



**PLANT PURCHASING
SPECIFICATION
HYDERABAD**

HY 107 98

REV. NO: 02

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**VACUUM DEGASSED STAINLESS STEEL PROFILE BARS
FOR STEAM TURBINE BLADES, HARDENED & TEMPERED**

(Gr: V-X20CrMo13V)

1.0 GENERAL:

This specification governs the requirements of vacuum degassed, hardened and tempered stainless steel drawn profile bars of grade V-X20CrMo13V for steam turbine blades.

2.0 APPLICATION :

For the manufacture of steam turbine guide blades suitable for operation upto 535°C.

3.0 CONDITION OF DELIVERY :

The bars shall be supplied in hardened & tempered, cold drawn and finally stress relief annealed condition.

4.0 DIMENSIONS AND TOLERANCES:

4.1 Dimensions: The dimensions shall be as specified in the drawing/order; Unless otherwise specified in the order, the profile bars shall be supplied in lengths of 3 to 4 metres.

4.2 Tolerances: The tolerances on dimensions, Straightness and twist for different types of profiles shall be as indicated below:

- | | | | |
|-------------|-----|---|----------------------|
| a) Annexure | I | - | Profile T1 |
| b) Annexure | II | - | Profiles T2 & T3 |
| c) Annexure | III | - | Profiles T4, T6 & T7 |

5.0 MANUFACTURE:

The steel used in the manufacture of the profile bars shall be produced by Electric furnace process and shall be fully killed and subsequently vacuum degassed. Sufficient discard shall be made in the ingot to ensure purity of the steel.

Revisions: 1) Tolerances modified MPI included.
2) Annexure-III modified.

Issued :

**STANDARDS
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6.0 HEAT TREATMENT:

The recommended heat treatment cycle shall be as follows:

Harden in oil or air at 1000-1050°C

Temper at 650-700°C & cool in air

However, the supplier may select suitable heat treatment schedule to achieve the specified mechanical properties. But, tempering in no case shall be performed below 650°C and cooling from tempering temperature shall be done slow enough to minimise residual stresses. The details of the actual heat treatment cycle followed shall be furnished in the test certificate.

7.0 FREEDOM FROM DEFECTS:

The profile bars shall be free from decarburization cracks, laps, lamination and other harmful defects.

8.0 FINISH:

The surface shall be smooth, clean and bright, without any dents, scratches or roll marks. Cleaning of the surfaces by grinding, after heat treatment is permissible, however within the limits of tolerances.

9.0 CHEMICAL COMPOSITION:

The analysis of the material shall be as follows:

Element	C	Si	Mn	Cr	Mo	Ni	P	S
% min.	0.17	0.10	0.30	12.0	0.80	-	-	-
% max.	0.22	0.50	0.80	13.0	1.20	0.80	0.030	0.02

10.0 TEST SAMPLES:

10.1 For chemical Analysis: One sample bar from each melt, taken at random shall be subjected to check analysis.

10.2 For Mechanical Tests: Profile bars of the same size shall be grouped into lots belonging to the same melt and heat treatment batch.

All the bars constituting a lot shall be tested for hardness. The softest and hardest bars, identified by the hardness test, shall be taken up for tensile and impact tests.

NOTE: When the profile dimensions are such as not to allow for the preparation of Impact Specimens, the impact testing shall be performed on a separate bar which undergoes similar



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Degree of working. In such cases the sample test piece shall be heat treated along with the batch it represents.

11.0 MECHANICAL PROPERTIES:

The mechanical properties of the sample in longitudinal direction, at room temperature shall be as follows:

Tensile strength, max	:	930 N/mm ² (95 kgf/mm ²)
yield strength, min.	:	590-740 N/mm ² (60-75 kgf/mm ²)
Elongation, min(l=5d)	:	15%
Reduction in area, min	:	50%
Impact strength, min	:	27J (4 kgm/cm ²)
Hardness (BHN)		240-280

NOTE: 1): The tensile test shall be carried out in accordance with IS:1608 or any reputed National Standard. The test specimens cut from the sample bars shall be so tested as to subject as far as practicable, the complete cross section of the profile to tension. The cross sectional area of the profile can be noted from the corresponding drawing supplied.

2) The charpy Impact test shall be performed in accordance with IS:1499 or any reputed National Standard. The specimen size shall be 10x10x55mm with a 3mm deep U-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.

12.0 RETEST:

If any of the test specimen fails to meet the mechanical property requirements, the sample bar from which the test specimen was cut shall be rejected and two further sample bars from the same test unit, close in hardness to the rejected bar shall be selected for retest.

If the retesting as said above fails, manufacturer is at liberty to heat treat the profile bars in question. However not more than two reheat treatments are allowed.



If after all the three trails of heat treatment, the mechanical properties specified are not complied with, all the bars of the concerned test unit shall be rejected.

13.0 HIGH TEMPERATURE PROPERTIES:

The following elevated Temperature Yield properties shall be guaranteed by the supplier.

Temp °C	o.2% Proof stress, min. N/mm ² (Kgf/mm ²)	
200	400	(41)
250	382	(39)
300	365	(37)
350	335	(34)
400	305	(31)

14.0 NON-DESTRUCTIVE TESTS:

Each profile bar shall be subjected to Magnetic particle Examination as per ASTM: A275 and no crack shall be acceptable.

15.0 METALLOGRAPHIC TESTS:

15.1 Microstructure: The microstructure shall be studied on the factured tensile specimen at x100 and photo micrographs shall be furnished to B.H.E.L. The microstructure shall have a uniform tempered martensite, structure with grain size ASTM E112 No.5 or finer. Average deltaferrite shall not exceed 5%.

15.2 Non-Metallic Inclusions: The sample for testing shall be taken on a longitudinal plane, located midway between the centre and the surface of the bar. The rating of inclusions shall be based upon average length of inclusion, the longest inclusion and the general background. When tested as per ASTM E45, plate 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.



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15.3 Mixup Test: Each profile bar shall be tested by any spectrochemical or eddy current methods to detect any mix-up of materials and to ensure that bars to this specification only are supplied.

16.0 DIMENSIONAL INSPECTION:

Each profile bar shall be inspected for the accuracies of dimensions, profile and straight ness.

17.0 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 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 this specification.

18.0 TEST CERTIFICATE:

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

- a) BHEL Order No.
- b) BHEL Specification No. HY 107 98
- c) Material Grade: V-x20CrMo13V
- d) Name of supplier
- e) Profile No./Drawing No.
- f) Melt No.
- g) Process of manufacture
- h) Heat treatment batch No. and details of heat treatment.
- i) Results of chemical analysis and mechanical tests (C1.9 & 11)
- j) Results of metallographic test with representative photomicrograph X 100 (c1.13)
- k) Guarantee for high temperature properties (c1.13)

19.0 PACKING AND MARKING:

19.1 Marking: The Factory Mark, Melt No. and the profile Identification No. (or Drawing No.) shall be marked on each and every bar.



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Profile bars of same section, belonging to the same melt and heat treatment batch shall be suitably bundled and a metal lable bearing the following information shall be securely attached to each bundle.

- a) BHEL Order No.
- b) Specification No.HY107 98
- c) Melt No. & Heat treatment batch No.
- d) Profile No. & Weight.
- e) Supplier's Trade Mark

19.2 Packing: The bundles covering the profile 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.



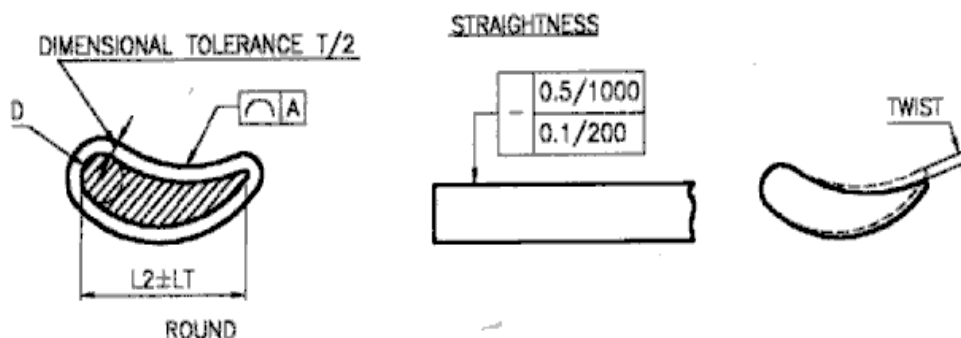
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ANNEXURE-I DIMENSIONAL TOLERANCES FOR PROFILE T1

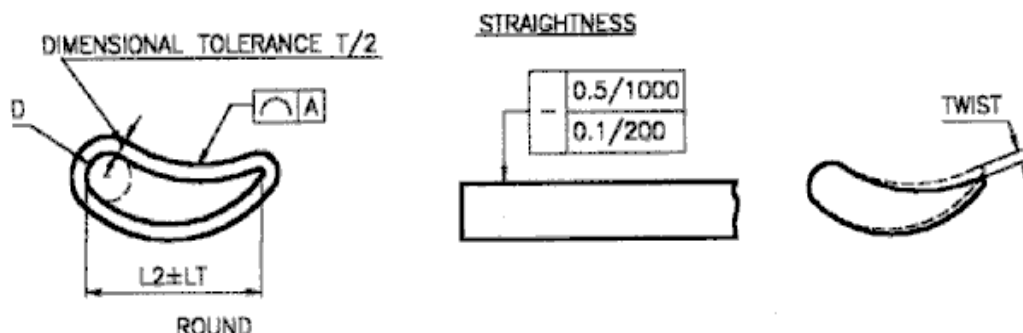


TWIST: MAX. PERMISSIBLE TWISTING IN THE SECTION PERPENDICULAR
TO THE AXIS OF BAR SHALL BE 0.5mm PER METRE LENGTH

ALL DIMENSIONS IN 'mm'

Profile size	D	T	L2	LT	A	PROFILE CO-ORD DRG. NOS 4-301-76-00015-00 AND
T1-12.5	3.47	+0.05	12.72	0.08	0.03	4-301-76-00001-00
T1-16	4.442	+0.05	16.282	0.10	0.03	4-301-76-00002-00
T1-20	5.552	+0.05	20.352	0.13	0.03	4-301-76-00003-00
T1-22.5	6.246	+0.08	22.896	0.13	0.036	4-301-76-00021-00
T1-25	6.942	+0.08	25.44	0.15	0.036	4-301-76-00004-00
T1-28	7.773	+0.08	28.493	0.15	0.036	4-301-76-00022-00
T1-32	8.883	+0.08	32.563	0.15	0.036	4-301-76-00005-00
T1-36	9.993	+0.08	36.633	0.15	0.07	4-301-76-00023-00
T1-40	11.104	+0.10	40.704	0.15	0.07	4-301-76-00006-00
T1-45	12.492	+0.10	45.792	0.15	0.07	4-301-76-00007-00
T1-50	13.88	+0.10	50.88	0.15	0.07	4-301-76-00008-00
T1-56	15.546	+0.10	56.986	0.15	0.07	4-301-76-00009-00
T1-63	17.489	+0.10	64.109	0.15	0.07	4-301-76-00010-00
T1-71	19.71	+0.12	72.25	0.15	0.084	4-301-76-00011-00
T1-80	22.208	+0.12	81.408	0.15	0.084	4-301-76-00012-00
T1-90	24.984	+0.12	91.584	0.15	0.084	4-301-76-00013-00
T1-100	27.76	+0.12	101.76	0.15	0.084	4-301-76-00014-00

ANNEXURE-II DIMENSIONAL TOLERANCES FOR PROFILE T2&T3



TWIST: MAX, PERMISSIBLE TWISTING IN THE SECTION PERPENDICULAR TO THE AXIS OF BAR SHALL BE 0.5mm PER METRE LENGTH.
ALL DIMENSIONS IN 'mm'

Profile size	D	T	L2	LT	A	PROFILE CO-ORD DRG. NOS 4-301-76-00017-00 AND
T2-16	6.05	+0.08	16.97	0.10	0.036	4-301-11-00062-00
T2-20	7.56	+0.10	21.22	0.13	0.036	4-301-11-00061-00
T2-25	9.45	+0.10	26.52	0.15	0.058	4-301-11-00060-00
T2-32	12.10	+0.10	33.95	0.15	0.07	4-306-48-00042-00
T2-40	15.12	+0.10	42.44	0.15	0.07	4-301-11-00058-00
T2-50	18.90	+0.10	53.05	0.15	0.084	4-301-11-00063-00
T2-64	24.19	+0.10	67.90	0.15	0.084	4-301-76-00018-00
T2-80	30.24	+0.12	84.87	0.15	0.10	4-301-76-00019-00

Profile size	D	T	L2	LT	A	PROFILE CO-ORD DRG. NOS 4-301-75-00020-00 AND
T3-12.5	4.918	+0.05	13.317	0.08	0.03	4-301-75-00010-00
T3-16	6.295	+0.08	17.046	0.10	0.036	4-301-75-00011-00
T3-20	7.869	+0.10	21.307	0.13	0.036	4-301-75-00012-00
T3-25	9.836	+0.10	26.634	0.15	0.058	4-301-75-00013-00
T3-32	12.59	+0.10	34.09	0.15	0.07	4-301-75-00014-00
T3-40	15.738	+0.10	42.614	0.15	0.07	4-301-75-00015-00
T3-50	19.672	+0.10	53.268	0.15	0.084	4-301-75-00016-00
T3-63	24.787	+0.10	67.118	0.15	0.084	4-301-75-00017-00
T3-80	31.476	+0.12	85.228	0.15	0.1	4-301-75-00018-00
T3-100	39.344	+0.12	106.536	0.15	0.1	4-301-75-00019-00



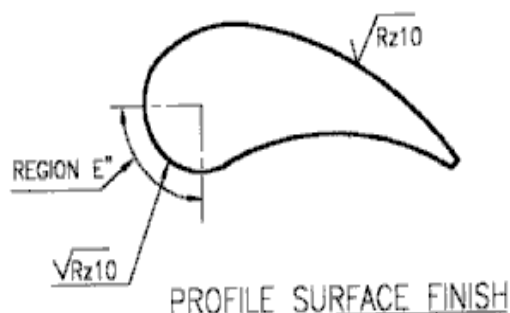
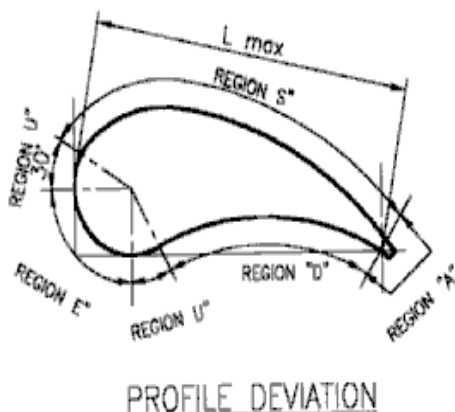
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ANNEXURE-III DIMENSIONAL TOLERANCES FOR PROFILE T7,T6&T4



Profile size	THICKNESS		LENGTH		PROFILE DEV.IN REGIONS			PRO. COORD. DRG. NOS. 4-301-75-00164-00
	Dm	Allo. Dev.	Lmax	Allo. Dev.	D,S	E	A	
T7-12.5	5.00	+0.10	13.68	+0.25	+0.05	-0.10	+0.20	4-301-75-00190-00
T6-16	6.41	+0.10	17.52	+0.25	+0.05	-0.10	+0.20	4-301-75-00189-00
T4-20	8.01	+0.12	21.91	+0.26	+0.06	-0.12	+0.20	4-301-75-00166-00
T4-25	10.02	+0.14	27.38	+0.32	+0.07	-0.14	+0.25	4-301-75-00167-00
T4-32	12.82	+0.16	35.05	+0.38	+0.08	-0.16	+0.30	4-301-75-00168-00
T4-40	16.03	+0.18	43.81	+0.49	+0.09	-0.18	+0.40	4-301-75-00170-00
T4-50	20.03	+0.20	54.76	+0.50	+0.10	-0.20	+0.40	4-301-75-00172-00

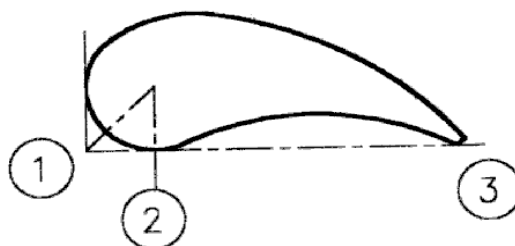
PROFILE STRAIGHTNESS

FOR CHECKING THE PROFILE STRAIGHTNESS
THE PROFILE IS TO BE KEPT ON A HORIZONTAL
MEASURING TABLE AS SHOWN IN FIG.1
THE AIR GAPS AT POINTS 1,2&3 ARE TO BE
CHECKED WITH FEELER GAUGES.

THE MAX PERMISSIBLE VALUE

$$H=0.001 \times L$$

H IS GAP AND
L IS LENGTH OF PROFILE BAR



PROFILE SURFACE FINISH

FIG. 1

RESTRICTED USE

