of the ingot to ensure freedom from piping, segregation and other injurious defects.

6.3 Bars shall be made after giving sufficient reduction to each ingot ensuring that the cast structure is completely broken into fine grain structure. The reduction ratio shall not be less than 4:1 from ingots.

7.0 HEAT TREATMENT:

The bars shall be supplied in annealed condition. The suggested heat treatment for the test samples shall be as follows. Two separate test pieces per melt and heat treatment batch shall be subjected to heat treatment cycles for classes L1 & L4 and mechanical properties shall be proved as specified in clause 12.

Hardening : Heating to 960-990°C soaking 2 hours and quenching in oil. Water quenching is not permitted.

Tempering L₁: Heating to not less than 660°C, soaking 3 hours and cooling in air.

L₄: Heating to not less than 530°C, soaking 3 hours and cooling in air.

The details of actual heat treatment followed by the supplier shall be furnished in the test report. The time temperature charts of the heat treatment shall be enclosed along with the test certificate.

8.0 SURFACE FINISH:

8.1 The surface finish of bars shall be smooth without any laps, rolled in scales, pit marks, etc. Dents, roll marks and scratches are permitted provided their depth does not exceed half the tolerance limits.

8.2 The edges of the bars shall be cut square by sawing or shearing and no crop ends shall be permissible.



**PLANT PURCHASING
SPECIFICATION
HYDERABAD**

HY10668

Rev. No.05

PAGE 3 OF 5

9.0 FREEDOM FROM DEFECTS:

Bars shall be sound and free from any cracks, flakes, cavities and other harmful defects. The bars shall be free from internal defects such as shrinkage, porosity, pipes and non-metallic inclusions.

10.0 CHEMICAL COMPOSITION:

The steel shall conform to the following chemical composition.

Element		C	Si	Mn	Cr	Mo	V	S	P	Cu	H2
Ladle Ana-lysis	Min.	0.13	0.30	0.40	2.10	0.90	-	-	-	-	-
	Max.	0.17	0.50	0.60	2.40	1.10	0.02	0.015	0.015	0.10	1.50 PPM
Permissible variation in Product Analysis		±0.01	±0.03	±0.03	±0.05	±0.03	-	+0.003	+0.003	-	-

11.0 TEST SAMPLES:

One test sample for chemical analysis shall be taken from a bar representing each melt. Test samples shall be subjected to heat treatment as per clause-7 before mechanical testing. Supplier has got the option of upsetting the test coupon to a further 1.5 reduction ratio before heat treatment for the bars of sizes above 200 mm diameter.

12.0 MECHANICAL PROPERTIES

Test samples shall be taken from heat treated test coupon in tangential direction for each melt and shall meet the following mechanical properties. The values obtained shall be reported in test certificate.


Class	Tensile Strength N/mm ² min.	0.2% Proof Stress N/mm ²	Elongation % min. (l=5d)	Charpy Impact strength ** (5mm- U-Notch) J min.	Hardness BHN
L1	690	540-635	14	20	210-240
L4	1130	980-1070	14	20	330-360

****Testing temperature shall be as follows:**

Minus 59°C for Grade 'L₁'

Room Temperature for Grade 'L₄'

Note: a) The tensile test shall be performed as per IS 1608 or any other reputed National Standards.

HY10668	PLANT PURCHASING SPECIFICATION HYDERABAD	
Rev. No.05		
PAGE 4 OF 5		

b) The charpy impact test shall be performed on 10x10x55 mm specimen with 5mm U notch.

c) Value indicated for impact strength is the average of 3 test specimens. Only one value can be lower than the specified min. value, but not less than 2/3rd of the specified min. value. All the three values shall be reported in the test certificate.

12.1 Hardness: 10% of the bars or 10 bars minimum (whichever is higher) shall be tested for hardness in annealed condition. The hardness shall not be more than 200 BHN. The hardness values for the tested bars shall be reported in the test certificate.

13.0 ULTRASONIC TEST:

All bars more than 50 mm diameter shall be ultrasonically tested according to ASTM - A388 (or BHEL Standard AA 0850118) and following shall be the unacceptable defects.
(Category I of AA0850118 is acceptable)

i) Cracks, flakes, seams and laps.

ii) Defects giving indication larger than that from a 2 mm diameter equivalent flaw.

iii) Group of defects with maximum indication less than that from a 2 mm diameter equivalent flaw which cannot be separated at testing sensitivity if the back echo is reduced to less than 70%.

iv) Defects giving indication of 1 to 2mm diameter equivalent flaws & separated by a distance less than four times the size of the larger of the adjacent flaws.

14.0 TEST FOR CLEANLINESS :

The inclusion contents of the steel shall not be greater than class-2 (thin series) and 0.5 (thick series) of ASTM:E45 Plate III for A, B, C and D type of inclusions.


15.0 RETESTS:

If any of the selected test samples fail to meet the specified requirements due to some mechanical reasons, another specimen may be taken.

In the event of failure due to heat treatment, not more than two reheat treatments may be carried out. However, retempering is not considered as reheat treatment.

16.0 INSPECTION AT SUPPLIER'S WORKS:

16.1 BHEL representative/BHEL appointed Inspection Agency shall have free entry and access to all areas where the manufacture of the bars is carried out. All reasonable facilities shall be extended to him including labour wherever necessary.

	<p style="text-align: center;">PLANT PURCHASING SPECIFICATION HYDERABAD</p>	HY10668
		Rev. No.05
		PAGE 5 OF 5

16.2 BHEL representative/BHEL appointed Inspection Agency shall be given sufficient advance intimation to witness the various processes, tests, etc. Punching and identification of test coupons and execution of various tests shall be done in presence of BHEL representative/BHEL appointed Inspection Agency.

16.3 Unless otherwise indicated in the enquiry, Lloyds shall be the BHEL representative for inspection activities mentioned at 16.1 and 16.2

17.0 TEST CERTIFICATE:

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

- a) BHEL Specification No. HY 10668 Rev.05
- b) BHEL Order No.
- c) Melt No. / Size
- d) Process of manufacture
- e) Results of chemical analysis
- f) Results of mechanical tests including hardness of each bar
- g) Results of ultrasonic test.
- h) Inclusion content of steel.
- i) Details of heat treatment and batch no. along with HT charts duly endorsed by BHEL/BHEL appointed inspection agency.

17.2 The test certificate shall be signed by the chief of inspection / chief metallurgist of the supplier and shall be attested by BHEL representative/BHEL appointed inspection agency.

18.0 MARKING AND PACKING:

18.1 The following details shall be legibly stamped on each bar on one of the end face.


- a) HY 10668 Rev.05
- b) Manufacturer's Mark
- c) Melt No.
- d) BHEL inspector's / BHEL appointed inspection agency's stamp.


18.2 The bars shall be suitably protected from damage during transport.

19.0 REJECTION AND REPLACEMENT:

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

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

	PLANT PURCHASING SPECIFICATION HYDERABAD	HY10666 REV. NO. 04 PAGE 1 OF 6						
<u>ALLOY STEEL BARS FOR HIGH TEMPERATURE SERVICE – HEAT TREATED</u> (GR. 11 Cr Mo 910)								
<p>1.0 <u>GENERAL:</u></p> <p>This specification governs the requirements of alloy steel bars of grade 11 Cr Mo 910 in heat treated condition.</p> <p>2.0 <u>APPLICATION :</u></p> <p>For the Manufacture of high temperature fasteners, bushes etc. involving welding.</p> <p>3.0 <u>CONDITIONS OF DELIVERY :</u></p> <p>The bars shall be supplied in hot rolled/forged and heat treated condition..</p> <p>4.0 <u>COMPLIANCE WITH STANDARDS:</u></p> <p>This material complies in general with DIN EN10273-2000 Gr.11CrMo910 (Number 1.7383). Assistance is also drawn from EN10222-2 : 2000 specification in preparation of this standard.</p> <p>5.0 <u>DIMENSION AND TOLERANCES:</u></p> <p>5.1 Dimensions: The sizes shall be as specified in the order. Unless otherwise Specified, the bars shall be supplied in random lengths of 3 to 6 metres with maximum of 10% shorts down to 1 metre. Forged bars shall be supplied in lengths of 1.5 to 3.0 metres.</p> <p>5.2 Tolerances:</p> <p>5.2.1 Hot rolled bars: The bars shall not vary from specified diameter or distance across flats by more than $\pm 2\frac{1}{2}$ %.</p> <p>5.2.2 Forged bars: The tolerance on the forged bars shall be as follows:</p>								
Revisions: Revised in line with EN10273-2000.		Issued : STANDARDS ENGINEERING DEPARTMENT						
Rev. No. 04	Amd. No.	Reaffirmed:						
Dt. FEB. 2006	Dt.	Year:						
<table style="width: 100%; border: none;"> <tr> <td style="width: 33%; border: none;">Prepared:</td> <td style="width: 33%; border: none;">Approved:</td> <td style="width: 33%; border: none;">Dt. of 1st issue:</td> </tr> <tr> <td style="border: none;">STANDARDS</td> <td style="border: none;">AGM (ENGG.)</td> <td style="border: none;">JUL., 1982</td> </tr> </table>			Prepared:	Approved:	Dt. of 1st issue:	STANDARDS	AGM (ENGG.)	JUL., 1982
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STANDARDS	AGM (ENGG.)	JUL., 1982						

HY10666	PLANT PURCHASING SPECIFICATION HYDERABAD	
REV. NO. 04		
PAGE 2 OF 6		

<u>Diameter, mm</u>	<u>Tolerance, mm</u>
Above 50 to 125	+ 6.0
>125 to 175	+ 8.0
>175 ---	+ 12.5

Note: (FOR HOT ROLLED & FORGED BARS)
Insignificant surface defects in the form of dent and ripple marks are permissible provided their depth does not exceed half the tolerances on each size.

6.0 MANUFACTURE:

Steel shall be made by basic electric process and subsequently vacuum degassed. If any other process is employed, it shall be to mutual agreement between the supplier and BHEL.

Note: Raw material like ingots/blooms/billets required for forgings should be procured from BHEL approved sources alongwith test certificate.

7.0 HEAT TREATMENT:

7.1 The suggested heat treatment process shall be as follows:

Austenitizing at 920-980° C followed by air cooling or liquid quenching.

Tempering at 650-760° C followed by air cooling.

7.2 The supplier has the option of following heat treatment as per EN10273 or EN10222.

7.3 The actual heat treatment cycle followed shall be reported in the test certificate.

8.0 FREEDOM FROM DEFECTS:

The bars shall be straight, sound and free from internal and surface defects viz., cracks, piping, scabs, laps, hairline cracks etc. The bars shall be free from twists and bends.

9.0 FINISH:

9.1 The surface of the bars shall be smooth without any laps, rolled in scales etc. Dents, roll marks and scratches are permitted provided their depth does not exceed half the tolerance limits as specified in Cl.5.0.

9.2 The edges of bars shall be cut square by sawing or shearing and no crop ends shall be permissible.



**PLANT PURCHASING
SPECIFICATION
HYDERABAD**

HY10666

REV. NO. 04

PAGE 3 OF 6

10.0 SELECTION OF TEST SAMPLES:

10.1 Chemical Analysis: Each melt shall be analysed for chemical composition.

10.2 Mechanical Tests:

10.2.1 One sample per lot, comprising of bars of same size, melt and heat treatment batch shall be taken for mechanical testing.

10.2.2 For bars of nominal size 150mm and below, longitudinal test specimen shall be taken. The test samples shall be taken as per EN10273.

11.0 CHEMICAL COMPOSITION:

The melt analysis of the material shall be as follows:

Element		C	Si	Mn	Cr	Mo	P	S	Cu
Melt analysis	Min.	0.08	-	0.40	2.00	0.90	-	-	-
	Max.	0.15	0.50	0.80	2.50	1.10	0.030	0.025	0.30
Variation in product analysis		± 0.02	± 0.05	+ 0.10 - 0.05	± 0.10	± 0.04	+0.005	+0.005	-

NOTE: The Al content of the melt shall be determined and stated in the test certificate.

12.0 MECHANICAL PROPERTIES:

The following mechanical properties shall be achieved when tested at room temperature.

12.1 For bars of sizes upto 100 mm diameter (As per EN10273-2000).

Size mm	Tensile strength N/mm ² , min.	Yield Strength N/mm ² , min.	% Elongation (l=5d), min.	Impact Strength, J, min. (2 mm-V notch)
Upto 60	520-670	310	18	40J
> 60 to 100	520-670	310	17	40J

HY10666	PLANT PURCHASING SPECIFICATION HYDERABAD	
REV. NO. 04		
PAGE 4 OF 6		

12.2 For bars above 100 mm (As per EN10222-part 2-2000).

Size mm	Tensile strength N/mm ² , min.	Yield Strength, min.	% Elongation (l=5d), min.		Impact Strength, J, min. (2 mm-V notch)	
			L	T	L	T
>100 to 200	520-670	310	20	20	60	50
>200 to 500	450-600	265	23	21	50	34

NOTE: 1) The tensile test shall be carried out in accordance with IS:1608 or any reputed National Standard.

2) Impact Test shall be conducted as per IS:1757 or any reputed National Standard. The impact value given above is the average of 3 ISO-V notch samples. All the three values shall be reported. Only one value of the three can be below the specified minimum, but in no case below 2/3rd of the specified minimum value.

13.0 RETESTS:

13.1 If any of the test specimen fails to meet the requirements specified in cl .12, the sample bar from which the test specimen was cut shall be rejected and two further sample bars from the same lot shall be taken for retest.

13.2 If the retests also fail, manufacturer is at liberty to reheat treat the bars in question. Not more than two reheat treatments are allowed. However retempering is not considered as reheat treatment.

13.3 If after reheat treatment, the mechanical properties are not complied with, the entire lot shall be rejected.

14.0 HIGH TEMPERATURE PROPERTIES:

The elevated temperature and creep properties as specified in EN10273 shall be guaranteed by the supplier.



**PLANT PURCHASING
SPECIFICATION
HYDERABAD**

HY10666

REV. NO. 04

PAGE 5 OF 6

15.0 ULTRASONIC TEST :

All bars above 50 mm diameter shall be ultrasonically tested according to ASTM:A388 (BHEL Standard AA0850118), to ensure freedom from defects.

The following defects (Category 2 of AA0850118) shall be unacceptable.

- i) Cracks, flakes, seams and laps.
- ii) Defects giving indications larger than that from a 4mm diameter equivalent flaw.
- iii) Groups of defects with maximum indication less than that from a 4mm diameter equivalent flaw which can not be separated at testing sensitivity if the back echo is reduced to less than 50%
- iv) Defects giving indications of 2 to 4mm diameter equivalent flaw separated by a distance less than four times the size of the larger of the adjacent flaws.

16.0 INSPECTION AT SUPPLIER'S WORKS:

The representative of BHEL shall have free access to the supplier's works at all times during the execution of the order, to satisfy himself that the material is produced as per the quality requirements of this specification. All reasonable facilities shall be extended to him, free of charge. He may also witness the sampling, testing and marking called for in this specification.

17.0 TEST CERTIFICATES :

Five copies of the test certificate shall be furnished giving the following details.

- a) Specification No. HY 10666 / Rev.04
- b) BHEL Order No.
- c) Size
- d) Name of the Supplier
- e) Process of steel manufacture & bars
- f) Melt No.
- g) Heat Treatment details and batch No.
- h) Results of chemical analysis and mechanical tests.
- i) Results of Ultrasonic tests.
- j) Guarantee for high temperature properties.

18.0 PACKING AND MARKING :

- 18.1 Marking:** All bars with cross-sectional dimension greater than 50mm shall be stamped with the melt number, specification number and supplier's trade mark on one end face of the bars.

HY10666	PLANT PURCHASING SPECIFICATION HYDERABAD	
REV. NO. 04		
PAGE 6 OF 6		

Bars of sectional dimension 50mm and below shall be bundled as per each size and a metal label bearing the following information shall be securely attached to each bundle.

- a) BHEL Specification No. HY 10666 / Rev.04
- b) BHEL Order No.
- c) Melt No. & Heat Treatment batch No.
- d) Size & Weight
- e) Supplier's trade mark

18.2 Packing : The bars shall be suitably packed to prevent corrosion and damage during transit.


19.0 REJECTION AND REPLACEMENT :


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

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

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	<div>PLANT PURCHASING SPECIFICATION HYDERABAD</div>			HY10665	
				REV. NO. 03	
				PAGE 1 OF 6	
<div>BOLTING STEEL BARS FOR HIGH TEMPERATURE SERVICE – H & T (Gr.:21CrMoV57)</div> <div>1.0 GENERAL: This specification governs the quality requirements of 21CrMoV57 bolting steel bars in hardened and tempered condition upto 600 mm diameter / size.</div> <div>2.0 APPLICATION: For the manufacture of steam turbine bolts, nuts, studs, spindles, bushes and other components operating in the temperature range of 300 - 540° C.</div> <div>3.0 CONDITION OF DELIVERY: Hot rolled/forged and hardened and tempered. The bars shall be supplied with ends square and true. The bars shall be supplied in straight lengths without twists and bends.</div> <div>4.0 COMPLIANCE WITH NATIONAL STANDARDS: The material shall comply, in general, with the requirements of the following national standard and also meets the requirements of this specification. DIN EN 10269-1999: Steels and nickel alloys for fasteners with specified elevated and/or Gr. 21 Cr Mo V 57 : low temperature properties.</div> <div>5.0 DIMENSIONS AND TOLERANCES: 5.1 Sizes: Bars shall be supplied to the dimensions specified in BHEL order.</div> <div>5.1.1 Length: Unless otherwise specified, hot rolled bars shall be supplied in 3 to 6 metres length or in multiples with maximum of 10 per cent, shorts down to 1 metre. Forged bars shall be supplied in lengths of 1.5 to 3 metres.</div>					
Revisions: Revised to bring inline with CPS AA10620 and EN10269.			Issued : STANDARDS ENGINEERING DEPARTMENT		
Rev. No. 03	Amd. No.	Reaffirmed:	Prepared: STANDARDS ENGG.	Approved: AGM (G)	Date of 1 st issue: JULY, 1985
Dt. DEC. 2005	Dt.	Year:			

HY10665	PLANT PURCHASING SPECIFICATION HYDERABAD	
Rev. No. 03		
PAGE 2 OF 6		

5.2 Tolerance:

5.2.1 Hot rolled bars:

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

5.2.2 Forged bars:

The tolerance on the forged bars shall be as follows:

<u>Diameter, mm</u>	<u>Tolerance, mm</u>
50 to 125	+ 6.0
125 to 175	+ 8.0
175 ---	+ 12.5

Note: (FOR HOT ROLLED & FORGED BARS)
Insignificant surface defects in the form of dent and ripple marks are permissible provided their depth does not exceed half the tolerances on each size.

6.0 MANUFACTURE:

Steel shall be made by basic electric process and subsequently vacuum degaussed. If any other process is employed, it shall be to mutual agreement between the supplier and BHEL.

Note: Raw material like Ingots/Blooms/Billets required for forgings should be procured from BHEL approved sources alongwith test certificate.

7.0 HEAT TREATMENT:

7.1 The bars shall be heat treated to get the mechanical properties specified as per clause 12.0.

7.2 Following heat treatment is suggested:

Harden at 900-950°C
Temper at 680 - 720°C, minimum 2 hours.
Hardening above 950°C and tempering below 680°C shall not be done to avoid embrittlement.

7.3 The temperature shall be uniform all over the cross section. Minimum possible residual stresses shall be aimed with slow cooling and longer duration in tempering treatment.

7.4 If the bars need straightening after heat treatment, the straightening operation shall be followed by stress relief annealing at 30°C below the tempering temperature with slow cooling after the total straightening process.



**PLANT PURCHASING
SPECIFICATION
HYDERABAD**

HY10665

Rev. No. 03

PAGE 3 OF 6

8.0 FREEDOM FROM DEFECTS:

The bars shall be straight, sound and free from internal and surface defects viz., cracks, piping, scabs, laps, hairline cracks, etc. The bars shall be free from twists and bends.

9.0 FINISH:

9.1 The surface of the bars shall be smooth without any laps, rolled in scales, etc. Dents, roll marks and scratches are permitted provided their depth does not exceed half the tolerance limits specified in clause 5.0.

9.2 The edges of bars shall be cut square by sawing or shearing and no crop ends shall be permissible.

10.0 CHEMICAL COMPOSITION:

The analysis of the material and the permissible variation in the composition from the specified limits shall be as follows:

Element	Percent		Permissible variation, %
	min.	max.	
Carbon	0.17	0.25	± 0.02
Silicon	-	0.40	+ 0.05
Manganese	0.40	0.80	± 0.04
Chromium	1.20	1.50	± 0.05
Molybdenum	0.55	0.80	± 0.05
Vanadium	0.20	0.35	± 0.03
Sulphur	-	0.020	+ 0.005
Phosphorus	-	0.020	+ 0.005
Copper	-	0.20	
Tin	-	0.025	
Arsenic	-	0.010	
Antimony	-	0.010	
Aluminium	-	0.02	

Note: Nickel content of about 0.80% max. is permissible.

11.0 TEST SAMPLES:

11.1 Chemical analysis:

Each melt shall be analysed for chemical composition.

11.2 MECHANICAL TESTS:

A hardness test is to be carried out to verify the uniformity of the strength within the delivery lot (per melt and heat treatment batch). The test amount shall be 10% of the bars, but not less than 10 bars. In case of less than 10 bars, all bars shall be hardness tested. Mechanical properties shall be tested on hardest and softest bar.

The taking of specimens has to be carried out according to EN 10083-2 with the following exception:

Up to a diameter (d) or an edge length (a,b) > 100 mm, the transversal specimens can be taken with a distance of d/3 or a/3 and b/3 from outside (instead of longitudinal specimens).

12.0 MECHANICAL PROPERTIES:

12.1 Tensile:

When tested in accordance with IS:1608, the test pieces shall show the following properties (values for transverse specimens in brackets):

Property	Bar < 160mm	Bar 160-600mm
Tensile strength, N/mm ²	700-850	700-850
0.2% Proof stress, N/mm ² ,min	550	550
Elongation (l= 5d), % min.	16	16 (13)
Reduction in area, % min.	60	60 (35)
Impact energy (J) *	63	63 (20)
Hardness (HB 30)	210-250	215-260

• Charpy Impact (ISO - V) Value :

When tested in accordance with IS : 1757, the piece shall show a minimum average Charpy impact value over three test values as specified above. Only one test value out of the three can be below the specified value but in no case shall be less than two-thirds the minimum specified value. All the 3 test values shall, however, be reported.

The test is applicable for bars of sizes above 16 mm only.

13.0 NON-DESTRUCTIVE TEST:

13.1 Verification inspection of all bars.



**PLANT PURCHASING
SPECIFICATION
HYDERABAD**

HY10665

Rev. No. 03

PAGE 5 OF 6

13.2 100% Ultrasonic inspection of all bars above 40mm size according to EN 10228-3 type 1a and 1b table 3). Acceptance criteria shall be quality class 4 according to EN 10228-3 (table 5). In general, the decision limit for loss of back wall echo is 4 dB and for the real reflector length max. 10mm.

14.0 RETESTS:

As per EN10021.

15.0 TEST CERTIFICATE:

Three copies of test certificates shall be supplied unless otherwise stated on the order. In addition the supplier shall ensure to enclose one copy of test certificate alongwith their dispatch documents to facilitate quick clearance of material.

The test certificate shall bear the following information:

BHEL references:

BHEL order No.

HY10665 , Rev.No. 03: Bolting Steel bars for HTS - H & T (Gr.:21CrMoV57)

Supplier Referances:

Supplier's Name

Heat or Cast No.

Process of manufacture

Identification No.

Particulars of heat treatment & Batch No.

Results of Tests:

Chemical analysis

Mechanical properties

Ultrasonic test

Results of dimensional inspection

Mill test certificate

The certificate must be signed by the Chief, Inspection Department / Chief Metallurgist of the supplier's plant.

16.0 PACKING AND MARKING:

Bars shall be suitably packed to prevent corrosion and damage during transportation.

Bars over 63 mm diameter shall be individually stamped / painted on one end face with cast number and HY10665. Bars of 63 mm diameter and less shall be bundled together and identified by means of a metal label stating the cast number and specification No. HY10665 attached to the bundle.

HY10665	PLANT PURCHASING SPECIFICATION HYDERABAD	
Rev. No. 03		
PAGE 6 OF 6		

Each package shall, in addition bear the following information:

AA HY10665 : Bolting Steel bars for HTS - H & T (Gr.:21CrMoV57)

BHEL Order No.

Supplier's name and trade mark, if any.

Cast / Batch No.

Identification No.

Size and quantity supplied.

17.0 REFERRED STANDARDS (Latest Publications Including Amendments):

1) DIN 10269

2) IS: 3739

3) IS:1608

4) IS:1757

5) EN 10228-3

6) EN10021

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			REV. NO. 06								
			PAGE 1 OF 5								
<div>ALLOY STEEL BARS - QUENCHED & TEMPERED</div> <div>(GR: 42 Cr Mo 4)</div> <div>1.0 GENERAL:</div> <div>This specification governs the requirements of alloy steel bars of grade 42 Cr Mo 4 in quenched and tempered condition.</div> <div>2.0 APPLICATION :</div> <div>For the manufacture of high tensile and high temperature fasteners and other components requiring high tensile strength coupled with good ductility and resistance to shock and wear.</div> <div>3.0 CONDITIONS OF DELIVERY :</div> <div>The bars shall be supplied in hot rolled / forged and quenched and tempered condition.</div> <div>4.0 COMPLIANCE WITH STANDARDS:</div> <div>This specification complies in general with DIN EN 10083 / 1996, Grade : 42 Cr Mo4.</div> <div>5.0 DIMENSIONS AND TOLERANCES:</div> <div>5.1 Dimensions : The sizes shall be as specified in the order. Unless otherwise specified, the bars shall be supplied in random lengths of 3 to 5 metres.</div> <div>5.2 Tolerance:</div> <div>5.2.1 Hot rolled bars: The bars shall not vary from specified diameter or distance across flats by more than $\pm 2\frac{1}{2}$ %.</div> <div>5.2.2 Forged bars: The tolerance on the forged bars shall be as follows.</div> <table><tr><td>Diameter, mm</td><td>Tolerance, mm</td></tr><tr><td>50 mm to 175 mm</td><td>+ 8.0 mm</td></tr><tr><td>Above 175 mm</td><td>+ 12.5 mm</td></tr></table>						Diameter, mm	Tolerance, mm	50 mm to 175 mm	+ 8.0 mm	Above 175 mm	+ 12.5 mm
Diameter, mm	Tolerance, mm										
50 mm to 175 mm	+ 8.0 mm										
Above 175 mm	+ 12.5 mm										
Revisions: Modified clause 16.0 to add the results of hardness & NDT tests in test certificate.			Issued : STANDARDS ENGINEERING DEPARTMENT								
Rev.No. 06	Amd. No.	Reaffirmed	Prepared: Standards, Matls. Engg.	Approved:	Date of 1 st issue:						
Dt. FEB. 06	Dt.	Year:		AGM (Engg.)	AUG. 82						

HY10664	PLANT PURCHASING SPECIFICATION HYDERABAD	
REV. NO. 06		
PAGE 2 OF 5		

Note: (Hot rolled & forged bars).

Insignificant surface defects in the form of dent and ripple marks are permissible provided their depth does not exceed half the tolerance on each size.

6.0 MANUFACTURE:

Method of steel manufacture shall be at the manufacturer's discretion. The steel shall be fully killed..

7.0 HEAT TREATMENT:

7.1 The recommended heat treatment cycle shall be as follows:

Hardening : 820° - 860° C followed by water/ oil quenching.

Tempering at 540° - 680° C followed by Air cooling.

The actual heat treatment cycle followed shall be reported in Test Certificate.

7.2 If the bars need to be straightened after heat treatment, the bars shall be stress relieved, after straightening operation, at 30° C below the actual tempering temperature.

8.0 FREEDOM FROM DEFECTS:

The bars shall be free from Cracks, Scabs, laminations, and other harmful defects.

9.0 FINISH:

9.1 The surface of the bars shall be smooth without any laps, rolled in scales etc., Dents, roll marks and scratches are permitted provided their depth does not exceed half the tolerance limits .

9.2 The edges of bars shall be cut square by sawing or shearing and no crop ends shall be permissible.

10.0 CHEMICAL COMPOSITION:

The melt analysis of the material shall be as follows:

Element		C	Si	Mn	Cr	Mo	P	S
Melt Analysis	Min .	0.38	-	0.60	0.90	0.15	-	-
	Max.	0.45	0.40	0.90	1.20	0.30	0.035	0.035
Permissible variation in product analysis		± 0.02	+ 0.03	± 0.04	± 0.05	± 0.03	+ 0.005	+ 0.005

Note : Ni addition upto 0.50% is permitted for improving impact properties.



PLANT PURCHASING SPECIFICATION HYDERABAD

HY10664

REV. NO. 06

PAGE 3 OF 5

11.0 SELECTION OF TEST SAMPLES:

11.1 **Chemical Analysis:** Each melt shall be analysed for chemical composition.

11.2 Mechanical Tests:

11.2.1 One sample per lot, comprising of bars of same size, melt and heat treatment batch shall be taken for mechanical testing.

11.3 **Hardness:** Hardness shall be checked for 5% of the bars of same size, melt and heat treatment batch. In any case minimum two bars shall be tested for hardness.


12.0 MECHANICAL PROPERTIES :

The Mechanical properties of the material shall be as follows. For the size ranges upto 160 mm dia the properties given are for longitudinal specimen. For the size range 160 - 250, the properties for both longitudinal and transverse direction are given.

Ruling Section, mm	Tensile Strength N/mm ²	0.2% proof stress, min. N / mm ²	Elongation min. L = 5d	Reduction in area % min.	Notched bar impact strength min. (ISO - V notch) J	Hardness, BHN
Upto 16	1100-1300	900	10	40	--	315 - 375
>16 ≤40	1000-1200	750	11	45	25	285 - 335
>40 ≤100	900-1100	650	12	50	25	245 - 315
>100 ≤160	800-950	550	13	50	25	225 - 275
>160 ≤250 (L)	750-900	500	14	55	25	215 - 245
>160 ≤250 (T)	750-900	500	12	--	27 (DVM 3 mm - U notch)	215 - 245

NOTE: 1) The tensile test shall be carried out according to IS:1608 or any reputed national standard.

2) The charpy impact test shall be carried out according to IS:1757 or any reputed National Standard. The test shall be performed on ISO - Specimen of size 10x10x55mm with a 2 mm V-Notch.

HY10664	PLANT PURCHASING SPECIFICATION HYDERABAD	
REV. NO. 06		
PAGE 4 OF 5		

3) 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.

4) The hardness shall be tested in accordance with IS 1500 or any other equivalent international standard.

13.0 RETESTS:

13.1 If any of the test specimen fails to meet the requirements specified in cl.12, the sample bar from which the test specimen was cut shall be rejected and two further sample bars from the same lot shall be taken for retest

13.2 If the retests also fail, manufacturer is at liberty to reheat treat the bars in question. Not more than two reheat treatments are allowed. However, retempering is not considered as reheat treatment.

13.3 If after reheat treatment, the mechanical properties are not complied with, the entire lot shall be rejected.

14.0 ULTRASONIC TEST:

All bars above 50 mm dia/side shall be ultrasonically tested according to ASTM:A388 (BHEL Standard AA0850118), to ensure freedom from defects.

The following defects (Category 2 of AA 0850118) shall be unacceptable.

i) Cracks, flacks, seams and laps.

ii) Defects giving indications larger than that from a 4mm diameter equivalent flaw.

iii) Groups of defects with maximum indication less than that from a 4mm diameter equivalent flaw which can not be seperated at testing sensitivity if the back echo is reduced to less than 50%.

iv) Defects giving indications of 2 to 4mm diameter equivalent flaw seperated by a distance less than four times the size of the larger of the adjacent flaws.

15.0 INSPECTION AT SUPPLIER'S WORKS:

The representative of BHEL shall have free access to the supplier's works at all times during the execution of the order, to satisfy himself that the material is produced as per the quality requirements of this specification. All reasonable facilities shall be extended to him, free of charge. He may also witness the sampling, testing and marking called for in this specification.



**PLANT PURCHASING
SPECIFICATION
HYDERABAD**

HY 106 64

REV. NO. 06

PAGE 5 OF 5

16.0 TEST CERTIFICATES:

16.1 Five copies of the test certificate shall be furnished giving the following details.

- a) Specification No. HY10664 Rev. 06
- b) Material Grade : 42 Cr Mo 4
- c) BHEL Order No.
- d) Size
- e) Melt No.
- f) Process of manufacture
- g) Heat Treatment details and batch No.
- h) Results of chemicals analysis and mechanical properties.
- i) Results of hardness test.
- j) NDT tests (if applicable).

17.0 PACKING AND MARKING:

17.1 Marking: All bars with cross sectional dimension greater than 50 mm shall be stamped with the melt number, specification number and supplier's trade mark on both the end faces of the bars.

Bars of sectional dimension 50 mm and below shall be bundled as per each size and a metal label bearing the following information shall be securely attached to each bundle.

- a) BHEL Specification No. HY10664 Rev .06
- b) BHEL Order No.
- c) Melt No. & Heat Treatment batch No.
- d) Size & Weight
- e) Supplier's trade mark.

17.2 Packing: The bars shall be suitably packed to prevent corrosion and damage during transit.

18.0 REJECTION AND REPLACEMENT:

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

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



**PLANT PURCHASING
SPECIFICATION
HYDERABAD**

HY10663

Rev. No. 05

PAGE 1 OF 5

ALLOY STEEL BARS FOR HIGH TEMPERATURE SERVICE – H & T
(GR: 25 Cr Mo 4)

1.0 GENERAL:

This specification governs the quality requirements of alloy steel bars of grade 25 Cr Mo 4 in hardened and tempered condition.

2.0 APPLICATION :

For the manufacture of high temperature fasteners for steam turbines.

3.0 CONDITION OF DELIVERY :

The bars shall be supplied in hot rolled/forged and hardened and tempered condition.

4.0 COMPLIANCE WITH STANDARDS:

The material shall comply with DIN: 10269-1999 GR: 25 Cr Mo 4 : Heat resisting and highly heat resisting materials for bolts and nuts with the following additional / specific requirements.

5.0 DIMENSIONS AND TOLERANCES:

5.1 Dimensions: The sizes shall be as specified in the order. Unless otherwise specified, the bars shall be supplied in random lengths of 3 to 6 metres or in multiples with maximum of 10% shorts down to 1 metre.


Forged bars shall be supplied in lengths of 1.5 to 3.0 metres.

5.2 Tolerance:

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

5.2.2 Forged bars: The tolerance on the forged bars shall be as follows:

Revisions: Modified Cl. 5.0, 6.0, 10.0.			Issued : STANDARDS ENGINEERING DEPARTMENT		
Rev.No. 05	Amd. No.	Reaffirmed	Prepared: STDS.ENGG., MATLS.ENGG.	Approved: AGM (ENGG.)	Dt.of 1st Issue
Dt. FEB. 2006	Dt.	Year:			JUL. 1982

HY10663	PLANT PURCHASING SPECIFICATION HYDERABAD	
Rev. No. 05		
PAGE 2 OF 5		

<u>Diameter, mm</u>	<u>Tolerance, mm</u>
> 50 to 125	+ 6.0
>125 to 175	+ 8.0
>175 ---	+ 12.5

Note: (FOR HOT ROLLED & FORGED BARS)
Insignificant surface defects in the form of dent and ripple marks are permissible provided their depth does not exceed half the tolerances on each size.

6.0 MANUFACTURE:

Steel shall be made by basic electric process and subsequently vacuum degassed. If any other process is employed, it shall be to mutual agreement between the supplier and BHEL.

Note: Raw material like ingots/blooms/billets required for forgings should be procured from BHEL approved sources alongwith test certificate.

7.0 HEAT TREATMENT:

7.1 The heat treatment cycle shall be as follows:

Hardening at 840-880°C Cool in oil or water.

Tempering at 540°C-680°C for min. 2 hrs and cool in air slowly to minimize residual stresses.

7.2 If the bars need be straightened after heat treatment, the bars shall be stress relieved, after straightening operation, at 30°C below the actual tempering temperature.

The actual heat treatment cycle followed shall be reported in test certificate.

8.0 FREEDOM FROM DEFECTS:

The bars shall be straight, sound and free from internal and surface defects viz., cracks, piping, scabs, laps, hairline cracks etc. The bars shall be free from twists and bends.

9.0 FINISH:

9.1 The surface of the bars shall be smooth without any laps, rolled in scales etc. Dents, roll marks and scratches are permitted provided their depth does not exceed half the tolerance limits specified in Cl.5.0.

9.2 The edges of bars shall be cut square by sawing or shearing and no crop ends shall be permissible.



**PLANT PURCHASING
SPECIFICATION
HYDERABAD**

HY10663

Rev. No. 05

PAGE 3 OF 5

10.0 SELECTION OF TEST SAMPLES:

10.1 Chemical Analysis: Each melt shall be analysed for chemical composition.

10.2 Mechanical Tests:

One sample per lot, comprising of bars of same size, melt and heat treatment batch shall be taken for mechanical testing. For bars of diameter more than 160 mm the supplier has the option of reducing the diameter to 160 mm by forging or machining and then test it as per Cl. 12.0 of this specification to achieve the required properties of 160 mm dia. ruling section.

11.0 CHEMICAL COMPOSITION:

The chemical analysis of the material shall be as follows:

Element (%)		C	Si	Mn	Cr	Mo	P	S
Melt Analysis	min .	0.22	--	0.60	0.90	0.15	-	-
	max.	0.29	0.40	0.90	1.20	0.30	0.035	0.035
Permissible variation in product Analysis		± 0.02	±0.03	±0.04	±0.05	±0.04	+0.005	+0.005


12.0 MECHANICAL PROPERTIES

The Mechanical properties of the material shall be as follows:

Specimen	Limiting ruling Section (mm)	Tensile Strength N/mm ²	0.2% Proof stress, min N/mm ²	Elongation % min (l=5d)	Reduction in area % min	Impact strength, min (ISO-V Specimen) J
Longitudinal	≤ 100	600-750	440	18	60	60
	> 100		420			45
	≤ 160					

NOTE: 1) The tensile test shall be carried out according to IS:1608 or any reputed National Standard.

2) The charpy impact test shall be carried out according to IS:1757, or any reputed National Standard. The test shall be performed on ISO - V Specimen of size 10x10x55mm with a 2 mm V-Notch.

HY10663	PLANT PURCHASING SPECIFICATION HYDERABAD	
Rev. No. 05		
PAGE 4 OF 5		

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.

13.0 RETESTS:

13.1 If any of the test specimen fails to meet the requirements specified in cl 12, the sample bar from which the test specimen was cut shall be rejected and two further sample bars from the same lot shall be taken for retest.

13.2 If the retests also fail, manufacturer is at liberty to heat-treat the bars in question. However, not more than two re-heat treatments are allowed. Re-tempering is not considered as reheat treatment.

13.3 If after re-heat treatment, the mechanical properties are not complied with, the entire lot shall be rejected.

14.0 ULTRASONIC TEST:

All bars above 50mm dia shall be ultrasonically tested according to the latest ASTM:A388 (BHEL Standard AA0850118), to ensure freedom from defects.

The following defects (Category 2 of AA0850118) shall be unacceptable.

i) Cracks, flacks, seams and laps.

ii) Defects giving indications larger than that from a 4mm diameter equivalent flaw.

iii) Groups of defects with maximum indication less than that from a 4mm diameter equivalent flaw which can not be seperated at testing sensitivity if the back echo is reduced to less than 50%.

iv) Defects giving indications of 2 to 4mm diameter equivalent flaw seperated by a distance less than four times the size of the larger of the adjacent flaws.

15.0 INSPECTION AT SUPPLIER’S WORKS:

The representative of BHEL shall have free access to the supplier’s works at all times during the execution of the order, to satisfy himself that the material is produced as per the quality requirements of this specification. All reasonable facilities shall be extended to him, free of charge. He may also witness the sampling, testing and marking called for in this specification.



**PLANT PURCHASING
SPECIFICATION
HYDERABAD**

HY10663

Rev. No. 05

PAGE 5 OF 5

16.0 TEST CERTIFICATES:

16.1 Five copies of the test certificate shall be furnished giving the following details.

- a) Specification No: HY 10663 / Rev. 05
- b) BHEL order No
- c) Size
- d) Name of the Supplier
- e) Process of steel manufacture & bars.
- f) Melt No.
- g) Heat Treatment details and batch No.
- h) Results of chemical analysis and mechanical tests.
- i) Results of ultrasonic tests.

16.2 The test certificate shall be signed by the chief of Quality/Chief Metallurgist of the supplier and BHEL representative.

17.0 PACKING AND MARKING:

17.1 Marking: All bars with cross-sectional dimension greater than 50mm shall be stamped with the melt number, specification number and supplier's trade mark on both the end faces of the bars.

Bars of sectional dimension 50mm and below shall be bundled as per each size and metal lable bearing the following information shall be securely attached to each bundle.

- a) BHEL Specification No. HY 10663
- b) BHEL Order No.
- c) Melt No. & Heat Treatment batch No.
- d) Size & Weight
- e) Supplier's trade mark.

17.2 Packing: The bars shall be suitably packed to prevent corrosion and damage during transit.

18.0 REJECTION:

In the event of any material proving defective during the course of further processing or testing, such material shall be rejected and the supplier shall make immediate arrangements to replace the same free of cost.



**PLANT PURCHASING
SPECIFICATION
HYDERABAD**

HY 105 68

REV. NO: 01

PAGE 1 OF 4

1.5% MAGANESE STEEL BARS, NORMALIZED

1.0 GENERAL:

This specification governs the requirements of 1.5% Manganese steel bars.

2.0 APPLICATION :

For components requiring high strength.

3.0 CONDITION OF DELIVERY :

The material shall be procured in the hot rolled and Normalised condition.

4.0 COMPLIANCE WITH NATIONAL STANDARDS:

Specification complies with the requirements of:

BS: 970 (Pt-1) - 1983 | Specification for

Gr: 150M19 | Wrought steel

5.0 DIMENSIONS AND TOLERANCES:

5.1 Sizes: Bars shall be supplied to the dimensions specified on the order. Unless otherwise specified in the order, bars shall be supplied in random lengths of 3 to 6 meters.

5.2 Tolerances: The tolerances on bars shall comply with those of Grade 2 of IS:3739, reproduced below:

5.2.1 Rounds & Square Bars:

Nominal size mm		Tolerance, mm	
Over	Upto & including	Permissible deviation	Out of round
--	25	±0.50	0.50
25	50	±0.75	0.75
50	80	±1.00	1.00
80	100	±1.25	1.25
100	125	±1.50	1.50
125	150	±2.00	2.00

Revisions:

General Revision

Issued :

**STANDARDS
ENGINEERING DEPARTMENT**

Rev.No.

Rev.Date:

Revised:

Prepared:

Approved:

Date:

01

Mar 1992

Matls Engg.

STDS

GM (Engg)

Jan 1984



6.0 MANUFACTURE:

The steel shall be manufactured by basic oxygen process, basic open hearth process or basic electric furnace process and shall be fully killed.

7.0 FREEDOM FROM DEFECTS:

The bars shall be free from surface and internal defects such as piping, segregation etc. The bars shall be supplied in straight lengths with ends square and true.

8.0 HEAT TREATMENT:

Normalizing shall be done at 860°-900° C.

9.0 SELECTION OF TEST SAMPLES:

9.1 Chemical Analysis: Each melt shall be analysed for chemical composition.

9.2 Mechanical Properties: Bars of same size shall be divided into lots belonging to the same melt and heat treatment batch. One sample per lot shall be tested for mechanical properties. The test specimen shall be concentric with the bars for sectional dimension upto 40mm. For diameters or width across flats exceeding 40mm, the specimen location shall be 1/3rd the bar radius below the bar surface.

10.0 CHEMICAL COMPOSITION:

The melt analysis of material shall be as follows:

Element		C	Mn	Si	S	P
Melt analysis	min. %	0.15	1.30	-	-	-
	max. %	0.23	1.70	0.04	0.050	0.050
Permissible variation in Product analysis		±0.02	±0.10	+0.03	+0.008	+0.008

11.0 MECHANICAL PROPERTIES:

The material shall comply with the following mechanical properties:

Ruling Section (mm)	Tensile Strength N/mm ² Min.	Yield Strength N/mm ² Min.	Elongation % Min $l=5.65\sqrt{S_o}$	Brinell Hardness BHN	Charpy impact energy (ISO-V Notch) J, Min.
Upto 150	550	325	18	152-207	35
>150≤250	510	295	17	146-197	-



PLANT PURCHASING SPECIFICATION HYDERABAD

HY 105 68

Rev. No.01

PAGE 3 OF 4

NOTE: 1) The tensile test shall be performed as per IS:1608 any other reputed National standard.

2) The Brinell hardness test shall be performed as per IS:1500

3) The charpy impact test shall be performed in accordance with IS:1757 or any reputed National standard. The specimen size shall be 10x10x55mm with a 2 mm V-Notch.

An impact test shall consist of three specimens from a single test location, the average value of which shall be as specified above.

Only one value of the three can be below the specified minimum, but in no case below $2/3^{\text{rd}}$ of the specified average value.

All the three test results shall be reported in test certificate.

12.0 INSPECTION AT SUPPLIERS WORKS:

BHEL representative/BHEL appointed Inspection Agency shall have free entry and access to all areas where the manufacture of the bars is carried out. All reasonable facilities shall be extended to him including labour wherever necessary.

BHEL representative/BHEL appointed Inspection Agency shall be given sufficient advance intimation to witness the various processes, tests, etc. punching and identification of test coupons and execution of various tests shall be done in presence of BHEL representative/BHEL appointed Inspection Agency.

13.0 TEST CERTIFICATES:

Three copies of the test certificate shall be supplied bearing the following details.

BHEL order No

Specification No: HY 10568 / Rev. 01

Supplier's Name:

Identification No:

Size

Cast No.

Details of Heat treatment.

Results of Chemical analysis and mechanical tests called for in this specification.

14.0 PACKING AND MARKING:

The bars shall be suitably packed in bundles to prevent corrosion and damage during transit.

HY 105 68

Rev. No.01

PAGE 4 OF 4

**PLANT PURCHASING
SPECIFICATION
HYDERABAD**



Bars above 25mm in diameter or of equivalent cross-sectional area shall be stamped HY 10568 and Cast No. on the side near the end or on the end face.

A metal label shall be securely attached to each bundle and shall bear the following information.

HY 105 68/Rev. 01

BHEL Order No.

Consignment or Identification No:

Cast No.

Size & Weight.

Supplier's Name.

15.0 REJECTION AND REPLACEMENT:

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

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



PLANT PURCHASING SPECIFICATION

HY 10566

REV. NO: 01

PAGE 1 OF 4

ALLOY STEEL BARS FOR LOW TEMPERATURE SERVICE – H & T

(GR : L43)

1.0 GENERAL:

This specification governs the quality requirements of alloy steel bars of grade L43 for low temperature service, covering sizes upto 100mm only.

2.0 APPLICATION :

For stay bolts, cap nuts and studs for centrifugal compressor etc. required for low temperature service, upto - 101° C.

3.0 CONDITION OF DELIVERY :

Cold/Hot rolled, hardened and tempered condition.

4.0 COMPLIANCE WITH NATIONAL STANDARDS:

This specification complies in general with latest version of ASTM A 320 M 1993 Grade L43, with the following additional requirements.

5.0 DIMENSIONS AND TOLERANCES:

5.1 Dimensions : The sizes shall be as specified in the order. Unless otherwise specified, the bars shall be supplied in random lengths of 3 to 5 metres.

5.2 Tolerances:

5.2.1 The tolerances on rolled bars shall be as per grade 2 of IS:3739, reproduced below:

Size (mm)		Tolerance (mm)
Over	Upto & including	
-	25	± 0.50
25	50	± 0.75
50	80	± 1.00
80	100	± 1.25
100	120	± 1.50

Revisions:

Issued :

STANDARDS ENGINEERING SECTION

Rev.No.01

Amd.No.

Reaffirmed.

Prepared:

Approved:

Dt.of 1st Issue

Dt.DEC.96

Dt.

Year:

MANAGER
MATLS ENGG

AGM (E&CC)

Oct.92

HY 10566	PLANT PURCHASING SPECIFICATION	
Rev. No.01		
PAGE 2 OF 4		

6.0 **MANUFACTURE:**

The steel shall be produced by the electric furnace process or by the basic oxygen process or by an equivalent recognised process. The steel shall be fully killed.

7.0 **HEAT TREATMENT:**

7.1 The recommended heat treatment cycle shall be as follows:

Hardening : Heating to 820-850° C followed by oil quenching.

Tempering: Heating to 650-690° C followed by air cooling.

The actual heat treatment cycle followed shall be reported in test certificate..

7.2 If the bars need be straightened after heat treatment, the bars shall be stress relieved, after straightening operation, at 30° C below the actual tempering temperature.

8.0 **FREEDOM FROM DEFECTS:**

The bars shall be free from cracks, scabs, laminations, and other harmful defects.

9.0 **FINISH:**

9.1 The surface of the bars shall be smooth without any laps, rolled in scales etc. Dents, roll marks and scratches are permitted provided their depth does not exceed half the tolerance limits.

9.2 The edges of bars shall be cut square by sawing or shearing and no crop ends shall be permissible.

10.0 **SELECTION OF TEST SAMPLES:**

10.1 **Chemical Analysis:**

Each melt shall be analysed for chemical composition.

10.2 **Mechanical Tests:**

One sample per lot, comprising of same size, melt and heat treatment batch shall be taken for mechanical tests.

11.0 **CHEMICAL COMPOSITION:**

The melt analysis of the material shall be as follows:



PLANT PURCHASING SPECIFICATION

HY 10566

Rev. No.01

PAGE 3 OF 4

Element		C	Si	Mn	Cr	Mo	Ni	S	P
Melt Analysis	Min. %	0.38	0.15	0.60	0.70	0.20	1.65	-	-
	Max. %	0.43	0.35	0.85	0.90	0.30	2.00	0.040	0.035
Product Variation %		± 0.02	±0.02	±0.03	±0.03	±0.02	±0.05	+0.005	+0.005

NOTE: P and S contents shall be aimed as low as possible to achieve the average impact energy values of 27 J (minimum) at 101° C

12.0 MECHANICAL PROPERTIES

The material shall conform to the requirements as given below:

Tensile Strength N/mm ² min.	0.2% Proof Stress N/mm ² min.	% Elongation L=50mm min.	% Reduction in Area of Cross Section min.	Impact Strength (ISO-V) at - 101° C Joules min.
860	725	16	50	27

NOTE: 1) The tensile test shall be carried out according to IS:1608 or any reputed National Standard.

- 2) The charpy impact test shall be carried out according to IS:1757 or any reputed National Standard. The test shall be performed on ISO-specimen of size 10 x 10 x 55 mm with a 2 mm V notch.
- 3) The minimum impact value specified above is the average of 3 specimen from a single location. Only one value of the three can be below specified minimum, but in no case below 2/3rd of same. All the three values shall be reported.
- 4) If specified in the order, the impact test may be carried out at a temperature other than -101° C, provided the test temperature is as low as the intended service temperature.

13.0 RETESTS:

- 13.1 If any of the test specimen fails to meet the requirements specified in cl.12, the sample bar from which the test specimen was cut shall be rejected and two further sample bars from the same lot shall be taken for retest.
- 13.2 If the retests also fail, manufacturer is at liberty to reheat treat the bars in question. Not more than two reheat treatments are allowed. However, retempering is not considered as reheat treatment.
- 13.3 If after reheat treatment, the mechanical properties are not complied with, the entire lot shall be rejected

PLANT PURCHASING SPECIFICATION



14.0 INSPECTION AT SUPPLIER'S WORKS:

The representative of BHEL shall have free access to the supplier's works at all times during the execution of the order, to satisfy himself that the material is produced as per the quality requirements of this specification. All reasonable facilities shall be extended to him, free of charge. He may also witness the sampling, testing and marking called for in this specification

15.0 TEST CERTIFICATES:

15.1 Five copies of test certificates shall be supplied giving the following details:

- a) BHEL Specification No: HY 10566 Rev.01
- b) Material Grade: L43
- c) BHEL Order No.
- d) Size
- e) Melt No.
- f) Process of manufacture
- g) Heat Treatment details and batch No.
- h) Results of chemicals analysis and mechanical properties.

15.2 The test certificates shall be signed by the inspection/Chief Metallurgist of the mill.

16.0 PACKING AND MARKING:

16.1 **Marking:** All bars with cross sectional dimension greater than 50mm shall be stamped with the melt number, specification number and supplier's trade mark on both the end faces of the bars.

Bars of sectional dimension 50 mm and below shall be bundled as per each size and a metal label bearing the following information shall be securely attached to each bundle.

- a) BHEL Specification No. HY 10566
- b) BHEL Order No.
- c) Melt No. & Heat Treatment batch No.
- d) Size & Weight
- e) Supplier's trade mark.

16.2 **Packing:** The bars shall be suitably packed to prevent corrosion and damage during transit.

17.0 REJECTION AND REPLACEMENT:

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

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



AMENDMENT-NOTIFICATION

HY10566 REV.NO.01

PAGE 1 OF 1


ALLOY STEEL BARS FOR LOW TEMPERATURE SERVICE – H&T

(GR. L43)

Clause 5.2.2

+8% shall be replaced by +8 mm
-0 -0 mm

REF:	Amd.No.	APPROVED SR.MNGR. STDS.ENGG	ISSUED STDS. ENGG	DATE	CUM.Sr.No
	01			24 . 2 . 99	A 0274:

	PLANT PURCHASING SPECIFICATION HYDERABAD	HY10565			
		REV. NO. 03			
		PAGE 1 OF 4			
<u>1% CHROMIUM CASE HARDENING STEEL BARS, ANNEALED</u>					
(GR : 16 Mn Cr 5)					
1.0	<u>GENERAL:</u>	This specification governs the requirements of 1% chromium case hardening bars.			
2.0	<u>APPLICATION :</u>	For the manufacture of case hardened components.			
3.0	<u>CONDITION OF DELIVERY :</u>	The bars shall be supplied in the hot / cold rolled/ forged and Annealed condition			
4.0	<u>COMPLIANCE WITH NATIONAL STANDARDS:</u>	This specification complies with EN10084-1998 : Case hardening steels. Gr : 16 Mn Cr5			
5.0	<u>DIMENSIONS AND TOLERANCES:</u>				
5.1	<u>Dimensions :</u>	As specified in the order. Unless otherwise specified, the hot/cold rolled bars shall be supplied in random lengths of 3 to 6 meters. Forged bars shall be supplied in lengths of 1.5 to 3.0 metres.			
5.2	<u>Tolerance:</u>				
5.2.1	<u>Rolled bars:</u>	The bars shall not vary from specified diameter or distance across flats by more than $\pm 2\frac{1}{2}$ %.			
5.2.2	<u>Forged bars:</u>	The tolerance on the forged bars shall be as follows.			
	<u>Diameter, mm</u>	<u>Tolerance, mm</u>			
	50 mm to 175 mm	+ 8.0 mm			
	Above 175 mm	+ 12.5 mm			
	<u>Note:</u> (Hot rolled & forged bars). Insignificant surface defects in the form of dent and ripple marks are permissible provided their depth does not exceed half the tolerance on each size.				
Revisions: Revised in line with EN10084 (latest version).		Issued : STANDARDS ENGINEERING DEPARTMENT			
Rev.No. 03	Amd.No.	Reaffirmed	Prepared:	Approved:	Dt.of 1st Issue
Dt. FEB. 06	Dt.	Year:	MANAGER, MATLS ENGG	GM (ENGG)	JAN., 1984

HY10565	PLANT PURCHASING SPECIFICATION HYDERABAD	
REV. NO. 03		
PAGE 2 OF 4		

6.0 **MANUFACTURE:**

The method of steel manufacture is left to the discretion of the manufacturer. However, air or mixed air and oxygen bottom blown converter process is not acceptable. The steel shall be fully killed.

7.0 **FREEDOM FROM DEFECTS:**

The bars shall be free from surface and internal defects such as piping, segregation etc.

8.0 **HEAT TREATMENT:**

8.1 The bars shall be soft annealed at 650 - 700° C and furnace cooled.

8.2 The recommended heat treatment for sample test pieces shall be as follows:
Blank Carburize at 880 - 980° C, followed by air cooling.
Hardening : At 860 - 900° C followed by quench in oil or water.

The tempering temperature shall be 150 - 200 ° C. The actual heat treatment cycle followed shall be reported in the Test certificate.

9. **SELECTION OF TEST SAMPLES:**

9.1 **Chemical Analysis:** Each melt shall be analysed for chemical composition

9.2 **Mechanical Properties :** One sample per melt per size shall be tested for mechanical properties after heat treatment as per clause 8.2. For the bars beyond 250 mm diameter, the test samples shall be forged to dia 250 mm then tested for mechanical properties after heat treatment as per clause 8.2.

9.3 **Metallography tests :** One sample per melt per size shall be tested for metallography tests.

10.0 **CHEMICAL COMPOSITION:**

The melt analysis of the material shall be as follows:

Element		C	Si	Mn	Cr	P	S
Melt analysis	Min .%	0.14	--	1.00	0.80	--	-
	Max. %	0.19	0.40	1.30	1.10	0.035	0.035
Permissible variation in product analysis		± 0.02	+0.03	±0.05	±0.05	+0.005	+0.005



**PLANT PURCHASING
SPECIFICATION
HYDERABAD**

HY10565

REV. NO. 03

PAGE 3 OF 4

11.0 MECHANICAL PROPERTIES:

11.1 Tensile: The mechanical properties of the hardened and tempered test bars of ruling section 30 mm shall be as follows:

Tensile Strength N/mm ²	0.2% Proof Stress min. N/mm ²	% Elongation min. (l = 5 d)
780 - 1080	590	10

11.2 Hardness: 5 % of the bars or minimum 2 numbers, in annealed condition shall be tested for Brinell Hardness and the value shall be 207 BHN max.

12.0 METALLOGRAPHY TEST :

12.1 Grain size : Grain size shall be 5 or finer when tested in accordance with ASTM E 112.

12.2 Cleanliness Rating : Inclusion content shall be tested as per ASTM E 45 and inclusion rating for all types shall not be more than 2.0 (thin series) and 1.5 (thick series). The inclusion of all types i.e. A, B, C & D may exist simultaneously.


13.0 ULTRASONIC TESTING :

Each bar above 50 mm dia/size shall be tested ultrasonically in accordance with corporate standard AA0850118 to ensure freedom from internal defects. The norms of acceptance shall be as per category 2 of the above standard.

14.0 INSPECTION AT SUPPLIER'S WORKS:

BHEL representative/BHEL appointed Inspection Agency shall have free entry and access to all areas where the manufacture of the bars is carried out. All reasonable facilities shall be extended to him including labour wherever necessary.

BHEL representative/BHEL appointed Inspection Agency shall be given sufficient advance intimation to witness the various processes, tests, etc. punching and identification of test coupons and execution of various tests shall be done in presence of BHEL representative/BHEL appointed Inspection Agency.

HY10565	PLANT PURCHASING SPECIFICATION HYDERABAD	
REV. NO. 03		
PAGE 4 OF 4		

15.0 TEST CERTIFICATES:

Three copies of test certificates shall be supplied bearing the following details:

- a) BHEL Order No.
- b) BHEL Specification No: HY 10565 / Rev. 03
- c) Supplier's name:
- d) Identification No.
- e) Size:
- f) Cast No.
- g) Details of heat treatment carried out on material and test samples.
- h) Results of chemicals analysis and mechanical tests including hardness tests called for in this specification.
- i) Results of ultrasonic tests and metallography tests.

16.0 PACKING AND MARKING:

The bars shall be suitably packed in bundles to prevent corrosion and damage during transit.

Bars above 50mm in diameter or of equivalent cross-sectional area shall be stamped HY10565 and Cast No. on the side near the end or on the end face.


A metal lable shall be securely attached to each bundle and shall bear the following information for bars of diameters less than 50 mm.

HY 105 65/Rev. 03
BHEL Order No.
Consignment or Identification No:
Cast No.
Size & Weight.
Supplier’s Name.

17.0 REJECTION AND REPLACEMENT:

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

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

	PLANT PURCHASING SPECIFICATION HYDERABAD	HY10563
		REV. NO: 03
		PAGE 1 OF 5

1.5% NICKEL-CHROMIUM-MOLYBDENUM STEEL BARS - ANNEALED

Gr : 34 Cr Ni Mo 6
(Old Grade : 817 M40 / En24)

1.0 GENERAL:

This specification governs the requirements of 1.5% Nickel-Chromium-Molybdenum Steel Bars in annealed condition.

2.0 APPLICATION :

For general engineering applications requiring high tensile strength combined with good ductility and resistance to shock.

3.0 CONDITION OF DELIVERY :

Hot Rolled/forged, annealed..

4.0 COMPLIANCE WITH NATIONAL STANDARDS:

This specification complies with DIN EN 10083, : 1996
Quenched and tempered steels : Technical delivery conditions for special steels Gr. 34 Cr Ni Mo 6.

5.0 DIMENSION AND TOLERANCES:

5.1 Sizes: Bars shall be supplied to the dimensions specified as per order.

5.1.1 Length: Unless otherwise specified, hot rolled bars shall be supplied in 3 to 6 metres length or in multiples with maximum 10%, shorts down to 1 metre.


Forged bars shall be supplied in lengths of 1.5 to 3.0 metres.

5.2 Tolerance:

5.2.1 Hot rolled bars: The bars shall not vary from specified diameter or distance across flats by more than ± 2½ %.

5.2.2 Forged bars: The tolerance on the forged bars shall be as follows.

Revisions: Updated in line with EN10083-1.			Issued : STANDARDS ENGINEERING DEPARTMENT		
Rev. No. 03	Amd.No.	Reaffirmed	Prepared: MANAGER (MATLS.ENG)	Approved: AGM (E&CC)	Dt.of 1st Issue FEB.93
Dt. FEB. 06	Dt.	Year:			

HY10563	PLANT PURCHASING SPECIFICATION HYDERABAD	
Rev. No.03		
PAGE 2 OF 5		

<u>Diameter, mm</u>	<u>Tolerance, mm</u>
50 mm to 175 mm	+ 8.0 mm
Above 175 mm	+ 12.5 mm

Note: (Hot rolled & forged bars).
Insignificant surface defects in the form of dent and ripple marks are permissible provided their depth does not exceed half the tolerance on each size.

6.0 MANUFACTURE:

The method of steel manufacture is left to the discretion of the manufacturer. However air or mixed air and oxygen bottom blown converter process is not acceptable. The steel shall be fully killed.

7.0 FREEDOM FROM DEFECTS:

The bars shall be free from surface and internal defects such as piping, segregation etc.

8.0 HEAT TREATMENT:

8.1 The bars shall be soft annealed by heating to 650-700° C and cooled in the furnace.

8.2 The recommended heat treatment for sample test pieces shall be as follows:

Hardening: 830 - 860° C followed by oil quenching.
Tempering: 660° C max.

Note (1) Tempering between 280 - 500°C shall be avoided.

Note (2) The cooling rate between the tempering temperature and 200° C shall be such as to avoid temper embrittlement.

Note (3) The actual heat treatment cycle followed shall be reported in the test certificate.

9.0 SELECTION OF TEST SAMPLES:

9.1 Chemical Analysis: One sample from each melt shall be analysed for chemical composition.

9.2 Mechanical Properties:

9.2.1 Mechanical Properties: One sample per melt per heat treatment batch of same size shall be tested for mechanical properties after heat treatment as per clause 8.2.

For sizes beyond 250mm diameter, test samples shall be forged to dia 250mm, heat treated as per c1.8.2 and shall be tested for mechanical properties.



**PLANT PURCHASING
SPECIFICATION
HYDERABAD**

HY10563

Rev. No.03

PAGE 3 OF 5

9.2.2 Hardness Test: 5% of the bars or minimum 2 bars in soft annealed condition shall be tested for Brinell Hardness test.

10.0 CHEMICAL COMPOSITION:

The melt analysis of material shall be as follows:

Element		C	Si	Mn	Ni	Cr	Mo	S	P
Melt analysis	Min.	0.30	0.10	0.50	1.30	1.30	0.15	-	-
	Max.	0.38	0.40	0.80	1.70	1.70	0.30	0.035	0.035
Permissible in variation check analysis		± 0.02	± 0.03	± 0.04	± 0.05	± 0.05	± 0.03	+ 0.005	+ 0.005

11.0 MECHANICAL PROPERTIES:


The mechanical properties shall be as follows:

Ruling Section, mm (d=dia, t=thickness)	Tensile strength N/mm ²	0.2% Proof stress, min. N/mm ²	Elongation min (L=5d)	Reduction in area % min.	Notch bar impact strength, min. (ISO -V notch)	Hardness BHN
d ≤ 16 (t ≤ 8)	1200-1400	1000	9	40	35	360-420
16 < d ≤ 40 (8 < t ≤ 20)	1100-1300	900	10	45	45	330-390
40 < d ≤ 100 (20 < t ≤ 60)	1000-1200	800	11	50	45	300-360
100 < d ≤ 160 (60 < t ≤ 100)	900-1100	700	12	55	45	270-300
160 < d ≤ 250 (100 < t ≤ 160)	800-950	600	13	55	45	240-285

NOTE: 1) The tensile test shall be carried out in accordance with IS:1608 or any reputed national standard.

2) The charpy impact test shall be performed in accordance with IS:1757 or any reputed National Standard. The specimen size shall be 10x10x55mm with a 2 mm V-Notch.

An impact test shall consist of three specimens from a single test location, the average value of which shall be as specified above.

HY10563	PLANT PURCHASING SPECIFICATION HYDERABAD	
Rev. No.03		
PAGE 4 OF 5		

Only one value of the three can be below the specified minimum, but in no case below 2/3 of the specified average value.

All the three test results shall be reported in test certificate.

11.1 Hardness Test: Shall be tested for Brinell Hardness in accordance with IS:1500 or any other equivalent national standard and the value shall be 248 BHN max. (Applicable for annealed material). Hardness values shall also be reported for the test samples heat treated as per clause 8.2 and the hardness values shall be as per table given at Cl.No. 11.0.

12.0 ULTRASONIC TEST:

Each bar above 50 mm shall be tested ultrasonically in accordance with corporate standard AA 085 01 18 to ensure freedom from internal defects. The norms of acceptance shall be as per category 2 of the above standard.

13.0 INSPECTION AT SUPPLIER’S WORKS:

13.1 BHEL representative/BHEL appointed Inspection Agency shall have free entry and access to all areas where the manufacture of the bars is carried out. All reasonable facilities shall be extended to him including labour wherever necessary.

13.2 BHEL representative/BHEL appointed Inspection Agency shall be given sufficient advance intimation to witness the various processes, tests, etc. punching and identification of test coupons and execution of various tests shall be done in presence of BHEL representative/BHEL appointed Inspection Agency.

14.0 TEST CERTIFICATES:

Five copies of test certificate shall be supplied bearing the following details.

BHEL Order No
BHEL Specification No: HY 10563 Rev. 03
Supplier’s Name:
Identification No:
Size
Cast No.
Details of Heat treatment.
Results of Chemical analysis, mechanical tests including hardness and NDT called for in this specification.



**PLANT PURCHASING
SPECIFICATION
HYDERABAD**

HY10563

Rev. No.03

PAGE 5 OF 5

15.0 PACKING AND MARKING:

The bars shall be suitably packed in bundles to prevent corrosion and damage during transit.

Bars above 50mm in diameter or of equivalent cross-sectional area shall be stamped HY10563 Rev.03 and cast no. on the side near the end or on the end face.

A metal label shall be securely attached to each bundle and shall bear the following information for bars below 50 mm.

HY 10563 Rev. 03

BHEL Order No.

Consignment or Identification No:

Cast No.


Size & Weight.


Supplier's Name.

16.0 REJECTION AND REPLACEMENT:

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

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

	<div>PLANT PURCHASING</div> <div>SPECIFICATION</div> <div>HYDERABAD</div>		HY10561		
			REV. NO. 04		
			PAGE 1 OF 5		
<div>1.5% NICKEL-CHROMIUM-MOLYBDENUM STEEL BARS - H & T</div> <div>Gr : 34 Cr Ni Mo 6</div> <div>(Old Grade : 817 M40 (En24))</div>					
<div>1.0 <u>GENERAL:</u></div> <div>This specification governs the requirements of 1.5% Nickel-Chromium-Molybdenum Steel Bars in hardened and tempered condition.</div>					
<div>2.0 <u>APPLICATION :</u></div> <div>For general engineering applications requiring high tensile strength combined with good ductility and resistance to shock.</div>					
<div>3.0 <u>CONDITION OF DELIVERY :</u></div> <div>Hot Rolled/Forged, Hardened and Tempered.</div>					
<div>4.0 <u>COMPLIANCE WITH NATIONAL STANDARDS:</u></div> <div>This specification complies with DIN EN 10083 : 1996 ; Quenched and tempered : Technical delivery conditions for special steels ; Grade 34 Cr Ni Mo 6.</div>					
<div>5.0 <u>DIMENSIONS AND TOLERANCES:</u></div>					
<div>5.1 Sizes: Bars shall be supplied to the dimensions specified on the order.</div>					
<div>5.1.1 Length: Unless otherwise specified, hot rolled bars shall be supplied in 3 to 6 metres length or in multiples with maximum 10%, shorts down to 1 metre.</div> <div>Forged bars shall be supplied in lengths of 1.5 to 3.0 metres.</div>					
<div>5.2 Tolerance:</div>					
<div>5.2.1 Hot rolled bars: The bars shall not vary from specified diameter or distance across flats by more than $\pm 2\frac{1}{2}$ %.</div>					
<div>5.2.2 Forged bars: The tolerance on the forged bars shall be as follows.</div>					
<div>Revisions:</div> <div>Updated in line with EN10083-1.</div>			<div>Issued :</div> <div>STANDARDS ENGINEERING</div> <div>DEPARTMENT</div>		
Rev.No. 04	Amd.No.	Reaffirmed	Prepared:	Approved:	Dt.of 1 st Issue
Dt. FEB. 06	Dt.	Year:	STDS	SR.MGR(TS)	JAN., 1982

HY10561	PLANT PURCHASING SPECIFICATION HYDERABAD	
REV. NO. 04		
PAGE 2 OF 5		

<u>Diameter, mm</u>	<u>Tolerance, 8 mm</u>
50 mm to 175 mm	+ 8.0 mm
Above 175 mm	+ 12.5 mm

Note: (Hot rolled & forged bars).

Insignificant surface defects in the form of dent and ripple marks are permissible provided their depth does not exceed half the tolerance on each size.

6.0 MANUFACTURE:

The method of steel manufacture is left to the discretion of the manufacturer. However air or mixed air and oxygen bottom blown converter process is not acceptable. The steel shall be fully killed.

7.0 FREEDOM FROM DEFECTS:

The bars shall be free from surface and internal defects such as piping, segregation etc.

8.0 HEAT TREATMENT:

The recommended heat treatment shall be as follows:

Hardening: 830 - 860° C followed by oil quenching.
Tempering: 660° C max.

Note (1) Tempering between 280 - 500°C shall be avoided.

(2) The cooling rate between the tempering temperature and 200° C shall be such as to avoid temper embrittlement.

(3) The actual heat treatment cycle followed shall be reported in the Test certificate.

9.0 SELECTION OF TEST SAMPLES:

9.1 Chemical Analysis: Each melt shall be analysed for chemical composition.

9.2 Hardness: Hardness shall be checked for 5% of the bars of same size, melt and heat treatment batch. In any case minimum two bars shall be tested for hardness.

9.3 Mechanical Properties: One sample per lot, comprising of bars of same size, melt and heat treatment batch shall be taken for mechanical tests.



**PLANT PURCHASING
SPECIFICATION
HYDERABAD**

HY10561

REV. NO. 04

PAGE 3 OF 5

10.0 CHEMICAL COMPOSITION:

The melt analysis of material shall be as follows:

Element		C	Si	Mn	Ni	Cr	Mo	S	P
Melt analysis	Min.	0.30	0.10	0.50	1.30	1.30	0.15	-	-
	Max.	0.38	0.40	0.80	1.70	1.70	0.30	0.035	0.035
Permissible variation in check Analysis		± 0.02	± 0.03	± 0.04	± 0.05	± 0.05	± 0.03	+ 0.005	+ 0.005

11.0 MECHANICAL PROPERTIES:

The mechanical properties shall be as follows:

Ruling Section, mm (d=dia, t=thickness)	Tensile strength N/mm ²	0.2% Proof stress, min. N/mm ²	Elongation min (L=5d)	Reduction in area % min.	Notch bar impact strength, min. (ISO -V notch)	Hardness BHN
d ≤ 16 (t ≤ 8)	1200-1400	1000	9	40	35	360-420
16 < d ≤ 40 (8 < t ≤ 20)	1100-1300	900	10	45	45	330-390
40 < d ≤ 100 (20 < t ≤ 60)	1000-1200	800	11	50	45	300-360
100 < d ≤ 160 (60 < t ≤ 100)	900-1100	700	12	55	45	270-300
160 < d ≤ 250 (100 < t ≤ 160)	800-950	600	13	55	45	240-285


NOTE: 1) The tensile test shall be carried out in accordance with IS:1608 or any other reputed national standard.

2) The charpy impact test shall be performed in accordance with IS:1757 or any other reputed national standard. The specimen size shall be 10x10x55mm with a 2 mm V-Notch.

An impact test shall consist of three specimens from a single test location, the average value of which shall be as specified above.

Only one value of the three can be below the specified minimum, but in no case below 2/3rd of the specified average value.

All the three test results shall be reported in test certificate.

HY10561	PLANT PURCHASING SPECIFICATION HYDERABAD	
REV. NO. 04		
PAGE 4 OF 5		

11.1 Hardness test: The hardness shall be tested in accordance with IS 1500 or any other equivalent international standard.

12.0 ULTRASONIC TEST:

Each bar above 50 mm shall be tested ultrasonically in accordance with corporate standard AA 085 01 18 to ensure freedom from internal defects. The norms of acceptance shall be as per category 2 of the above standard.

13.0 RETESTS:

13.1 If any of the test specimen fails to meet the requirements specified in cl. 11, the sample bar from which the test specimen was cut shall be rejected and two further sample bars from the same lot shall be taken for retest.

13.2 If the retests also fail, manufacturer is at liberty to reheat treat the bars in question. Not more than two reheat treatments are allowed. However, retempering is not considered as reheat treatment.

13.3 If after reheat treatment, the mechanical properties are not complied with, the entire lot shall be rejected.

14.0 INSPECTION AT SUPPLIER’S WORKS:

14.1 BHEL representative/BHEL appointed Inspection Agency shall have free entry and access to all areas where the manufacture of the bars is carried out. All reasonable facilities shall be extended to him including labour wherever necessary.

14.2 BHEL representative/BHEL appointed Inspection Agency shall be given sufficient advance intimation to witness the various processes, tests, etc. Punching and identification of test coupons and execution of various tests shall be done in presence of BHEL representative/BHEL appointed Inspection Agency.

15.0 TEST CERTIFICATE:

Five copies of the test certificate shall be supplied bearing the following details.

BHEL Order No
BHEL Specification No: HY 10561/ Rev. 04
Supplier’s Name:
Identification No:
Size
Cast No.
Details of Heat treatment.
Results of Chemical analysis, mechanical tests including hardness & NDT called for in this specification.



**PLANT PURCHASING
SPECIFICATION
HYDERABAD**

HY 10561

REV. NO. 04

PAGE 5 OF 5

16.0 PACKING AND MARKING:

The bars shall be suitably packed in bundles to prevent corrosion and damage during transit.

Bars above 50mm in diameter or of equivalent cross-sectional area shall be stamped HY 10561/ Rev.04 and cast no. on the side near the end or on the end face.

A metal label shall be securely attached to each bundle and shall bear the following information for the sizes less than 50 mm diameter.

HY 105 61 Rev. 04

BHEL Order No.

Consignment or Identification No:

Cast No.

Size & Weight.

Supplier's Name.

17.0 REJECTION & REPLACEMENT:

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

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



PLANT PURCHASING SPECIFICATION

HY 104 61

REV. NO: 01

PAGE 1 OF 4

CARBON STEEL BARS FOR FORGING OF PRESSURE PIPING COMPONENTS

(ASTM A 696 GR." C ")

1.0 GENERAL:

This specification governs the requirements of carbon steel bars of grade C of ASTM A696 in normalized condition.

2.0 APPLICATION :

For the manufacture of piping and steam turbine components operating at high temperatures upto 400° C.

3.0 CONDITION OF DELIVERY :

The bars shall be supplied in hot/cold rolled and normalised condition. For sizes 125mm and above, bars may be supplied in forged and normalised condition.

4.0 COMPLIANCE WITH NATIONAL STANDARDS:

This specification complies with ASTM A 696, Gr. "C"

5.0 DIMENSION AND TOLERANCES:

5.1 Dimensions: The sizes shall be as specified in the order. Unless otherwise specified, the bars shall be supplied in random lengths of 3 to 5 meters.

5.2 Tolerances:

5.2.1 The tolerances on bars shall be as per Grade 2 of IS:3739, reproduced below:

Size (mm)		Tolerance (mm)
Over	Upto & including	
--	25	± 0.50
25	50	± 0.75
50	80	± 1.00
80	100	± 1.25
100	125	± 1.50
125	160	± 2.00
150	-	± 1.6% of the size

Revisions:

Issued :

**STANDARDS ENGINEERING
DEPARTMENT****Rev.No.01****Amd.No.****Reaffirmed****Prepared:**
MANAGER
(SED)**Approved:**

AGM (E&CC)

Dt.of 1st Issue

March 1985

Dt. NOV.,96

Dt.**Year:**

PLANT PURCHASING SPECIFICATION



5.2.2 The tolerances on forged bars shall be +8 mm of the size.
- 0

6.0 MANUFACTURE:

The steel shall be manufactured by BASIC ELECTRIC FURNANCE, and shall be fully killed. Use of Aluminium for killing shall be limited to 0.3 kg/ton of liquid metal. Titanium or any other Aluminium free degassifier may be used for necessary killing. Any other process shall be subjected to mutual agreement.

7.0 HEAT TREATMENT:

The recommended heat treatment shall be as follows:

Normalize at 890 - 920° C, cool in air.

8.0 FREEDOM FROM DEFECTS:

The bars shall be free from cracks, scabs, laminations shrinkage and other harmful defects.

9.0 FINISH:

9.1 The surface of the bars shall be smooth without any laps, rolled in scales etc. Dents, roll marks and scratches are permitted provided there depth does not exceed half the tolerance limits.

9.2 The edges of the bars shall be cut square by sawing or shearing and no crop ends shall be permitted.

10.0 CHEMICAL COMPOSITION:

The analysis of material shall be as follows:

Element		C	Si	Mn	Cr	Ni	Mo	Cu	Cr +Ni+Mo +Cu	P	S
Ladle analysis	Min.	-	0.15	-	-	-	-	-	-	-	-
	Max.	0.32	0.35	1.04	0.30	0.30	0.12	0.30	0.100	0.035	0.045

11.0 SELECTION OF TEST SAMPLES:

11.1 Chemical Analysis : Each melt shall be analysed for chemical composition.

11.2 Mechanical Tests:

11.2.1 One sample per lot, comprising of bars of same size ,melt and heat treatment batch shall be taken for mechanical tests.



PLANT PURCHASING SPECIFICATION

HY 10461

Rev. No.01

PAGE 3 OF 4

12.0 MECHANICAL PROPERTIES:

The mechanical properties shall be as follows:

Tensile strength N/mm ² (Min.)	Yield Strength N/mm ² . (min)	Elongation l = 4d % min	Hardness BHN max.
485	275	18	187

NOTE: 1) The tensile test shall be carried out in accordance to IS:1608 or any reputed National Standard.

13.0 RETESTS:

- 13.1** If any of the test specimen fails to meet the requirements specified in cl. 12, the sample bar from which the test specimen was cut shall be rejected and two further sample bars same lot shall be taken for retest.
- 13.2** If the retests also fail, manufacturer is at liberty to reheat the bars in question. Not more than two reheat treatments are allowed.
- 13.3** If after re-heat treatment, the mechanical properties are not complied with, the entire lot shall be rejected.

14.0 INSPECTION AT SUPPLIER'S WORKS:

The representative of BHEL shall have free access to the supplier's works at all times during the execution of the order, to satisfy himself that the material is produced as per the quality requirements of this specification. All reasonable facilities shall be extended to him, free of charge. He may also witness the sampling, testing and marking called for in this specification.

15.0 TEST CERTIFICATES:

Five copies of test certificate shall be furnished giving the following details.

- a) BHEL Specification No: HY 10461
- b) BHEL Order No
- c) Size
- d) Name of the Supplier's:
- e) Process of manufacture
- f) Melt No.
- g) Heat treatment Details and batch No.
- h) Results of Chemical analysis and mechanical tests.

PLANT PURCHASING SPECIFICATION



16.0 PACKING AND MARKING:

16.1 Marking: All bars with cross sectional dimension greater than 50mm shall be stamped with the melt number, specification number and supplier's trade mark on both the end faces of the bars.


Bars of sectional dimension 50 mm and below shall be bundled as per each size and a metal label bearing the following information shall be securely attached to each bundle.


- a) BHEL Specification No. HY 10461
- b) BHEL Order No.
- c) Melt No. & Heat Treatment batch No.
- d) Size & Weight
- e) Supplier's trade mark.


16.2 Packing: The bars shall be suitably packed to prevent corrosion and damage during transit.

17.0 REJECTION:

In the event of any material proving defective during the course of further processing or testing, such material shall be rejected and the supplier shall make immediate arrangements to replace the same free of cost.

	TD-215	AMENDMENT-NOTIFICATION	HY 10461		REV.No.01	
			PAGE 1	OF 1		
<div>CARBON STEEL BARS FOR FORGING OF PRESSURE PIPING COMPONENTS</div> <div>(ASTM A 696 Gr.C)</div> <div>Cl.10 CHEMICAL COMPOSITION</div> <div>Read ‘Cr+Ni+Mo+Cu = 1.00 (max.)’ in place of</div> <div>‘Cr+Ni+Mo+Cu = 0.100 (max.)’</div>						
REF:	AMD.NO.	APPROVED	ISSUED	DATE	CUM. Sl.No.	
	01	SR.MANAGER STDS. ENGG.	STDS. ENGG.	24.7.99	A 0291	

	PLANT PURCHASING SPECIFICATION HYDERABAD	HY10199			
		Rev. No. 03			
		PAGE 1 OF 4			
<div>CARBON STEEL BARS (Gr. 15 C8)</div> <div>1.0 GENERAL: This specification governs the quality of hot rolled/forged Carbon Steel bars of grade 15 C8.</div> <div>2.0 APPLICATION : For the manufacture of machined parts for general engineering purposes. Bars of dia 100 mm and above may be used for the manufacture of forged components also.</div> <div>3.0 CONDITION OF DELIVERY : 3.1 Bars upto dia / size 100 mm (inclusive) shall be supplied in hot rolled condition. 3.2 Bars above 100 mm dia / size can be supplied in hot rolled or forged condition. 3.3 Bars upto 40 mm dia / size can be supplied in as rolled condition if the mechanical properties specified in this specification are achieved. 3.4 All the bars above 40 mm dia / size shall be supplied in Normalised condition. 3.5 The bars shall be supplied with ends square and true. The bars shall be supplied in straight lengths.</div> <div>4.0 COMPLIANCE WITH NATIONAL STANDARDS: This specification complies with (1) IS: 1570 (Part II) – 1979] Schedules for Wrought Steels Gr: 15 C 8] Part II Carbon Steels (unalloyed Steels) (2) IS: 1875 – 1992 – Carbon steel bars for forgings.</div>					
Revisions: Revised to include carbon steel bars for reforging also.		Issued : STANDARDS ENGINEERING DEPARTMENT			
Rev.No. 03	Amd. No.	Reaffirmed	Prepared:	Approved:	Dt.of 1st Issue
Dt. DEC. 2005	Dt.	Year:	Standards	AGM (G)	FEB. 1981

HY10199	PLANT PURCHASING SPECIFICATION HYDERABAD	
Rev. No. 03		
PAGE 2 OF 4		

5.0 DIMENSIONS AND TOLERANCES:

5.1 Sizes: The bars shall be supplied to the dimensions specified on the order. Unless otherwise specified, Hot rolled bars / rounds shall be supplied in random lengths of 3 to 5 metres. However, the minimum length for Square bars shall be 4 metres.

Forged bars shall be supplied in the length of 1.5 to 3.0 meters.

5.2 Tolerances:

5.2.1 Hot rolled bars / flats: The dimensional tolerances shall be in accordance with Grade I of IS:3739.

5.2.2 Forged Bars: + 8 mm on diameter/side width.
- 0

5.2.3 Straightness: Unless otherwise agreed to, the permissible deviation in straightness shall not exceed 5 mm in any 1000 mm length.

5.2.4 The tolerance as per any other international standard are also acceptable with prior written approval of BHEL.

6.0 MANUFACTURE:

The steel shall be manufactured by the electric furnace, basic oxygen, duplex process or by a combination of these processes. The bars shall be manufactured from Killed steel.

Sufficient reduction and discard shall be made from each ingot to ensure freedom from piping, segregation and other harmful defects.

7.0 FREEDOM FROM DEFECTS:

The bars shall be sound and free from internal and surface defects like cracks, surface flaws and laminations.

8.0 HEAT TREATMENT :

The bars shall be normalised at a temperature of 880-910°C. The normalizing operation is optional for bars upto dia / size of 40 mm (inclusive).



**PLANT PURCHASING
SPECIFICATION
HYDERABAD**

HY10199

Rev. No. 03

PAGE 3 OF 4

9.0 CHEMICAL COMPOSITION:

9.1 The melt analysis of the material shall be as follows:

Element		C	Mn	Si	S	P
Ladle Analysis	% Min.	0.10	0.60	0.15	-	-
	% Max.	0.20	0.90	0.35	0.030	0.040
Permissible variation in product analysis		± 0.02	± 0.05	± 0.03	+0.005	+0.005

Note: 1. When the steel is aluminium killed or killed with both aluminium and silicon, the requirement of minimum silicon content is not applicable.

9.2 The following elements shall be tested and reported in the test certificate. The limits are specified below.

Ni = 0.30% max. ; Cr = 0.30% max. ; Cu = 0.25% max.
Mo = 0.15% max. ; B = 0.0003% max. ; V = 0.05% max.
Sn = 0.05%

Note: (1) $(Cr + Ni + Mo \leq 0.50\%)$
(2) $(Cu\% + 10 \times Sn\% \leq 0.5\%)$
(3) Carbon Equivalent = 0.42% max.

10.0 SELECTION OF TEST SAMPLES:


10.1 One sample of each heat shall be analysed for chemical composition.

10.2 One sample from each melt / heat treatment batch / size shall be taken for mechanical testing. Location of the test sample shall be in line with IS 1875.

11.0 MECHANICAL PROPERTIES:

11.1 Tensile : When tested in according with IS : 1608, the test pieces shall show the following properties :

Tensile Strength : 410 N/mm², minimum
Yield strength : 220 N/mm², minimum
Elongation on
5.65 $\sqrt{S_0}$ gauge length : 25 percent min.

HY10199	PLANT PURCHASING SPECIFICATION HYDERABAD	
Rev. No. 03		
PAGE 4 OF 4		

11.2 Hardness: 10% of the bars or minimum 10 bars (whichever is more) shall be tested for hardness in accordance with IS 1500 or any other reputed national standard. The hardness shall not be less than 110 BHN.

12.0 ULTRASONIC TEST :

Each bar above 100 mm dia / side width shall be ultrasonically tested in accordance with AA 085 01 18 to ensure freedom from internal defects. The norms of acceptance shall be as per category 2 of the same.

13.0 TEST CERTIFICATES:

Three copies of the test certificate bearing the following information shall be furnished.

BHEL Order No :

BHEL Specification No : HY 10199 Rev. 03

Supplier’s Name:

Cast No :

Results of Chemical analysis and Mechanical tests.

Results of ultrasonic test (if applicable)

14.0 PACKING AND MARKING:

Bars shall be supplied in securely packed bundles and shall be suitably protected from corrosion and damage during transit. Bars over 50 mm diameter shall be stamped at one end with cast number, HY10199, and BHEL P.O. for easy identification.

Bars of 50 mm diameter and below shall be bundled and a metal lable shall be securely attached to each bundle bearing the following details:

HY 10199 Rev. 03 : Hot rolled Carbon Steel bars, Gr:15 C8

BHEL Order No:

Consignment or Indentification No:

Cast No:

Size and Weight:

Supplier’s name:



CORPORATE PURCHASING SPECIFICATION

AA 107 58

Rev. No. 07

PREFACE SHEET

STAINLESS STEEL BILLETS AND BLOOMS, X 12 Cr 13

FOR INTERNAL USE ONLY
REMOVE THIS PREFACE BEFORE ISSUE TO SUPPLIERS

Comparable Standards:

- | | |
|-----------|---|
| 1. GERMAN | : DIN EN 10272 – 2001, Material No. 1.4006
Gr. X12 Cr 13 |
| 2. INDIAN | : IS: 6529-1996, Gr.:12Cr13 |

Suggested/Probable Suppliers and Grades:

Use plant vendors list

User Plant References:

- | | |
|------------------|-------|
| 1. HEEP, HARDWAR | : --- |
|------------------|-------|

Revisions : e-mail: dt 4.2.2005 from HW
 Cl 29.6. 21 of MOM of MRC-FCF+HTM

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HARDWAR

Corp. R&D

MAY, 1980



CORPORATE PURCHASING SPECIFICATION

AA 107 58

Rev. No. 07

PAGE 1 OF 4

STAINLESS STEEL BILLETS AND BLOOMS, X 12 Cr 13

1.0 GENERAL:

This specification governs the quality requirements of 13% Chromium Stainless Steel Billets and Blooms, Gr.: X12Cr13.

This specification covers raw material for forgings to BHEL specification AA 193 20 : Stainless Steel Forgings –Gr.:X12Cr13, H & T.

2.0 APPLICATION:

Suitable for forging various components.

3.0 CONDITION OF DELIVERY:

Hot rolled/Forged and annealed.

4.0 COMPLIANCE WITH NATIONAL STANDARDS:

The material shall comply with the requirement of the following national standard and also meet the requirements of this specification.

DIN EN 10272 - 2001 :
Gr: X 12Cr13, Material No. 1.4006

5.0 DIMENSIONS AND TOLERANCES:

5.1 Sizes:

The sizes of billets and blooms shall be as specified in BHEL Order .

5.2 Tolerances:

5.2.1 Hot Rolled:

The tolerance and radii of curvature for various hot rolled square billets and blooms be as follows:

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Cl 29.6. 21 of MOM of MRC-FCF+HTM

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Side of square of billet/bloom, mm	Radius of curvature, mm	Tolerance on side of Square, mm	
		(+)	(-)
100	15	+ 1.8	- 3.0
150	21	+ 2.4	- 4.0
200	30	+ 4.0	- 6.0
250	35	+ 5.0	- 7.0
300	45	+ 7.0	- 8.0

5.2.2 Forged: The tolerance on various forged square billets/blooms shall be as follows:

Side of square of Billet/bloom, mm	Tolerance, mm
Upto 100	± 6
125 to 150	± 7
160 to 200	± 8
250 to 300	± 10
300 to 400	± 12

5.3 Length:

Billets/blooms shall be supplied in standard lengths of 2 to 6 metres in multiples of 1 metre length.

6.0 MANUFACTURE:

Billets and blooms shall be manufactured from steel made by the open hearth, electric or such other process as may be agreed to between BHEL and the manufacturer.

The steel shall be fully killed.

Sufficient discard shall be made from the top and bottom of each ingot to ensure freedom from piping, undue segregation, shrinkage, cavities and other metallurgical defects.

Billets and blooms shall be made after giving sufficient reduction to each ingot ensuring that the cast structure is completely broken.

**7.0 HEAT TREATMENT:**

Billets and blooms shall be annealed.

8.0 FREEDOM FROM DEFECTS:

The material shall be free from internal and surface defects.

The billets and blooms shall be free scales, tears, seams, laps, rough, jagged and imperfect edges and all other surface defects which may result in defects in forgings made therefrom.

The billets and blooms shall be free from internal defects such as shrinkage, porosity, pipes, laminations, cracks, harmful non-metallic inclusions and other defects.

9.0 SURFACE-CONDITIONING:

Surface defects on billets/blooms are removed by longitudinal chipping and cleaning.

The material may be conditioned to remove injurious surface defects, provided the depth of conditioning does not exceed 1 mm for every 15 mm of dimensions concerned upto a maximum depth of 20 mm and provided that the width of the conditioning is at least four times its greatest depth. The maximum depth of conditioning on two parallel sides at opposite locations shall not exceed one and half times the maximum allowed for one side. The transition between conditioned and non conditioned areas shall be gradual.


10.0 CHEMICAL COMPOSITION:

The melt analysis of the steel and the permissible variation in the composition of the billets and blooms from the melt analysis shall be as follows:

Element	<u>Melt analysis percent</u>		<u>Permissible variation, percent, max.</u>
	min.	max.	
Carbon	0.08	0.15	± 0.001
Silicon	--	1.00	± 0.05
Manganese	--	1.50	± 0.04
Chromium	11.50	13.50	± 0.15
Nickel	--	0.75	± 0.03
Phosphorus	--	0.040	+ 0.005
Sulphur	--	0.015	+ 0.005

11.0 HARDNESS TEST (Brinell):

When tested to accordance with IS: 1500 the material shall show a Brinell hardness value of 230 HB, max., in annealed condition.

AA 107 58	CORPORATE PURCHASING SPECIFICATION	
Rev. No. 07		
PAGE 4 OF 4		

12.0 ULTRASONIC TEST:

All billets/blooms shall be tested ultrasonically in accordance with BHEL standard AA 085 01 18 ensure form internal defects. The norms of acceptance shall be as per category 2 of the above standard.

13.0 TEST CERTIFICATES:

Three copies of test certificates shall be supplied, unless otherwise stated in the order.

In addition, the supplier shall ensure to enclose one copy of test certificate along with their despatch documents to facilitate quick clearance of the material.

The test certificates shall bear the following information.

BHEL References:
AA 107 58 (Rev.No.07): Stainless steel Billets and Blooms, X 12 Cr 13
BHEL Order No.

Supplier's References:
Supplier's Name
Melt No.

Test Results:
Dimensional inspection.
Heat treatment details
Chemical Composition
Hardness test
Ultrasonic test
Reduction ration

14.0 PACKING AND MARKING:

Billets/blooms shall be properly protected form corrosion and damage during transit and shall be transported in lots consisting of billets/bloom of size and same melt.

Specification No. and Melt No. shall be stamped/punched and other particulars mentioned below shall be marked on each billets/bloom on the side near the end or on the end face:

AA 107 58
BHEL Order No.
Consignment/Identification No.
Melt No.
Size & Weight.
Supplier's Name.

15.0 REFERRED STANDARDS (Latest Publications Including Amendments):

1) IS: 1500 2) DIN EN 10272 3) AA 085 01 18



CORPORATE PURCHASING SPECIFICATION

AA 107 21

Rev. No. 07

PREFACE SHEET

STAINLESS STEEL BARS (MARTENSITIC), Gr: X 20 Cr 13, HARDENED AND TEMPERED

FOR INTERNAL USE ONLY
REMOVE THIS PREFACE SHEET BEFORE ISSUE TO SUPPLIERS

Comparable Standards:

- | | | |
|-------------|---|---|
| 1. EUROPEAN | : | EN 10088-3
Gr : X 20 Cr 13, H&T |
| 2. AMERICAN | : | a) AISI 420, Hot rolled, H&T
b) ASTM A 276, S 42000, Hot rolled, H&T |

Suggested/Probable Suppliers And Grades:

Refer Plant Vendors list

User Plant References:

- | | | |
|------------------|---|--|
| 1. BHOPAL | : | 105 15 |
| 2. HYDERABAD | : | BS 970, Gr.:420 S 37 (En 56C), Condition: R
ASEA 22303-03 |
| 3. HEER, HARDWAR | : | -- |
| 4. TIRUCHY | : | BM-S2 |

Revisions :
Cl.29.5.0.-(e) of MOM of 29th MRC-S&GPS

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MAY, 1978



CORPORATE PURCHASING SPECIFICATION

AA 107 21

Rev. No. 07

PAGE 1 OF 4

STAINLESS STEEL BARS (MARTENSITIC) Gr:X 20 Cr 13, HARDENED AND TEMPERED

1.0 GENERAL :

This specification governs the quality requirements of Stainless Steel Bars (Martensitic), Hardened and Tempered.

2.0 APPLICATION :

For general engineering purposes involving stresses under corrosive conditions.

3.0 CONDITION OF DELIVERY :

Hot rolled and hardened and tempered.

For size above 100 mm, forgings in H&T condition are also acceptable.

Bars shall be supplied in the descaled condition.

The ends of bars shall be square and true.

The bars shall be supplied in straight lengths without twists and bends.

4.0 COMPLIANCE WITH NATIONAL STANDARDS :

The material shall comply with the requirements of the following National standard and also meet the requirements of this specification.

EN 10088-3, Gr. X 20 Cr 13 : General Purpose Semi-finished Products, Bars,
Hardened and Tempered : Rods and Sections

5.0 DIMENSIONS AND TOLERANCES :

5.1 Sizes: The bars shall be supplied to the dimensions specified in BHEL order.

5.2 Tolerances:

5.2.1 For Forged bars: The tolerances shall be + 8 mm - 0 mm.

5.2.2 Tolerances on rolled bars shall comply with following specifications:

EURONORM 58: Hot rolled flats for general purposes

EURONORM 59: Hot rolled square bars for general purposes

EURONORM 60: Hot rolled round bars for general purposes

Tolerances as per equivalent IS Standards are also acceptable

1

Revisions:

Cl.29.5.0. of MOM of MRC-S&GPS

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Corp. R&D

MAY, 1978

**5.3 Length :**

Unless otherwise specified, hot rolled bars shall be supplied in lengths of 3 to 6 meters or in multiples with maximum of 10% shorts down to 1 meter.

Forged bars shall be supplied in lengths of 1.5 to 3 metres.

6.0 MANUFACTURE :

Process used for the manufacture of the bars is left to the discretion of the manufacturer. Material shall be manufactured from fully killed steel. Sufficient reduction and discard shall be made from each ingot to ensure freedom from pipe, harmful segregation and other defects.

7.0 HEAT TREATMENT :

The recommended heat treatment is as follows:

Harden in oil / air at temperature of 950-1050°C.

Temper at suitable temperature between 650-750°C.

Details of the actual heat treatment cycle followed shall be specified in the test certificate.

8.0 FREEDOM FROM DEFECTS :

The bars shall be free from internal and surface defects. Bars shall be free from twist and bends.

9.0 CHEMICAL COMPOSITION :

The melt analysis of steel and the permissible variation in the composition of the material from the melt analysis shall be follows :

Element	<u>Melt analysis, percent</u>		Permissible variation, percent,
	min.	max.	
Carbon	0.16	0.25	- 0.01 + 0.02
Silicon	--	1.00	+ 0.05
Manganese	--	1.50	+ 0.04
Chromium	12.00	14.00	± 0.20
Sulphur	—	0.030	+ 0.005
Phosphorus	—	0.040	+ 0.005

Note: Elements not listed in this table shall not be intentionally added to the steel without the agreement of the purchaser except for finishing the cast. All appropriate precautions are to be taken to avoid the addition of such elements from scrap and other materials used in production which would impair mechanical properties and the suitability of the steel.

**10.0 TEST SAMPLES :**

The test samples shall be selected as per EN 10088 Part 3.

11.0 MECHANICAL PROPERTIES :**11.1 Tensile and impact:**

The test pieces shall show the following properties:

Ruling section, mm	Tensile strength, N/mm ²	Yield strength, min N/mm ²	Percent Elongation, min	Impact Strength at Room Temperature, ISO – V, Joules	Hardness BHN
Upto 160mm (Inclusive)	700-850	500	13	25	208-252

Note:

1. The mechanical properties required for sizes above 160 mm shall be as per mutual agreement between BHEL and manufacturer.
2. The tensile test shall be carried out in accordance with IS: 1608 or any reputed National Standard.
3. The charpy impact test shall be performed in accordance with IS: 1499 or any reputed National Standard.

An impact test shall consist of three specimens from a single test location, the average value of which shall be as specified above.

Only one value of the three can be below the specified minimum but in no case below 2/3 of the specified minimum value.

- 4 Hardness shall be informed in the test certificates for information.

12.0 ULTRASONIC TEST:

- 12.1 Each bar above 100 mm shall be tested ultrasonically in accordance with BHEL standard AA 085 01 18 to ensure freedom from internal defects. The norms of acceptance shall be as per category 2 of the above standard.

12.2 Optional tests:

If specified in order, each bar > 40 to 100mm shall be tested ultrasonically in accordance with BHEL standard AA 085 01 18 to ensure freedom from internal defects and the norms of acceptance shall be as per category 2.

**13.0 TEST CERTIFICATES :**

Three copies of test certificates shall be supplied, unless otherwise stated in the order.

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:

BHEL References:

AA 107 21 (Rev. No. 07) : Stainless steel bars (martensitic), Gr: X 20 Cr 13, H&T
BHEL order No.

Supplier's References :

Name
Identification No.
Melt No.
Details of heat treatment.

Result of Tests:

Dimensional inspection.
Results of chemical analysis, mechanical tests and Hardness check called for in this specification.

14.0 PACKING AND MARKING:

The material shall be suitably packed in bundles-Hessian wrapped-to prevent sagging and damage during transit.

Each bar/flat 50 mm in diameter/width across flats shall be stamped with 'AA 107 23', melt No., BHEL order No., at one end or on the end face.


Bars bar/flat upto and including 50 mm in diameter/width across flats shall be bundled together and tied with wire at 3 to 4 places along the length of the bars.

A metal label shall be securely attached to each bundle and shall bear the following information :

AA107 21 : Stainless steel bars (martensitic), Gr: X 20 Cr 13, H&T
BHEL Order No.
Consignment/Identification No.
Melt No.
Size and Weight.
Supplier's Name.

15.0 REFERRED STANDARDS (Latest Publications Including Amendments):

1. EN 10088-3
2. AA 0850118
3. EURONORM 58, 59 & 60

	CORPORATE PURCHASING SPECIFICATION			AA 106 22										
				Rev. No. 09										
				PREFACE SHEET										
<p>ALLOY STEEL BARS FOR HIGH TEMPERATURE BOLTS UPTO 565⁰ C – H&T (20CrMoVTiB 4 10) ↑</p> <p>FOR INTERNAL USE ONLY REMOVE THIS PREFACE SHEET BEFORE ISSUE TO SUPPLIERS</p> <div style="display: flex; justify-content: space-between;"> <div> <p>Comparable Standards:</p> </div> <div> <p>DIN EN 10269 – 1999 Gr: 20CrMoVTiB 4 10 (Derehete 1055)</p> </div> </div> <p>Suggested / Probable Suppliers and Grades:</p> <ol style="list-style-type: none"> 1. M/S MUSCO, KHOPALI 2. M/S ASP, DURGAPUR 3. Plant vendor's list <p>User Plant References:</p> <table style="width: 100%;"> <tr> <td style="width: 40%;">1. BHOPAL</td> <td style="width: 10%;">:</td> <td style="width: 50%;">---</td> </tr> <tr> <td>2. HEEP, HARDWAR</td> <td>:</td> <td>1. HW 0210299 2. AA 10623</td> </tr> <tr> <td>3. HYDERABAD</td> <td>:</td> <td></td> </tr> </table>						1. BHOPAL	:	---	2. HEEP, HARDWAR	:	1. HW 0210299 2. AA 10623	3. HYDERABAD	:	
1. BHOPAL	:	---												
2. HEEP, HARDWAR	:	1. HW 0210299 2. AA 10623												
3. HYDERABAD	:													
Revisions : e-mail dt: 10.03.2007 from HW			APPROVED : INTERPLANT MATERIAL RATIONALISATION COMMITTEE-MRC (FCF+HTM)											
Rev. No. 09	Amd.No.	Reaffirmed	Prepared	Issued	Dt. of 1st Issue									
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CORPORATE PURCHASING SPECIFICATION

AA 106 22

Rev. No. 09

PAGE 1 OF 4

ALLOY STEEL BARS FOR HIGH TEMPERATURE BOLTS UPTO 565⁰ C – H&T (20CrMoVTiB 4 10) ¹

1.0 GENERAL:

This specification governs the quality requirements of alloy steel bars suitable for machining.

2.0 APPLICATION: Used mainly for bolts, nuts and studs etc.

3.0 CONDITION OF DELIVERY:

Hot rolled/forged bars shall be supplied in the hardened and tempered condition ¹ according to EN10269 Table B.1 to comply with the mechanical properties specified in ¹ the specification.

4.0 COMPLIANCE WITH NATIONAL STANDARDS:

There is no Indian standard covering this material. However, assistance has been derived from DIN EN 10269 material grade 20CrMoVTiB4-10 "Steels and Nickel alloys for fasteners with specified elevated and / or low temperature properties".

5.0 DIMENSIONS AND TOLERANCES:

Sizes: Bars shall be supplied to the dimensions specified in BHEL order.

5.1.1 Length:

Unless otherwise specified, hot rolled bars shall be supplied in 3 to 6 metres length or in multiples with maximum of 10 per cent, shorts down to 1 metre.

Forged bars shall be supplied in lengths of 1.5 to 3 metres.

5.1 Tolerances:

5.2.1 Hot rolled bars:

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

5.2.2 Forged bars: The tolerance on the forged bars shall be as follows:

<u>Diameter, mm</u>	<u>Tolerance, mm</u>
> 50 to 125	+ 6.0
>125 to 175	+ 8.0
>175 ---	+ 12.5

Note: (FOR HOT ROLLED & FORGED BARS)

Insignificant surface defects in the form of dent and ripple marks are permissible provided their depth does not exceed half the tolerances on each size.

Revisions :

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6.0 MANUFACTURE

The steel shall be made by electric furnace process and degassed (e.g. vacuum degassed). Any other process shall be subjected to the mutual agreement between BHEL and the manufacturers.

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

Bars shall be annealed at 660-700°C followed by air cooling, hardened by heating uniformly to 970-990°C and quenching in water/ oil. They shall be tempered at temperatures between 680-720°C.

If bars need to be straightened after heat treatment, stress relieving is mandatory after completion of the entire straightening process. Stress relieving shall be carried out at 30°C below the tempering temperature with a subsequent slow cooling rate.

8.0 FREEDOM FROM DEFECTS

The bars shall be straight, sound and free from internal defects. Cracks, other material separations or more severe linear inclusion lines are only acceptable when located in the dimensional tolerance areas.

9.0 CHEMICAL COMPOSITION:

The analysis of the material shall be as follows:

Element	Percent	
	Minimum	Maximum
Carbon	0.17	0.23
Silicon	--	0.40
Manganese	0.35	0.75
Chromium	0.90	1.20
Molybdenum	0.90	1.10
Vanadium	0.60	0.80
Titanium	0.07	0.15
Boron	0.001	0.010
Sulphur	--	0.020
Phosphorus	--	0.020 *
Copper	--	0.20
Tin	--	0.020 *
Arsenic	--	0.020
Aluminium	0.015	0.08 **

* The elements P and Sn shall be controlled according to the formula $P+3.6XSn \leq 0.055\%$

** A maximum Al-value of 0.03% is to be aimed.

**10.0 TEST SAMPLES**

10.1 CHEMICAL ANALYSIS: Each melt shall be analysed for chemical composition.

10.2 MECHANICAL TESTS

A hardness test is to be carried out to verify the uniformity of the strength within the delivery lot (per melt and heat treatment batch). Hardness check shall be conducted on 10% of the bars or a minimum 10 numbers of bars whichever is higher. In case the lot consist of less than or equal 10 bars, then all the bars need to be checked for hardness. Mechanical properties shall be tested on hardest and softest bar.

A specimens are to be taken in longitudinal direction according to EN 10083-1. For bars with diameter (d) respectively side lengths (a,b)>100mm, the specimens shall be taken at a distance d/3 respectively a/3 and b/3 from the respective surfaces. In this case transverse specimens are also allowed.

11.0 MECHANICAL PROPERTIES

11.1 When tested in accordance with IS:1608, the test pieces shall show the following properties at room temperature (EN 10269):

PROPERTIES	d ≤ 100mm	100 > d ≤ 160mm*
Ultimate tensile strength	820-1000 N/mm ²	820-1000 N/mm ²
0.2% proof stress	≥ 660 N/mm ²	≥ 660 N/mm ²
Elongation on 5.65 √So gauge length	≥ 15 %	≥ 15 %
Reduction in area	≥ 50%	≥ 50%
Impact(Avg. of 3 Charpy U-notch) (J)	≥ 82	≥ 64

* For d>160mm, 5% reduction over the lower limit is acceptable for ultimate tensile strength and 0.2% proof stress.

11.2 Hardness (Brinell)- for information only

When tested in accordance with IS:1500, the material shall have a Brinell hardness in the range of 245 - 310 BHN.


12.0 NON-DESTRUCTIVE TEST

12.1 Verification inspection of all bars.

12.2 100% Ultrasonic inspection of all bars according to EN 10308 type 1a-1c (table 1). Acceptance criteria shall be quality class 4 according to EN 10308 (table 2). In general, the decision limit for loss of back wall echo is 4 dB for all bar dimensions. Every linear or surface-like inhomogeneity larger than 10mm in any direction is not acceptable.

13.0 RETESTS

As per EN10021.

AA 106 22	CORPORATE PURCHASING SPECIFICATION	
Rev. No. 09		
PAGE 4 OF 4		

14.0 TEST CERTIFICATE:

Three copies of test certificates shall be supplied unless otherwise stated in the order.

In addition the supplier shall ensure to enclose one copy of test certificate alongwith their despatch documents to facilitate quick clearance of material.

The test certificate shall bear the following information:

BHEL references:
BHEL order No.
AA 106 22 (Rev.No. 09): Alloy steel bars for high temperature bolts up to 565°C-H&T (20CrMoVTiB 4 10)

Supplier References:
Supplier's Name
Heat or Cast No.
Process of manufacture
Identification No.
Particulars of heat treatment and Batch No.

Results of Tests:
Chemical analysis
Non-destructive tests
Mechanical properties
Results of dimensional inspection
Mill test certificate (for forge master)
The certificate must be signed by the Chief, Inspection Department / Chief Metallurgist of the supplier's plant.

15.0 PACKING AND MARKING

Bars shall be suitably packed to prevent corrosion and damage during transportation.

Bars over 63 mm diameter shall be individually stamped / painted on one end face with cast number and AA 106 22.

Bars of 63 mm diameter and less shall be bundled together and identified by means of a metal label stating the cast number and specification No. AA 106 22 attached to the bundle.

Each package shall, in addition bear the following information:

AA 106 22 : Alloy steel bars for high temperature bolts up to 565°C-H&T(20CrMoVTiB 4 10)
BHEL Order No.
Cast / Batch No.
Identification No.
Weight.
Supplier's Name.

16.0 REFERRED STANDARD (Latest publications including Amendments)

1. IS : 1500	2. IS :1608	3. DIN EN 10269	4. EN10021
5. EN 10204	6. EN 10308	7. EN10083-1	



CORPORATE PURCHASING SPECIFICATION

AA 106 20

Rev. No. 08

PREFACE SHEET

BOLTING STEEL BARS FOR HIGH TEMPERATURE SERVICE-H & T (Gr: 21CrMoV5-7+QT)

FOR INTERNAL USE ONLY
REMOVE THIS PREFACE SHEET BEFORE ISSUE TO SUPPLIERS

Comparable Standards:

GERMAN : DIN EN 10269-1999
Gr: 21CrMoV5-7 (1.7709)

Suggested / Probable Suppliers and Grades:

As per user plant vendor list

User Plant References:

- | | | |
|--------------------------|---|------------------|
| 1. HYDERABAD | : | HY10665 |
| 2. PIPING CENTRE, MADRAS | : | A 193, B7 |
| 3. TIRUCHY | : | A 193, B7 |
| 4. HARIDWAR | : | HW10673, HW10681 |

Revisions : As per Email Dt 3.6.2008 from Shri
Pradeep Agrawal, BHEL Hyderabad

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CORPORATE PURCHASING SPECIFICATION

AA 106 20

Rev. No. 08

PAGE 1 OF 5

BOLTING STEEL BARS FOR HIGH TEMPERATURE SERVICE - H & T (Gr.:21CrMoV5-7+QT)

1.0 GENERAL:

This specification governs the quality requirements of 21CrMoV5-7 bolting steel bars in hardened and tempered condition upto 600 mm diameter / size.

2.0 APPLICATION:

For the manufacture of steam turbine bolts, nuts, studs, spindles, bushes and other components operating in the temperature range of 300 - 540° C.

3.0 CONDITION OF DELIVERY:

Hot rolled/Forged and Hardened and Tempered.

The bars shall be supplied with ends square and true. The bars shall be supplied in straight lengths without twists and bends.

4.0 COMPLIANCE WITH NATIONAL STANDARDS:

The material shall comply, in general, with the requirements of the following National standard and also meets the requirements of this specification.

DIN EN 10269-1999 Gr: 21 Cr Mo V 57 :Steels and nickel alloys for fasteners with specified elevated and/or low temperature properties.

5.0 DIMENSIONS AND TOLERANCES:

5.1 Sizes:

Bars shall be supplied to the dimensions specified in BHEL order.

5.1.1 Length:

Unless otherwise specified, hot rolled bars shall be supplied in 3 to 6 metres length or in multiples with maximum of 10 per cent, shorts down to 1 metre.

Forged bars shall be supplied in lengths of 1.5 to 3 metres.

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**5.2 Tolerance:****5.2.1 Hot rolled bars:**

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

5.2.2 Forged bars:

The tolerance on the forged bars shall be as follows:

<u>Diameter, mm</u>	<u>Tolerance, mm</u>
50 to 125	+ 6.0
125 to 175	+ 8.0
175 ---	+ 12.5

Note: (FOR HOT ROLLED & FORGED BARS)

Insignificant surface defects in the form of dent and ripple marks are permissible provided their depth does not exceed half the tolerances on each size.

6.0 MANUFACTURE:

Steel shall be made by basic electric process and subsequently vacuum degaussed. If any other process is employed, it shall be to mutual agreement between the supplier and BHEL.

Note: Raw material like Ingots/Blooms/Billets required for forgings should be procured from BHEL approved sources alongwith test certificate.

7.0 HEAT TREATMENT:

7.1 The bars shall be heat treated as per EN10269 to get the mechanical properties specified as per clause 12.0.

7.2 Following heat treatment is suggested:

Harden at $900-950^{\circ}\text{C}$, cooling in the circulated air / oil depending on Cross Section.
Temper at $680 - 720^{\circ}\text{C}$, minimum 2 hours.

The duration of tempering as well as the controlled cooling rate are to be chosen to achieve minimum residual stress.

7.3 If the bars need straightening after heat treatment, the straightening operation shall be followed by stress relief annealing at 30°C below the tempering temperature with slow cooling after the total straightening process.

8.0 FREEDOM FROM DEFECTS:

The bars shall be straight, sound and free from internal and surface defects viz., cracks, piping, scabs, laps, hairline cracks, etc. The bars shall be free from twists and bends.

9.0 FINISH:

9.1 The surface of the bars shall be smooth without any laps, rolled in scales, etc. Dents roll marks and scratches are permitted provided their depth does not exceed half the tolerance limits specified in clause 5.0.

9.2 The edges of bars shall be cut square by sawing or shearing and no crop ends shall be permissible.

**10.0 CHEMICAL COMPOSITION:**

The analysis of the material and the permissible variation in the composition from the specified limits shall be as follows:

Element	Percent for bar dia. up to 160		Percent for bar dia. 160 – 600 mm		Permissible variation, %
	min.	max.	min.	max.	
Carbon	0.17	0.25	0.17	0.25	± 0.02
Silicon	-	0.40	0.15	0.35	+ 0.05
Manganese	0.40	0.80	0.35	0.85	± 0.04
Chromium	1.20	1.50	0.90	1.20	± 0.05
Molybdenum	0.55	0.80	0.65	0.80	± 0.05
Vanadium	0.20	0.35	0.25	0.35	± 0.03
Sulphur	--	0.020	--	0.20	+ .005
Phosphorus	--	0.020	--	0.20	+ 0.005
Copper	-	0.20	--	0.20	
Tin	-	0.025	--	0.025	
Arsenic	-	0.010	--	0.010	
Antimony	-	0.010	--	0.010	
Aluminium (Total) -		0.03	--	0.015	
Nickel	-	0.60	0.50	0.80	

11.0 TEST SAMPLES:**11.1 CHEMICAL ANALYSIS:**

Each melt shall be analysed for chemical composition.

11.2 MECHANICAL TESTS:

A hardness test is to be carried out to verify the uniformity of the strength within the delivery lot (per melt and heat treatment batch). The test amount shall be 10% of the bars, but not less than 10 bars. In case order is of less than 10 bars, all bars shall be hardness tested. Mechanical properties shall be tested on hardest and softest bar.

The taking of specimens has to be carried out according to EN 10269 with the following exception:

Up to a diameter (d) or an edge length (a,b) > 160 mm, the transverse specimens can be taken (instead of longitudinal specimens).

**12.0 MECHANICAL PROPERTIES:****12.1 Tensile:**

When tested in accordance with IS: 1608, the test pieces shall show the following properties (values for transverse specimens in brackets):

Property	Bar = 160mm	Bar 160- 600mm
Tensile strength, N/mm ²	700-850	700-850
0.2% Proof stress, N/mm ² , min	550	550
Elongation (1= 5d), % min.	16	16 (13)
Reduction in area, % min.	60	60 (35)
Impact energy (J) *	63	63 (20)
Hardness (HB 30)	210-250	215-260

*** Charpy Impact (ISO - V) Value :**

When tested in accordance with IS : 1757, the piece shall show a minimum average Charpy impact value over three test values as specified above. Only one test value out of the three can be below the specified value but in no case shall be less than two-thirds the minimum specified value. All the 3 test values shall, however, be reported.

The test is applicable for bars of sizes above 16 mm only.

13.0 NON-DESTRUCTIVE TEST:

13.1 Verification inspection of all bars.

13.2 100% Ultrasonic inspection of all bars above 40mm size according to EN 10308 type 1a and 1c table 1). Acceptance criteria are as follows.

- **d or (a,b) = 200mm quality class 4**
- **d or (a,b) = 200mm quality class 3**

In general, the decision limit for loss of back wall echo is 3 dB and for the real reflector length max. 10mm.

14.0 RETESTS:

As per EN10021.

15.0 TEST CERTIFICATE:

Three copies of test certificates shall be supplied unless otherwise stated on the order. In addition the supplier shall ensure to enclose one copy of test certificate alongwith their dispatch documents to facilitate quick clearance of material.

The test certificate shall bear the following information:

BHEL references:

BHEL order No.

AA 106 20 , Rev.No. 08: Bolting Steel bars for HTS - H & T (Gr.:21CrMoV5-7- QT)

Supplier References:

Supplier's Name

Heat or Cast No.

Process of manufacture

Identification No.

Particulars of heat treatment & Batch No.



CORPORATE PURCHASING SPECIFICATION

AA 106 20

Rev. No. 08

PAGE 5 OF 5

Results of Tests:

Chemical analysis

Mechanical properties

Ultrasonic test

Results of dimensional inspection

Mill test certificate

The certificate must be signed by the Chief, Inspection Department / Chief Metallurgist of the supplier's plant.

16.0 PACKING AND MARKING:

Bars shall be suitably packed to prevent corrosion and damage during transportation.

Bars over 63 mm diameter shall be individually stamped / painted on one end face with cast number and AA 106 20. Bars of 63 mm diameter and less shall be bundled together and identified by means of a metal label stating the cast number and specification No. AA 106 20 attached to the bundle.

Each package shall, in addition bear the following information:

AA 106 20 : Bolting Steel bars for HTS - H & T (Gr.:21CrMoV57)

BHEL Order No.

Supplier's name and trade mark, if any.

Cast / Batch No.

Identification No.

Size and quantity supplied.

17.0 REFERRED STANDARDS (Latest Publications Including Amendments):

1) DIN 10269

2) IS: 3739

3) IS:1608

4) IS:1757

5) EN 10228-3

6) EN10021

Note: Alternative equivalent standards are acceptable with prior agreement.



CORPORATE PURCHASING SPECIFICATION

AA 105 02

Rev. No. 08

PREFACE SHEET

1.5% CHROMIUM-ALUMINIUM-MOLYBDENUM NITRIDING STEEL BARS - H & T

FOR INTERNAL USE ONLY
REMOVE THIS PREFACE SHEET BEFORE ISSUE TO SUPPLIERS

Comparable Standards:

- | | | |
|-----------|---|--|
| 1. INDIAN | : | IS : 5517-1993
Gr: 40 Cr7Al10Mo2, Type J, H & T |
| 2. GERMAN | : | DIN 17211-1970
Gr: 41 Cr Al Mo7 |

Suggested/Probable Suppliers And Grades:

Refer Plant Vendors list

User Plant References:

- | | | |
|------------------|---|-----------------------|
| 1. BHOPAL | : | PS 106 05 & PS 105 67 |
| 2. HEER, HARDWAR | : | HW 0210299 |
| 3. HYDERABAD | : | HY 0210299 |
| 4. TRICHY | : | BM-N1, N2 & N3 |

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CI 27.6.16 of MOM of MRC-S&GPS

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CORPORATE PURCHASING SPECIFICATION

AA 105 02

Rev. No. 08

PAGE 1 OF 5

1.5% CHROMIUM-ALUMINIUM-MOLYBDENUM NITRIDING STEEL BARS - H & T

1.0 GENERAL:

This specification governs the quality requirements of 1.5% Chromium-Aluminium-Molybdenum Nitriding Steel Bars, Gr: 40 Cr7Al10Mo2, in hardened and tempered condition.

2.0 APPLICATION:

For the manufacture of valve spindles, guide bushes, valve seats etc.

3.0 CONDITION OF DELIVERY:

Hot Rolled / Forged, Hardened and tempered.

Note: Sizes upto 100mm in hot rolled
>100 to 180mm in hot rolled or forged
above 180mm in forged

The ends of bars shall be reasonably square and true.

The bars shall be supplied in straight lengths without twists and bends.

4.0 COMPLIANCE WITH NATIONAL STANDARDS:

The material shall comply with the requirements of the following National standard and also meet the requirements of this specification.

IS : 5517-1993 : Steel for
Gr:40 Cr 7 Al 10 Mo 2, Type: J : Hardening and Tempering
Hardened & Tempered

5.0 DIMENSIONS AND TOLERANCES:

5.1 Sizes:

The bars shall be supplied to the dimensions specified In BHEL order.

5.2 Tolerances:

5.2.1 For Forged bars:

The tolerances shall be + 8 mm - 0 mm.

Revisions :

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5.2.2 Tolerances on hot rolled bars shall comply with those of Grade 2 of IS:3739: reproduced below:

Round and Square Bars :

Nominal size. mm		Tolerance, mm	
Over Upto & Including		Permissible deviation	Out of round/ square
---	25	± 0.50	0.50
25	50	± 0.75	0.75
50	80	± 1.00	1.00
80	100	± 1.25	1.25
100	125	± 1.50	1.50
125	160	± 2.00	2.00
160	200	± 2.50	2.50
200	250	± 3.00	3.00

5.2.3 On Straightness

Unless otherwise agreed to, the permissible deviation in straightness, shall not exceed the following limits in any 1000 mm length of the bar.

Upto & incl. 40 mm size of bars - 6 mm

Above 40 mm size of bars - 5 mm

5.3 Length

Bars shall be supplied in 3 to 6 metres length or in multiples with maximum of 10% shorts down to 1 metre.

Forged bars shall be supplied in length of 1.5 to 3 metres.

6.0 MANUFACTURE:

Material shall be manufactured from fully killed steel.

7.0 HEAT TREATMENT:

The recommended heat treatment is as follows:

Harden in oil / water from a temperature of 850-900°C.

Temper at a suitable temperature between 550-700°C.

**8.0 FREEDOM FROM DEFECTS**

The bars shall be sound, straight and free from internal and surface defects, such as seams, laps, cracks or any other defects which may impair the end use.

9.0 CHEMICAL COMPOSITION

The melt analysis of steel and the permissible variation in the composition of the finished product from the melt analysis shall be follows:

Element	Melt analysis, percent,		Permissible variation, percent, in product analysis
	Min.	Max.	
Carbon	0.35	0.45	± 0.02
Silicon	0.10	0.35	± 0.03
Manganese	0.40	0.70	± 0.04
Chromium	1.50	1.80	± 0.05
Molybdenum	0.10	0.25	± 0.03
Aluminium	0.90	1.30	± 0.10
Sulphur	---	0.035	+ 0.005
Phosphorus	---	0.035	+ 0.005

10.0 TEST SAMPLES :

10.1 One sample shall be taken from each melt for chemical analysis.

10.2 One sample shall be taken from each heat treatment batch for testing of mechanical properties. Test pieces for mechanical tests shall be taken in the longitudinal direction of the piece in accordance IS:5517.

For ruling section up to & including 40mm, the test piece shall be machined coaxially from the test bars. For ruling section above 40mm the longitudinal axis shall be atleast 12.5 mm from surface of the test bars.

Test methods for determining mechanical properties shall be as per IS:1598 (For IZOD impact test)/IS:1757 (For impact test in ISO-V Charpy) and IS:1608 (For tensile test).

10.3 For ruling section above 200mm, tensile test samples can be taken in tangential or transverse direction.



11.0 MECHANICAL PROPERTIES (In Hardened and Tempered Condition)

Ruling section, mm	Tensile strength, N/mm ²	0.2% PS/YS N/mm ² , min	% E 5.65√So min	* IZOD impact J, min
≤ 63	900 -1050	700	15	48 (42)
>63 to ≤ 100	800 - 950	600	16	55 (50)
>100	700 - 850	540	18	55 (50)

* Average of 3 samples applicable for sizes above 16 mm ruling section only. Values in bracket are in ISO - V Charpy.

12.0 ULTRASONIC TEST

12.1 Each bar above 100 mm shall be tested ultrasonically in accordance with BHEL standard AA 085 01 18 to ensure freedom from internal defects.

The norms of acceptance shall be as per category 2 of the above standard.

12.2 Optional tests: If specified on order, each bar >40 to 100 mm shall be tested ultrasonically in accordance with BHEL standard AA 085 01 18 to ensure freedom from internal defects and the norms of acceptance shall be as per category 2 .

13.0 TEST CERTIFICATES:

Three copies of test certificates shall be supplied, unless otherwise stated on the order.

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 :

BHEL References :

AA 105 02; (Rev. No. 08) : 1.5% Chromium-Aluminium-Molybdenum Nitriding Steel Bars - H & T.

BHEL order No,

Result of Tests:

Dimensional inspection.

Results of chemical analysis, mechanical and Ultrasonic tests.

**Supplier's References :**

Name

Identification No.

Melt No.

Details of heat treatment.

14.0 PACKING AND MARKING

The bars shall be suitably packed in bundles to prevent corrosion and damage during transit.

All bars 50mm and above in diameter or of equivalent cross sectional area shall be stamped with 'AA 105 02' and melt number on the side near the end or on the face.

Bars below 50 mm shall be bundled together and tied with wire at 3 to 4 places along the length of the bars.

A metal label shall be securely attached to each bundle and shall bear the following information :

AA 105 02 : 1.5% Chromium-Aluminium-Molybdenum Nitriding Steel Bars - H & T.

BHEL Order No.

Consignment/Identification No.

Melt No.

Size and Weight.

Supplier's Name.

15.0 REFERRED STANDARDS (Latest Publications Including Amendments):

1. IS : 1598

2. IS : 1608

3. IS : 1757

4. IS : 3739

5. IS: 5517

6. AA 085 01 18



CORPORATE PURCHASING SPECIFICATION

AA 103 05

Rev. No. 08

PREFACE SHEET

HOT ROLLED / FORGED CARBON STEEL BARS, Gr : 55C8 - NORMALISED

FOR INTERNAL USE ONLY
REMOVE THIS PREFACE SHEET BEFORE ISSUE TO SUPPLIERS

Comparable Standards:

- | | | |
|-----------|---|--|
| 1. INDIAN | : | IS : 1570 (Part 2-Section 1) - 1979
Gr: 55C8 (C55 Mn75), Normalised |
|-----------|---|--|

Suggested/Probable Suppliers And Grades:

Refer Plant Vendors List

User Plant References:

- | | | |
|--------------|---|--------------|
| 1. BHOPAL | : | PS 103 05 |
| 2. HYDERABAD | : | HY 021 02 99 |
| 3. TIRUCHY | : | BM - C 55 |

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AA 103 05

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PAGE 1 OF 4

HOT ROLLED / FORGED CARBON STEEL BARS, Gr : 55 C8 - NORMALISED

1.0 GENERAL:

This specification governs the quality requirements of Hot Rolled / Forged Carbon Steel Bars Gr: 55C8, Normalised.

2.0 APPLICATION :

General engineering purposes.

3.0 CONDITION OF DELIVERY :

Hot Rolled / Forged and normalised.

Note: Sizes upto 100mm in hot rolled.
>100 to 180mm in hot rolled or forged
above 180mm in forged.

Bars shall be supplied in straight lengths without twists and bends and with the ends square and true.

4.0 COMPLIANCE WITH NATIONAL STANDARDS:

The material shall comply with the requirements of the following National standard and also meet the requirements of this specification.

IS : 1570, (Part 2-Sec.1)-1979	:	Schedules for Wrought Steels- Part 2 :
	:	Carbon Steels (Unalloyed Steels) -Sec.1:
Gr : 55 C8 (C55 Mn75) Normalised.	:	Wrought products (other than wire) with specified Chemical Composition and related Properties.

5.0 DIMENSIONS AND TOLERANCES :

5.1 Sizes:

Bars shall be supplied to the dimensions specified in BHEL order.

5.1.1 Length :

Unless otherwise specified, hot rolled bars shall be supplied in 3 to 6 metres.
Forged bars shall be supplied in length of 1.5 to 3 metres.

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AA 103 05	CORPORATE PURCHASING SPECIFICATION	
Rev. No. 08		
PAGE 2 OF 4		

5.2 Tolerances :

5.2.1 Hot Rolled Bars :

Tolerances on hot rolled bars shall comply with those of Grade 2 of IS : 3739: Dimensional Tolerances for Carbon and Alloy Constructional Steel products, reproduced below:

Nominal Size, mm		Tolerance, mm	
Over	Upto & Including	Permissible deviation	Out of round/ square
---	25	± 0.50	0.50
25	50	± 0.75	0.75
50	80	± 1.00	1.00
80	100	± 1.25	1.25
100	125	± 1.50	1.50
125	160	± 2.00	2.00
160	200	± 2.50	2.50

5.2.2 Flats :

Nominal size, mm		Tolerance, mm			
Over	Upto & Incl.	On width	On thickness		
			6 to 13 Incl.	Over 13 to 25 Incl.	Over 25 to 50 Incl.
--	50	± 1.0	± 0.5	± 0.8	± 1.0
50	100	± 2.0	± 0.5	± 1.0	± 1.5
100	150	± 3.0	--	--	± 2.0

5.2.3 Hexagonal Bars :

Nominal Size, mm		Tolerance, mm	
Over	Upto & Including	Permissible deviation	Out of hexagon
---	25	± 0.50	0.75
25	50	± 0.80	1.20
50	85	± 1.60	2.40

5.2.4 Forged Bars :

Tolerance on size for forged bars shall be + 8.0 mm -0 mm.

5.2.5 Straightness for Hot Rolled Bars :

Unless otherwise agreed to, the permissible deviation in straightness, shall not exceed 5 mm in any 1000 mm length.

6.0 MANUFACTURE:

The steel shall be manufactured by the open hearth, electric, basic oxygen or a combination of these processes.

Sufficient discard shall be made from each ingot to ensure freedom from piping, harmful segregation and internal and surface defects.

Material shall be manufactured from killed steel.

**7.0 HEAT TREATMENT :**

The bars shall be normalised at a temperature of 810-840°C.

8.0 FREEDOM FROM DEFECTS :

The bars shall be sound, straight and free from internal and surface defects, such as seams, laps and injurious imperfections. Bars shall be free from twists and bends.

9.0 CHEMICAL COMPOSITION :

The melt analysis of steel and the permissible variation in the composition of the material from the melt analysis shall be follows :

Element	Melt analysis, percent,		Permissible variation, percent,
	min.	max.	
Carbon	0.50	0.60	± 0.03
Silicon	0.10	0.35	± 0.03
Manganese	0.60	0.90	± 0.04
Sulphur	---	0.035	+ 0.005
Phosphorus	---	0.035	+ 0.005

10.0 TEST SAMPLES :**10.1 Tensile :**

Bars from the same melt and of the same size shall be grouped in batches of 40,000 kg or part thereof. One tensile test piece shall be cut from a selected bar from each batch.

For bars of sizes upto and including 40 mm, the test pieces shall be machined concentrically from the bars selected for test. Alternatively the full cross-section of the bars may be tested.

For bars of sizes over 40 mm, the longitudinal axes of the test pieces shall not be less than 12.5 mm from the surface of the bars selected for test.

Tensile test pieces shall have a gauge length equal to $5.65 \sqrt{S_o}$.

10.2 Ruling section above 200mm, tensile test samples can be taken in longitudinal or transverse direction.

11.0 MECHANICAL PROPERTIES :


When tested in accordance with IS : 1608, the test pieces shall show the following properties :

Tensile strength	:	720N/mm ² , min.
Yield strength	:	396 N/mm ² , min
Elongation on $5.65 \sqrt{S_o}$ gauge length	:	13 percent, min.

12.0 ULTRASONIC TEST :

12.1 Each bar above 100 mm shall be tested ultrasonically in accordance with BHEL standard AA 085 01 18 to ensure freedom from internal defects.

The norms of acceptance shall be category 2 of the above standard.

AA 103 05	CORPORATE PURCHASING SPECIFICATION	
Rev. No. 08		
PAGE 4 OF 4		

12.2 Optional Test:

If specified in order, each bar > 40 to 100mm shall be tested ultrasonically in accordance with BHEL standard AA 085 01 18 to ensure freedom from internal defects and the norms of acceptance shall be as per category 2.

13.0 TEST CERTIFICATES :

Unless otherwise stated in the order, three copies of test certificates shall be supplied.

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 :

BHEL References :

AA 103 05, Rev. No. 08: Hot rolled / Forged Carbon Steel Bars, Gr : 55C8 - Normalised.
BHEL order No.

Supplier's References :

Name
Identification No.
Melt No.
Details of Heat treatment.

Result of Tests:

Dimensional inspection.
Results of chemical analysis, mechanical and ultrasonic tests.

14.0 PACKING AND MARKING :

The material shall be suitably packed in bundles - hessian wrapped-to prevent sagging, corrosion and damage during transit. A suitable clear temporary rust preventive shall be applied on all the bars.

Each bar over 50 mm shall be stamped at one end with "AA 103 05", melt no., BHEL order No., at one end or on the end face.

Bars 50 mm and below shall be bundled together and tied with wire at 3 to 4 places along the length of the bars.

A metal label shall be securely attached to each bundle and shall bear the following information :

AA 103 05: H.R / Forged Carbon Steel Bars, Gr : 55C8 - Normalised.
BHEL Order No.
Consignment/Identification No.
Melt No.
Size and Weight.
Supplier's Name.

15.0 REFERRED STANDARDS (Latest Publications Including Amendments):

1. AA 085 01 18	2. IS : 1570, part2,
3. IS : 1608	4. IS : 3739



CORPORATE PURCHASE SPECIFICATION

AA 102 13

Rev. No. 07

PREFACE SHEET

HOT ROLLED / FORGED MEDIUM CARBON STEEL BARS, Gr : 30C8 - NORMALISED

FOR INTERNAL USE ONLY
 REMOVE THIS PREFACE BEFORE ISSUE TO SUPPLIERS

Comparable Standards:

1. INDIAN

IS : 1570, Part II, Section I - 1979 (Reaffirmed 1998)
 Gr: 30C8(C30) Normalised

Suggested/Probable Suppliers and Grades:

Refer Plant Vendors list

User Plant References:

1. BHOPAL	:	PS 102 13
3. HYDERABAD	:	---
4. TIRUCHY	:	BM - C 30 For Bars

Revisions :

CI 24.4.19 of MOM of MRC-S&GPS

APPROVED :

INTERPLANT MATERIAL RATIONALISATION
 COMMITTEE-MRC (S&GPS)

Rev. No. 07

Amd.No.

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Dt :

Year :

BHOPAL

Corp. R&D

SEP. '76



CORPORATE PURCHASE SPECIFICATION

AA 102 13

Rev. No. 07

PAGE 1 OF 4

HOT ROLLED / FORGED MEDIUM CARBON STEEL BARS, Gr: 30 C8-NORMALISED

1.0 GENERAL

This specification governs the quality requirements of Hot Rolled / forged Carbon Steel Bars, suitable for machining.

2.0 APPLICATION

General engineering purposes.

3.0 CONDITION OF DELIVERY

Hot Rolled / forged and Normalised.

Note: Sizes upto 100mm in hot rolled
>100 to 180mm in hot rolled or forged
above 180mm in forged

Bars shall be supplied in straight lengths with ends square and true.

4.0 COMPLIANCE WITH NATIONAL STANDARDS:

Material shall comply with the requirements of the following National standards and also meet the requirements of this specification.

IS : 1570-Part 2, Section 1-1979	:	Schedule for wrought Steels Part 2
(Reaffirmed 1998)	:	Carbon Steels (Unalloyed Steels)
Gr:30C8 (C30), Normalised	:	Sec.1: Wrought Products (other than wire) with specified Chemical composition and related properties.

5.0 DIMENSION AND TOLERANCES

5.1 Sizes:

Bars shall be supplied to the dimensions specified on BHEL order.

5.1.1 Length:

Unless otherwise specified, hot rolled bars shall be supplied in lengths 3 to 6 metres and forged bars shall be supplied in lengths of 1.5 to 3 metres

Revisions :

CI 24.4.19 of MOM of MRC-S&GPS

APPROVED :

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Year :

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Corp. R&D

SEP., 1976

**5.2 Tolerances:****5.2.1 For Forged bars:**

The tolerances shall be + 8 mm - 0mm.

5.2.2 Tolerances on hot rolled bars shall comply with those of Grade 2 of IS:3739: Dimensional Tolerances for Carbon and Alloy Constructional Steel Products, reproduced below:**5.2.2.1 Round and Square Bars:**

Nominal Size mm		Tolerances, mm	
Over	Up to & Including	Permissible deviation	Out of round / square
--	25	± 0.50	0.50
25	50	± 0.75	0.75
50	80	± 1.00	1.00
80	100	± 1.25	1.25
> 100		± 1.6% of diameter or width of side	75 % of total tolerance (+ and -)

5.2.2 Straightness:

Unless otherwise agreed to the permissible deviation in straightness shall not exceed 5 mm in any 1 metre length.

6.0 MANUFACTURE

Material shall be manufactured from fully killed steel.

7.0 HEAT TREATMENT

The bars shall be normalised at a temperature of 860-890 °C.

8.0 FREEDOM FROM DEFECTS

The bars shall be sound, straight and free from internal and surface defects, such as seams, laps, cracks or any other defects which may impair the end use.

Bars shall be free from twists and bends.



CORPORATE PURCHASE SPECIFICATION

AA 102 13

Rev. No. 07

PAGE 3 OF 4

9.0 CHEMICAL COMPOSITION

The melt analysis of steel and the permissible variation in the composition of the material from the melt analysis shall be as follows:

Element	Melt analysis, percent,		Permissible variation, percent,
	Min.	Max.	
Carbon	0.25	0.35	± 0.02
Silicon	0.10	0.35	± 0.03
Manganese	0.60	0.90	± 0.04
Sulphur	---	0.035	+ 0.005
Phosphorus	---	0.035	+ 0.005

10.0 TEST SAMPLES :

10.1 One sample shall be taken from each melt for chemical analysis.

10.2 One sample shall be taken from each heat treatment batch for testing of mechanical properties. Test pieces for mechanical tests shall be taken in the longitudinal direction of the piece.

For ruling section up to and including 40mm, the test piece shall be machined coaxially from the test bars. For ruling section above 40mm the longitudinal axis shall be atleast 12.5 mm from surface of the test bars.

Test methods for determining mechanical properties shall be as per IS:1608 (For tensile test).

10.3 For ruling section above 200mm, tensile test samples can be taken in tangential or transverse direction.

11.0 MECHANICAL PROPERTIES (IN NORMALISED CONDITION):

Mechanical properties of the material shall be as follows:

Tensile strength	: 500 - 600 N/mm ²
Yield strength	: 275 N/mm ² , min
% of elongation	: 21%, min.

12.0 ULTRASONIC TEST :

Each bar above 100 mm shall be tested ultrasonically in accordance with BHEL standard AA 085 01 18 to ensure freedom from internal defects.

The norms of acceptance shall be as per category 2 of the above standard.



13.0 TEST CERTIFICATES

Three copies of test certificates shall be supplied, unless otherwise stated on the order.

In addition, the supplier shall ensure to enclose one copy of the test certificate along with their despatch documents to facilitate quick clearance of the material.

The test certificate shall bear the following information :

AA 102 13; Rev. No. 07

BHEL order No,

Supplier's Reference :

Name

Identification No.

Melt No.

Details of heat treatment.

Results of Tests :

Results of Dimensional inspection.

Results of chemical analysis, mechanical tests & Ultrasonic test.

14.0 PACKING AND MARKING :

The material shall be suitably packed in bundles-hessian wrapped to prevent sagging, corrosion and damage during transit. A suitable clear temporary rust preventive shall be applied on all the bars.

Each bar of 50 mm & above shall be stamped with AA 102 13, melt no, BHEL order no, at one end or on the end face.

Bars below 50mm shall be bundled together and tied with wire at 3 to 4 places along the length of the bars.

A metal label shall be securely attached to each bundle and shall bear the following information :

AA 102 13 : Hot Rolled / Forged Medium Carbon Steel Bars, 30C8-Normalised.

BHEL Order No.

Consignment/Identification No.

Melt No.

Size and Weight.

Supplier's Name.

15.0 REFERRED STANDARDS (Latest Publications Including amendments):

1. IS : 1570 Part II
2. I S:1608
3. IS : 3739
4. AA 085 01 18



PLANT PURCHASING SPECIFICATION HYDERABAD

HY10995

REV. NO. 04

PAGE 1 OF 5

ELECTROSLAG REFINED, STAINLESS STEEL BARS, ANNEALED (GR : V X 12 Cr 13)

1.0 GENERAL:

This specification governs the quality requirements of ESR processed stainless steel bars of grade VX 12 Cr 13, in annealed condition.

2.0 APPLICATION :

These bars are used for the manufacture of open upset forgings meant for welded type impellers of centrifugal compressors.

3.0 CONDITION OF DELIVERY :

The bars shall be supplied in hot rolled/forged and annealed condition.

4.0 COMPLIANCE WITH NATIONAL STANDARDS:

The bars shall in general comply with UNI-6900, X 12 Cr 13, with the following specific/additional requirements.

5.0 DIMENSIONS AND TOLERANCES:

5.1 Dimensions: The dimensions shall be as specified in the order. Unless otherwise specified in the order, the hot rolled bars shall be supplied in random lengths of 3 to 6 meters with a maximum of 10% shorts down to 1 meter. Forged bars shall be supplied in random lengths of 1.5 to 3.0 meters.

5.2 Tolerances: The tolerances on cross sectional dimension shall be as follows.

5.2.1 Hot Rolled Bars :

Size (mm)		Tolerance (mm)
Over	Upto & including	
--	25	± 0.50
25	50	± 0.75
50	80	± 1.00
80	100	± 1.25
100	125	± 1.50
125	150	± 2.00
150	-	± 1.60 % of size

5.2.2 Forged Bars : + 8 mm on size
- 0.0 mm

Revisions:

Upgradation of the technical requirement.
Modified clauses 1.0, 6.0, 8.0 & 12.0

Issued :

STANDARDS ENGINEERING DEPARTMENT

Rev. No. 04

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Dt.

Year:

MATLS. ENGG.

SR.DGM
(E&CC)

OCT, '90

HY10995	PLANT PURCHASING SPECIFICATION HYDERABAD	
REV. NO.04		
PAGE 2 OF 5		

6.0 **MANUFACTURE:**

- 6.1 The steel used shall be fully killed and shall be manufactured from basic electric furnace and shall subsequently be refined through ESR process. Any other process of steel melting and refining shall be mutually agreed upon.
- 6.2 The actual gas content shall be analysed and reported. The hydrogen content shall be less than 1.5 PPM.
- 6.3 Sufficient discard shall be given from top and bottom of the ingot to ensure freedom from piping, segregation and other injurious defects.
- 6.4 Bars shall be made after giving sufficient reduction to each ingot ensuring that the cast structure is completely broken into fine grain structure. The reduction ratio shall not be less than 4:1 from ingots.

7.0 **HEAT TREATMENT:**

Bars shall be supplied in annealed condition. However, test samples shall be subjected to the following suggested heat treatment.

Hardening: Heating to 970 - 1000°C and quenching in oil/air.

Tempering: Heating to not less than 600°C, soaking for 3 hours and cooling in air.

The details of actual heat treatment cycle followed by the supplier shall be furnished in the test report.

8.0 **SURFACE FINISH:**

- 8.1 The surface finish of the bars shall be smooth without any laps, rolled in scales, pit marks etc. Dents, roll marks and scratches are permitted provided their depth does not exceed half the tolerance limits.
- 8.2 The edges of bars shall be cut square by sawing or shearing and no crop ends shall be permissible.

9.0 **FREEDOM FROM DEFECTS:**

Bars shall be sound and free from any cracks, flakes, cavities, tears, laps and other harmful defects. The bars shall be free from internal defects such as shrinkage, porosity, pipes etc.

10.0 **CHEMICAL COMPOSITION:**

The Steel shall conform to the following Chemical Composition.

Element		C	Si	Mn	Cr	Ni	S	P	S+P	H ₂
Ladle Analysis	Min.	0.09	-	-	11.5	-	-	-	-	-
	Max.	0.15	1.0	1.0	14.0	1.0	0.020	0.020	0.035	1.50 PPM
Variation in product analysis		±0.01	+0.05	+0.03	±0.15	+0.03	+0.003	+0.003	-	-



PLANT PURCHASING SPECIFICATION HYDERABAD

HY10995

REV. NO.04

PAGE 3 OF 5

11.0 TEST SAMPLES:

One test sample for chemical analysis shall be taken from a bar representing each melt. Test samples shall be heat treated according to clause -7, before mechanical testing. Supplier has got the option of upsetting the test coupon to further 1.5 reduction ratio before heat treatment for the bars of sizes above 200 mm diameter.

12.0 MECHANICAL PROPERTIES:

12.1 Test samples shall be taken from heat treated test coupon in tangential direction for each melt and shall meet the following mechanical properties. The values obtained shall be reported in test certificate.

Tensile strength N/mm ² (Kgf/mm ²)	0.2% Proof Stress N/mm ² (Kgf/mm ²)	Elongation % min. $L = \sqrt{5.65} S_0$	Impact Strength , min. (5mm 'U' notch) J (Kgf/Cm ²) at room temperature
930 max. (95 max.)	640-740 (65-75)	14	20 (4)

NOTE: 1) The tensile tests shall be performed as per IS:1608 or any reputed National Standard.

2) The charpy Impact test shall be performed on a 5mm 'U' notch in accordance with IS:1757 or any reputed National Standard.


The minimum Impact strength value specified above is the average of three samples at the same location. Only one value can be lower than the minimum specified value, but not less than 2/3rd of the minimum specified value. All the three values shall be reported in test certificate.

12.2 **Hardness:** 10% of the bars or 10 bars minimum (whichever is higher) in annealed condition shall be tested for hardness. Hardness shall be less than 208 BHN. The hardness values for the tested bars shall be reported in test certificate.

13.0 NON-DESTRUCTIVE TEST:

13.1 Ultrasonic Test:

The bars shall be subjected to ultrasonic testing as per ASTM A 388 (BHEL Standard AA 0850118) and following shall be the unacceptable defects (category-1 of AA0850118 is acceptable).

HY10995	PLANT PURCHASING SPECIFICATION HYDERABAD	
REV. NO.04		
PAGE 4 OF 5		

i)

Cracks, Flakes, Seams & Laps.

ii)

Defects giving indication larger than that from a 2mm diameter equivalent flaw.

iii)

Group of defects with maximum indication less than that from a 2 mm diameter equivalent flaw which cannot be separated at testing sensitivity if the back echo is reduced to less than 70%.

iv)

Defects giving indication of 1 to 2mm diameter equivalent flaws & separated by a distance less than four times the size of the larger of the adjacent flaws.

14.0

NON METALLIC INCLUSIONS:

The inclusion rating number of the steel for all types, namely A,B, C & D shall not be greater than 2 (thin series) and 0.5 (thick series) as per ASTM E45 plate III.

15.0

RETESTS:

If any of the selected test samples fail to meet the specified requirements due to some mechanical reasons, another specimen may be taken.

In the event of failure due to heat treatment, not more than two reheat treatments may be carried out. However, retempering is not considered as reheat treatment.

16.0

INSPECTION AT SUPPLIER’S WORKS:

16.1

BHEL representative/BHEL appointed Inspection Agency shall have free entry and access to all areas where the manufacture of the bars is carried out. All reasonable facilities shall be extended to him including labour wherever necessary.

16.2

BHEL representative/BHEL appointed Inspection Agency shall be given sufficient advance intimation to witness the various processes, tests, etc., punching and identification of test coupons and execution of various tests shall be done in presence of BHEL representative/BHEL appointed Inspection Agency.

16.3

Unless otherwise indicated in the enquiry, Llyods shall be the BHEL representative for inspection activities mentioned at 16.1 and 16.2.



**PLANT PURCHASING
SPECIFICATION
HYDERABAD**

HY10995

REV. NO.04

PAGE 5 OF 5

17.0 TEST CERTIFICATE:

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

- a) BHEL Specification No. HY 10995 Rev.04
- b) BHEL Order No.:
- c) Melt No. / Size
- d) Process of manufacture.
- e) Results of Chemical Analysis
- f) Results of Mechanical Tests
- g) Results of hardness test on bars.
- h) Results of NDT
- i) Inclusion content of steel.
- j) Details of heat treatment cycles along with HT charts duly endorsed by BHEL / BHEL appointed Inspection Agency.

17.2 The test certificates shall be signed by the chief of inspection / chief metallurgist of the Supplier and shall be attested by BHEL representative / BHEL appointed inspection agency.

18.0 MARKING AND PACKING:

18.1 The following details shall be legibly stamped on each bar on one of the end face.

- a) HY 10995 / Rev.04
- b) Manufacturer's Mark.
- c) Melt No./ size.
- d) BHEL Inspector's/BHEL appointed Inspection Agency's Stamp.

18.2 The bars shall be suitably protected from damage during transport.

19.0 REJECTION AND REPLACEMENT:

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

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