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EOI No.: PPX-BHEL/FLAT BLADE BAR & FLAT NIMONIC BAR MATERIAL/EOI/23-24

Due Date: 20.05.2023

Notice for Expression of Interest (EOI) for empanelment of New Vendors

The Heavy Electrical Equipment Plant (HEEP) located in Haridwar, is one of the major manufacturing plants of BHEL. The core business of HEEP includes design and manufacture of large size steam and gas turbines, turbo generators, heat exchangers, condensers and auxiliaries.

We are looking for reputed vendors having capability to manufacture & supply of flat blade bar material & flat blade Nimonic bar material for Steam Turbine application.

Prospective suppliers may submit their offers for the EOIs.

Contact persons:

Mr. Ravi Kumar

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Designation: Sr. Manager (PPX - T)

Email: jgauri@bhel.in

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The offers received will be technically evaluated by BHEL & successful short listed parties will be asked to submit their detailed Techno-Commercial offers through formal NIT/Enquiry for our future requirements. Vendors shall confirm that there is no deviation with respect to BHEL Specifications. However, deviations, if any are to be listed as a separate attachment. The offers that do not meet the substantial requirements of our specifications are liable to be ignored.



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Following documents are to be necessarily filled and submitted along with the technical offer:

- 1. Details/Documents in support of Specification/PQR (Annexure-PQR).
- Supplier/Vendor Registration Form Go through online supplier registration portal https://supplier.bhel.in/. After filling the online registration form send the copy of same along with your offer within due date.
- 3. Details of Manufacturing Facility.
- 4. Company Profile.
- 5. Past experience along with documentary proof.

Only Technical BID along with the documents mentioned above should be sent and the envelope containing the offer shall be duly sealed and super scribed as "Technical Bid for manufacture & supply of 'flat blade bar material & flat blade Nimonic bar material for Steam Turbine application against 'BHEL EOI No. PPX-BHEL/FLAT BLADE BAR & FLAT NIMONIC BAR MATERIAL/EOI/23-24 Due Date - 20.05.2023, submitted by (Name of company)".

- This notification shall be published on www.hwr.bhel.com, www.bhel.com & www.eprocure.gov.in
- Last date for downloading tender documents shall be 11.05.2023 till 1700 Hrs.(IST). EOIs received up to 13:45 Hrs. (IST) on 20.05.2023 will be considered and opened on the same day at 14:00 Hrs. (IST).
- Technical Offers complete in all respect must be addressed to "Sr. DGM (PPX & AIX-T)".
- EMD & Tender fee are not applicable.
- The Quotation should be from the Principal/Original Manufacturer, failing which the quotation is likely to be ignored. In Case the quotation is submitted through agent, the quotation must accompany original authorization letter.
- BHEL will not be responsible for any type of postal delay / incomplete information from vendor.
- Amendments / Corrigendum, if any, will be hosted on our web site only.
- Specifications attached herewith.
- Vendors submitting their bids through e-mail may be advised to have following clear subject line:

1.	EOI/	Γender	Enc	luiry	Reference	No	
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2.	Bid opening Date	(Techno-commercial)	

Vendor to submit their bids as attachment (pdf format) with password protection and share the password through mail (tendercell.heep@bhel.in) after 1:45 PM (IST) on the day of bid opening, however, if no password is received up to 4:00 PM (IST) bids will not be opened and will be ignored. Submission of bids through email shall be considered as consent to open the bid without physically witnessing the event.

For any further details, please log on to www.hwr.bhel.com, www.bhel.com & www.eprocure.gov.in.



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Annexure-PQR

Expression of Interest

Item Required: Rectangular flat bars

Material Grade: X20Cr13, X22CrMoV121, X19CrMoVNbN11-1, X12CrMoWVNbN10-1-1, X13CrMoCoVNbNB9-2-

1 (ESR Grade)

1. Rectangular flat bars of above-mentioned material grade are used for manufacturing of milled blades for Steam Turbines of rating 250 to 800MW.

- Flat bars are to be manufactured and supplied as rolled/forged & heat-treated condition as per respective specification. Vendor to furnish in house manufacturing facility for steel melting, secondary refining including Electro Slag re-melting (if available), rolling / forging, heat treatment and straightening to manufacture rectangular bars.
- 3. Vendor to furnish in house testing facilities to carry out testing as per the requirements of BHEL specification. In case of outsourcing of any test, vendor has to inform BHEL and agree to carry out testing at Government accredited labs only.
- 4. Vendor to submit their manufacturing experience of flats in material grade X20Cr13 / X22CrMoV121 / X19CrMoVNbN11-1 / X12CrMoWVNbN10-1-1 in rectangular cross-sectional sizes (width X thickness e.g. 46mmx27mm, 143x83 mm etc.) with length 3000 6000mm.

Test certificates of past supplies (if available) for above material grades, to be submitted.



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Expression of Interest

Item Required: Rectangular flat bars

Material Grade: NiCr20TiAl

- Vendor should have experience for manufacturing of flats in material grade NiCr20TiAl or other Nickel based precipitation hardened flat bar in rectangular cross-sectional sizes (width X thickness e.g. 64X29, 60X26, 62X28mm etc.). Test certificates of past supplies (if available) for above material grades, to be submitted.
- Flat bars are to be manufactured and supplied as rolled/forged & heat-treated condition as per respective specification.
- 3. Manufacturing facility required to manufacture flat bar of NiCr20TiAl are as follows:
 - Vacuum Induction melting
 - Electro Slag remelting / Vacuum Arc remelting
 - Rolling / Forging of ingot
 - Heat Treatment

Vendor to furnish above in-house manufacturing facility. In case of outsourcing of any operation, vendor to inform operation outsourced with their source details.

 Testing facility required are – Mechanical Testing, Non-destructive testing, Metallography and Creep. Vendor to furnish in house testing facilities to carry out above testing. Outsourcing of test at NABL approved labs are also permitted.

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PLANT PURCHASE SPECIFICATION

(HEEP - HARIDWAR)

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HEAT RESISTANT STEEL BARS FOR TURBINE BLADES, GRADE: X13CrMoCoVNbNB9-2-1 (FB2)

This specification governs the quality of Steel rectangular bars in steel grade X13CrMoCoVNbNB9-2-1 (FB2). Material as per TLV9265 04 Oct'2014 from Collaborators approved supplier is also acceptable.

For machined/milled blades for Steam Turbine.

3.0 Condition of Delivery:

Rolled or Forged and Heat Treated.

4.0 Dimension and Tolerances:

Dimensional tolerance, straightness, twisting and bulging limits shall be as per HW0993008.

5.0 Manufacture:

Electro slag re-melted steel (ESR) shall be used.

The manufacturing process must ensure a homogenous grain structure over the entire length of the bar and the bar cross section.

6.0 General Requirements:

- Prerequisite requirement for approval of a new vendor (other than Collaborator approved vendor) is a successful Process qualification. Manufacturing process established during this shall be the basis for future manufacture.
- Manufacturing plan shall be prepared and submitted after successful process qualification. Manufacturing plan shall include specific information on manufacturing like rolling temperature, reduction ratio, heat treatment temperature, hardening method and soaking time, rate of heating and cooling etc. Test instructions for nondestructive and destructive testing are to be provided in the manufacturing and testing plan.
- Product and process qualification is mandatory for each of the suppliers manufacturing plants.
- For new supplier (other than Collaborator approved vendor), process qualification shall be required for three purchase orders.
- If necessary, BHEL may ask for process qualification for verification of manufacturing reliability from regular suppliers also.
- Any change in the agreed manufacturing plan shall be informed to BHEL. BHEL will review the requirement of renewed process qualification.

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7.0 **Heat Treatment:**

Hardening:

Hardening temperature shall be 1100°C (air or liquid quenching, cooled down to a temperature < 100°C in the center of the bar)

Tempering:

A two-step tempering treatment must be performed as follows:

- The first tempering must be carried out at a temperature of 570°C and holding time of ≥ 4h. Air has to be used for cooling.
- Temperature of second tempering step has to be ≥ 690°C.

A fully transformed and tempered martensitic microstructure must be present over the entire cross section.

Hardening and tempering in bundles are not allowed. Suitable gaps between two bars are to be ensured during heat treatment for uniformity of properties.

If bars need to be straightened after the heat treatment, a stress relieving heat treatment shall be performed after completion of entire straightening process. Stress relieving is to be carried out at 20 30°C below the tempering temperature with a subsequent slow cooling rate.

The lowest possible residual stresses shall be targeted. Distortion of the finish machined part due to residual stresses from the manufacturing process or heat treatment process shall not occur.

Properties and their verification: 8.0

8.1 Chemical Composition:

Heat analysis in weight %

С	Si	Mn	P	S	Cr	Мо
0.12 - 0.15	≤ 0.10	0.30 - 0.50	≤ 0.010	≤ 0.005	9.0 - 9.4	1.40 - 1.60
Ni	Co	V	Nb	N	Al	В
0.10 - 0.20	0.90 - 1.30	0.15 - 0.25	0.040 - 0.060	0.015 - 0.030	≤ 0.010	80 – 110 ppm

Trace element content for Ti, Cu, As, Sb and Sn must be specified in the inspection certificate for information purposes.

8.2 Properties and Microstructure:

The specimens shall be taken in the longitudinal direction in accordance with Attachment 1. The properties described below shall be determined at room temperature in the delivery condition, i. e. after the last heat treatment including any stress relieving heat treatment.

The metallographic investigations shall be performed on the hardest and softest bar with an area of at least 320mm² each. The areas to be investigated must be in the longitudinal direction. The longitudinal direction must be indicated in the documentation.

8.2.1 Mechanical Properties:

Hardness of the bars in a test unit shall be verified by Brinell hardness testing in accordance with ISO 6506 -1, HBW10/3000 or HBW 5/750 may be used.

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PLANT PURCHASE SPECIFICATION

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(HEEP - HARIDWAR)

The surface of the bar shall be prepared in the area of the hardness measurement so that the result is not affected by the surface condition.

Hardness testing shall be performed on 10% of each test unit but at least on 10 bars or on each bar if test unit is less than 10 bars. The greatest resulting difference in hardness shall not exceed 35HBW.

Mechanical properties shall be determined on the hardest and softest bar determined in a test unit.

The requisite properties are to be maintained over the entire cross section of the bar, where the difference between strength values (0.2% Proof Stress and Tensile Strength) shall not be more than 7.5% of respective maximum.

Tensile testing shall be performed in accordance with ISO 6892 -1 or ASTM E8M (round specimen with L₀ = 50mm and d_0 = 10mm) or ASTM E8M (standard specimen in accordance with Figure 8).

Standard specimens Charpy (V-notch) in accordance with ISO 148 -1 shall be used for determining the absorbed impact energy.

The following properties must be achieved at room temperature:

0.2 % Proof Stress (N/mm²)	Tensile Strength (N/mm²)	Elongation After Fracture (%)	Reduction in area %	Impact Energy (J) ¹	Hardness HBW
730 - 830	870 - 970	≥ 14	≥ 50	≥ 40	270 - 310

¹ Average of 3 specimens and minimum value for two specimens in accordance with EN10021, where the lowest value shall be at least 30 Joule.

Additionally, on the softest bar a tensile test in accordance with ISO 6892 - 2 has to be performed (in longitudinal direction) at 625°C. The following properties must be achieved:

0.2 % Proof Stress	Tensile Strength	Elongation After	Reduction in area
(N/mm²)	(N/mm²)	Fracture (%)	(%)
≥ 360	≥ 385	≥ 19	≥ 70

8.2.2 Microstructure:

Microstructure must be uniform, without porosity, excessive segregation or other inhomogeneities.

8.2.2.1 Cleanliness:

The cleanliness shall be determined as per DIN 50602 - K1. A minimum of 4 specimens per heat shall be used for determination of cleanliness.

Acceptance criteria:

Summary value K1: ≤ 2.0 (relating to 1000mm²)

8.2.2.2 Delta Ferrite content and grain size:

• Delta ferrite content shall be < 5%. The determination of delta ferrite content shall be performed based on analysis method in accordance with ASTM E45 method A, "Worst field method" with V=100:1.

Non-destructive Testing: 8.3

8.3.1 Test Scope:

The following Non – destructive inspections shall be performed in the as delivered condition:

- Visual inspections of all bars
- Ultrasonic examination of all bars in accordance with TWP 1204, 03/25.10.2012. 100% of the volume must be tested in accordance with the recording level.

निर्माणकर्ता WORKED BY	Ashish Ranjan	Alayan	26/5/18
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An average grain size of 3 or finer has to be achieved. Grain size shall be determined on the martensitic secondary grain structure in accordance with ASTM E112 or ISO643. A deviation of more than 2 grain sizes in size of individual's grains from the average grain size is not allowable.

8.3.2 Recording level and acceptance criteria:

- Indications of surface defects such as rolled marks shall be ground out to investigate their depth at least at both ends, in the middle of the indication and at an interval of approx. 250mm.
- Surface defects with a depth extension of ≥ 1mm are not allowable, and these areas shall be cut out of the bar.
- Ultrasonic examination and acceptance of all bars in accordance with TWP 1204.
- Defects above the recording level are not acceptable.
- It shall be confirmed in writing to the BHEL that bar sections containing defects above the recording level have been cut out of the bar.
- The acceptance of material at vendor's works does not relieve the supplier of his responsibility for defects discovered at later stages.

8.3.3 Material Identity Test:

An identity test must be conducted on 100% of bars in the as – delivered condition.

Process Qualification:

The following additional investigations shall be performed in process qualification (see Attachment 2):

- Tensile tests:

The strength values (0.2% Proof Stress and Tensile Strength) in the transverse direction (specimen orientation ZQ) shall not differ by more than 10% from the corresponding longitudinal values.

The smallest individual value for absorbed impact energy in transverse direction shall not be below 30J.

For case where standard specimens in transverse direction cannot be made: -

- For tensile test specimens, a round specimen with L₀ = 5 d₀ or a flat specimen with a proportionality factor of k= 5.65. Proportional specimens in accordance with Fig 8 shall be used if ASTM E8 is applied.
 - An undersized specimen in accordance with ISO 148 -1 for impact test specimen. Undersize dimension to be reported.
 - If dimension do not allow testing in the transverse direction, even with special specimen, testing will be carried out in the longitudinal direction only.
- FATT: Determination of FATT (fracture appearance transition temperature) in accordance with ASTM A370. The FATT should be preferably evaluated based on SEP 1670 (software). The test scope must include at least 10 specimens. FATT < 25°C is to be achieved.
- The fraction of Intergranular fracture shall be determined over the entire brittle fracture portion of the fracture surface of the impact test specimens tested at room temperature. The fraction of Intergranular fracture shall not exceed 10%. This test is not required for materials which indicate ≥90% ductile fracture at room temperature.
- Performance of MT testing by magnetic flux leakage method, alternating current phase shifted and a field strength of 20-65A/cm.

Distribution, type and size of grain structure in-homogeneities (e.g. segregation or delta ferrite) shall not result in MT indications.

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जांचकर्ता

WORKED BY

निर्माणकर्ता

Ashish Ranjan

Gopal

Krishnan

26/5/18

CHECKED BY

26/5/18

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A creep rupture test on the softest bar in accordance with ISO 204 with determination of creep limits is to be performed at 650°C with an initial stress of 150MPa. The following requirement has to be fulfilled:

Rupture Time > 500. The test has to be performed up to rupture.

Creep limits, creep rupture time, elongation after creep rupture and reduction of area after creep rupture have to be submitted.

BHEL will review all result and based on result HCF test may also be asked for qualification.

All test results shall be submitted to BHEL for approval.

10.0 Identification Marking:

All bars are to be marked with following information:

- Purchase Order Number
- Size
- Material Grade
- Supplier Identification

The details are to be clearly stamped and encircled by oil paint. Each bar shall be painted with a band of colour orange - blue - orange on both ends. All the bars shall be suitably packed to protect them against corrosion and damage during transportation.

Bars having maximum and minimum hardness (from which test samples are taken) shall be clearly marked by oil paint for easy identification. Their respective hardness values shall also be punched on these bars.

11.0 Documentation:

Prior to, but in no case later than the delivery of the material, an inspection certificate as per EN 10204 shall be provided to BHEL in duplicate; this certificate must contain the following data:

- (a) Material code no and P.O. number
- (b) Material designation
- (c) Heat no., heat analysis and melting methods
- (d) Complete information on all heat treatments performed
- (d) Mechanical test results including hardness range and the metallurgical examination.
- (e) Results of non-destructive tests, UT inspection report
- (f) Confirmation of the material identity check
- (g) Confirmation of the dimensions and visual inspection

12.0 Cross Referred Standard:

HW0993008, ISO 6506 -1, ISO 6892 - 1, ISO 6892 - 2, ASTM E8M, ISO 148 - 1, EN10021, ASTM E45, ASTM E112, ISO 643, DIN50602, TWP 1204, ASTM A370, EN10204

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	Process		hment 2, Page 2/2
Label	Specimen		
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निर्माणकर्ता Ashish Ranjan 26 जि हि जांचकर्ता CHECKED BY Krishnan

संस्थान क्रय विनिर्देश (हीप: हरिद्वार) HW10786 दिनाक एवं हस्ताक्षर SIGN & DATE भी एम ई एम PLANT PURCHASE SPECIFICATION पृष्ट (HEEP: HARIDWAR) Page SUPERSEDES INVENTORY NO. 13% Cr Stainless Steel Bars for Turbine Blades Dec'13 **GRADE: X20Cr13+QT800** TLV9238/01, 1.0 General: मंख्या को करता है This specification governs the quality of Steel rectangular bars in steel grade X20Cr13, material no. मामग्री मूची अधिक्रमित व 1.4021, EN10088-3. 2.0 Application: For machining of blades for Steam Turbine. of the company COPYRIGHT AND CONFIDENTIAL
The information on this documents is the property of Bharat
Heavy Electrical Limited It must not be used directly or
indirectly in any way detrimental to the interest of the compan 3.0 Condition of Delivery: Rolled or Forged and Heat Treated. 4.0 Dimension and Tolerances: Dimensional tolerance, straightness, twisting and bulging limits shall be as per HW0993Q08. 5.0 Manufacture: Degassed steel (e.g. vacuum degassed) shall be used. Cast ingot is to be used as initial material for production of the bars. The manufacturing process must ensure a homogenous grain structure over the entire length of the bar and the bar cross section. प्रत्यक्ष 6.0 General Requirements: रे है इसका हानिकारक हो • Prerequisite requirement for approval of a new vendor is a successful Process qualification. भारत हेवी एतेक्ट्रिकलम लिमिटेड की मम्पत्ति भी तरह प्रयोग जो कि कंम्पत्ती के हित में इ किया जाय । Manufacturing process established during this shall be the basis for future manufacture. • Manufacturing plan shall be prepared and submitted after successful process qualification. स्वत्वाधिकार एवं गोपनीर Manufacturing plan shall include specific information on manufacturing like rolling temperature, reduction ratio, heat treatment temperature, hardening method and soaking time, rate of heating and cooling etc. Test instructions for nondestructive and destructive testing are to be provided in the मूबना किमी manufacturing and testing plan. की नाई म रूप में वि Product and process qualification is mandatory for supplier each manufacturing plants. प्रलेख में • For new supplier, process qualification shall be required for three purchase orders. If necessary, BHEL may ask for process qualification for verification of manufacturing reliability from regular suppliers also. · Any change in the agreed manufacturing plan shall be informed to BHEL. BHEL will review the requirement of renewed process qualification.

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ASHISH RANJAN

ASHISH RANJAN

PLANT STANDARDIZATION COMMITTEE

ISSUED: TSX

GOPAL KRISHNAN

TRANSLATED BY

संस्थान मानकीकरण समिति

WORKED BY

CHECKED BY

पर्यवेक्षणकर्ता SUPERVISED BY

जांचकर्ता

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PLANT PURCHASE SPECIFICATION (HEEP - HARIDWAR)

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गरत हेवी इलेक्ट्रीक्ल्स की सम्पत्ति है इसका प्रत्यक्ष , जो कि कम्पनी के हित में हानिकारक हो ना किया स्वत्वाधिकार प्रयोग स्चना तरह 郭 प्रलेख में दी ब से किसी भी

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7.0 Heat Treatment:

Hardening has to be done in accordance with EN 10088 - 3, + QT 800 in line with Table A.2 (950 - 1050°C /air or liquid quenching). Tempering must be done at a temperature ≥ 650°C.

A fully transformed and tempered martensitic microstructure must be present over the entire cross section.

Hardening and tempering in bundles are not allowed. Suitable gaps between two bars are to be ensured during heat treatment for uniformity of properties.

If bars need to be straightened after the heat treatment, a stress relieving heat treatment shall be performed after completion of entire straightening process. Stress relieving is to be carried out at 20 -30°C below the tempering temperature with a subsequent slow cooling.

The lowest possible residual stresses shall be targeted. Distortion of the finish machined part due to residual stresses from the manufacturing process or heat treatment process shall not occur.

- 8.0 Properties and their verification:
- 8.1 Chemical Composition:

Heat analysis in weight %

С	Si	Mn	Р	S	Cr	Ni
0.17 -0.22	0.10 - 0.60	0.30 - 0.80	≤ 0.030	≤ 0.020	12.5 - 14.0	0.30 - 0.80

Cobalt content must be specified in the inspection certificate for information purposes.

8.2 Properties and Microstructure:

The specimens shall be taken in the longitudinal direction in accordance with Attachment 1. The properties described below shall be determined at room temperature in the delivery condition, i. e. after the last heat treatment including any stress relieving heat treatment.

The metallographic investigations shall be performed on the hardest and softest bar with an area of at least 320mm² each. The areas to be investigated must be in the longitudinal direction. The longitudinal direction must be indicated in the documentation.

8.2.1 Mechanical Properties:

Hardness of the bars in a test unit shall be verified by Brinell hardness testing in accordance with ISO 6506 -1, HBW10/3000 or HBW 5/750 may be used.

The surface of the bar shall be prepared in the area of the hardness measurement so that the result is not affected by the surface condition.

Hardness testing shall be performed on 10% of each test unit but at least on 10 bars or on each bar if test unit is less than 10 bars. The greatest resulting difference in hardness shall not exceed 35HBW.

Mechanical properties shall be determined on the hardest and softest bar determined in a test unit.

Tensile testing shall be performed in accordance with ISO 6892 -1 or ASTM E8M (round specimen with $L_0 = 50$ mm and $d_0 = 10$ mm) or ASTM E8 (standard specimen in accordance with Figure 8). Standard specimens Charpy (V-notch) in accordance with ISO 148 -1 shall be used for determining the absorbed impact energy.

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PLANT PURCHASE SPECIFICATION (HEEP-HARIDWAR)

The following properties must be achieved at room temperature:

0.2 % Proof Stress (N/mm²)	Tensile Strength (N/mm²)	Elongation After Fracture (%)	Reduction in area %	Impact Energy (J) ¹	Hardness HBW
≥ 600	800 - 950	≥ 15	≥ 50	≥ 20	240 - 280

HW 10786

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8.2.2 Microstructure:

Microstructure must be uniform, without porosity, excessive segregation or other inhomogeneities.

8.2.2.1 Cleanliness:

The cleanliness shall be determined as per ASTM E45 method A. Acceptance criteria:

Inclusion: Thin Series

Type A, B, C: 2 max Type D: 2.5max

Inclusions: Heavy Series

Type A, B, C, D: 1.5max

Maximum Number and dimension of globular inclusions (type D)

IR (D) = n1 + 2.5n2, IR (D) is converted to an area of 160mm^2

IR (D) ≤ 10

n = number of globular inclusions

n1 (25-50µm); n2(51-75µm)

Any material discontinuities present at the inclusion must also be accounted for in determining the size of globular inclusion.

Inclusions > 75 µm, including any material discontinuities, are not allowed.

8.2.2.2 Delta Ferrite content and grain size:

- **Delta ferrite content shall be < 5%.** The determination of delta ferrite content shall be performed based on analysis methods in accordance with ASTM E45 Method A, "Worst field method" with V=100:1.
- An average grain size of 4 or finer has to be achieved. Grain size shall be determined on the martensitic secondary grain structure in accordance with ASTM E112 or ISO643. A deviation of more than 2 grain sizes in size of individual's grains from the average grain size is not allowable.

8.3 Non-destructive Testing:

8.3.1 Test Scope:

The following Non – destructive inspections shall be performed in the as delivered condition:

- Visual inspections of all bars
- Ultrasonic examination of all bars in accordance with TWP 1204. 100% of the volume must be tested in accordance with the recording level.

8.3.2 Recording level and acceptance criteria:

- Indications of surface defects such as rolled marks shall be ground out to investigate their depth at least at both ends, in the middle of the indication and at an interval of approx. 250mm.
- Surface defects with a depth extension of ≥ 1mm are not allowable, and these areas shall be cut out of the bar.

निर्माणकर्ता WORKED BY	Ashish Ranjan	ARayan	02.05.17
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¹ Average of 3 specimens and minimum value for two specimens in accordance with EN10021, where the lowest value shall be at least 14 Joule.

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PLANT PURCHASE SPECIFICATION

(HEEP - HARIDWAR)

HW 10786 पुष्ठ Page of 8

Ultrasonic examination shall be carried out on all bars in accordance with TWP 1204.

Defects above the recording level are not acceptable and must be cut out.

It shall be confirmed in writing to the BHEL that bar sections containing defects above the recording level have been cut out of the bar.

The acceptance of material at vendor's works does not relieve the supplier of his responsibility for defects discovered at later stages.

8.3.3 Material Identity Test:

An identity test must be conducted in the as – delivered condition on all bars.

9.0 Process Qualification:

In addition to testing as per clause 8.0 of this specification, following additional testing shall be performed in process qualification (see Attachment 2). All test results carried out during process qualification shall be submitted to BHEL for approval.

Tensile tests¹:

The strength values (0.2% Proof Stress and Tensile Strength) in the transverse direction (specimen orientation ZQ) shall not differ by more than 10% from the corresponding longitudinal values.

The absorbed impact energy in the transverse direction (KQ 1 -3) should not differ by more than 25% from the values in the longitudinal direction (KI at room temperature).

FATT: Determination of FATT (fracture appearance transition temperature) in accordance with ASTM A370. The FATT should be preferably evaluated based on SEP 1670 (software). The test scope must include at least 10 specimens. FATT < 30°C is to be achieved.

In accordance with ISO 6892 -2, a tensile test (in longitudinal direction) has to be performed at 500°C. The following properties must be achieved:

0.2 % Proof Stress	Tensile Strength (N/mm²)	Elongation After	Reduction in area
(N/mm²)		Fracture (%)	(%)
≥ 380	≥ 480	≥ 20	≥ 60

For case where standard specimens in transverse direction cannot be made: -

- For tensile test specimens, a round specimen with $L_0 = 5 d_0$ or a flat specimen with a proportionality factor of k= 5.65. Proportional specimens in accordance with Fig 8 shall be used if ASTM E8 is applied.
- An undersized specimen in accordance with ISO 148 -1 for impact test specimen. Undersize dimension to be reported.
- If dimension do not allow testing in the transverse direction, even with special specimen, testing will be carried out in the longitudinal direction only.

Intergranular Fracture Determination Test:

The fraction of Intergranular fracture shall be determined over the entire brittle fracture portion of the fracture surface of the impact test specimens tested at room temperature. The fraction of Intergranular fracture shall not exceed 10%. This test is not required for materials which indicate ≥90% ductile fracture at room temperature.

Magnetic Particle Test:

Performance of MT testing by the magnetic flux leakage method, alternating current phase shifted and a field strength of 20 - 65A/cm.

Distribution, type and size of grain structure in-homogeneities (e.g. segregation or delta ferrite) shall not result in MT indications.

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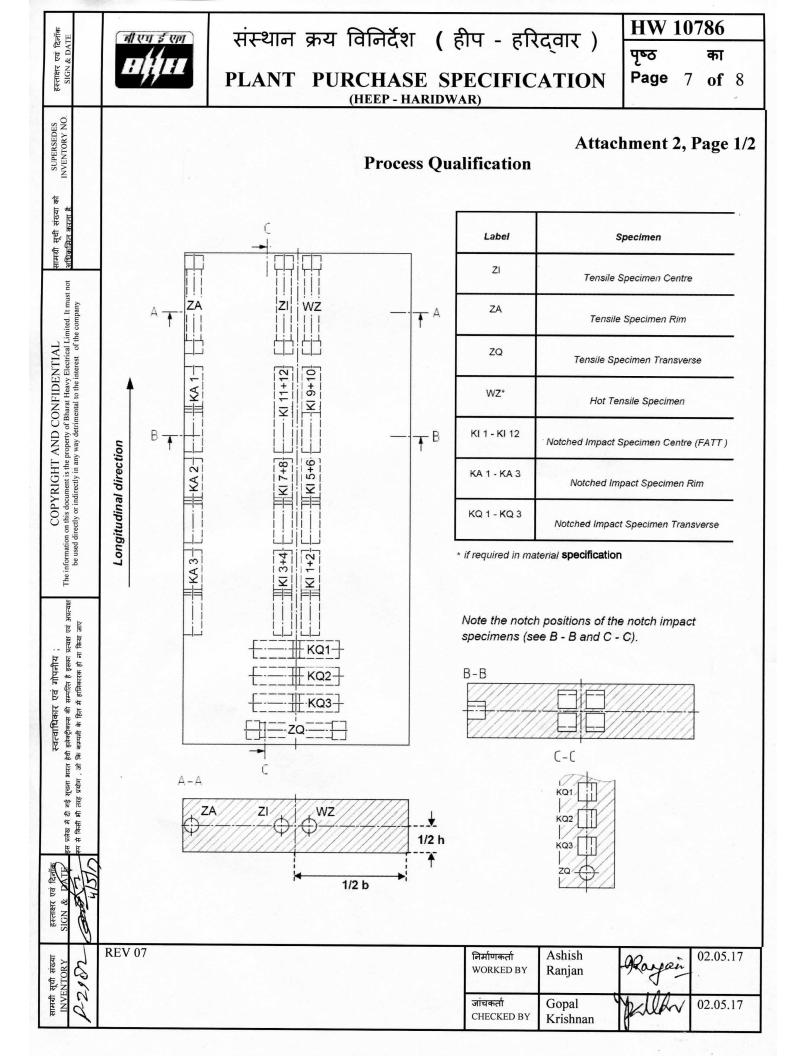
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REV 07 02.05.17 निर्माणकर्ता Ashish WORKED BY Ranjan 02.05.17 Gopal जांचकर्ता CHECKED BY Krishnan

		HW 10706
i दिनॉक DATE	<u>जिएग इंप्ल</u> संस्थान क्रय विनिर्देश (हीप - हरिद्वार)	HW 10786
हस्ताक्षर एवं दिने SIGN & DATE	PLANT PURCHASE SPECIFICATION (HEEP-HARIDWAR)	पृष्ठ का Page 5 of 8
सामग्री सूची संख्या को SUPERSEDES ted. It must not अधिकामित कराता है INVENTORY NO. ompany	10.0 Identification Marking: All bars are to be marked with following information: - Purchase Order Number - Size - Material Grade - Supplier Identification The details are to be clearly stamped and encircled by oil paint. Each bar shall colour with white strip on both ends. All the bars shall be suitably packed to corrosion and damage during transportation. Bars having maximum and minimum hardness (from which test samples are to	protect them against aken) shall be clearly
COPYRIGHT AND CONFIDENTIAL The information on this document is the property of Bharat Heavy Electrical Limited. It must not be used directly or indirectly in any way detrimental to the interest of the company	marked by oil paint for easy identification. Their respective hardness values sha these bars. 11.0 Documentation: Prior to, but in no case later than the delivery of the material, an inspection certif shall be provided to BHEL in duplicate; this certificate must contain the following (a) Material code no and P.O. number (b) Material designation (c) Heat no., heat analysis and melting methods (d) Complete information on all heat treatments performed (d) Mechanical test results including hardness range and the metallurgical exami (e) Results of non-destructive tests, UT inspection report (f) Confirmation of the material identity check (g) Dimensions and visual inspection reports	icate as per EN 10204 data:
स्वत्वाधिकार एवं गोपनीय ; स्त प्रतेख में दी गई भूषना भारत हेवी इतेक्टीकरम की सम्पत्ति है इसका प्रत्यक्ष एवं अप्रत्यक्ष स्प से किसी भी तरह प्रयोग , जो कि कम्पनी के हित में हानिकारक हो ना किया जाए	12.0 Cross Referred Standard: EN10088-3, HW0993008, ISO 6506-1, ISO 6892, ASTM E8, ISO 148-1, EN10021, A ASTM E112, ISO 643, ASTM A370, EN10204 13.0 Modification with respect to last revision: Clause 4.0 modified. Clause 9.0 modified. Clause 12.0 modified.	STM E45, TWP1204,
सामग्री सूची संख्या हस्ताक्षर एवं दिनोंक INVENTORY NO. SIGN & DATE P 21 & 2	REV 07 जिर्माणकर्ता WORKED BY Ashish Ranjan	Alayair 02.05.17

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INVENTORY P. 2787	REV 07		3	WORKED BY गांचकर्ता	Ashish Ranjan Gopal Krishnan	Prayan 02.05.17



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PLANT PURCHASE SPECIFICATION (HEEP - HARIDWAR)

HW 10786 पृष्ठ **Page** 8 **of** 8

Process Qualification

Attachment	2.	Page	2/2
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Label	Specimen
M	Metallographic Specimen
MP	Specimen for Magnetic Particle Test

1/2 b Longitudinal direction 1/2 h MP # 200 mm

Upper Surface of the Metallographic Specimen has to be examined. Longitudinal direction must be indicated in the documentation. A ≥ 320 mm²

Lower Surface of the specimen has to be examined in Magnetic Particle Test .

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REV 07

निर्माणकर्ता Ashish 02.05.17 WORKED BY Ranjan Gopal

जांचकर्ता CHECKED BY Krishnan

02.05.17

संस्थान क्रय विनिर्देश (हीप: हरिद्वार) HW10687 दिनाक एवं हस्ताक्षर SIGN & DATE बीएव ईएल PLANT PURCHASE SPECIFICATION पृष्ट (HEEP: HARIDWAR) Page SUPERSEDES INVENTORY TLV9248/06, Dec'13 **HEAT RESISTANT STEEL BARS FOR TURBINE BLADES** GRADE: X22CrMoV121 +OT2 1.0 General: सामग्री सूची संख्या को अधिक्रमित करता है This specification governs the quality of Steel rectangular bars in steel grade X22CrMoV121, material 2.0 Application: The information on this documents is the property of Bharat Heavy Electrical Limited.It must not be used directly or indirectly in any way detrimental to the interest of the company For machining of blades for Steam Turbine. 3.0 Condition of Delivery: Rolled or Forged and Heat Treated. 4.0 Dimension and Tolerances: Dimensional tolerance, straightness, twisting and bulging limits shall be as per HW0993008. 5.0 Manufacture: COPYRIGHT Degassed steel (e.g. vacuum degassed) shall be used. Cast ingot is to be used as initial material for production of the bars. The manufacturing process must ensure a homogenous grain structure over the entire length of the bar and the bar cross section. भारत हेबी एलेक्ट्रिकतम लिमिटड की मध्यति है डमका प्रत्यक्ष भी तरह प्रयोग, जो कि कंम्पती के हित में हातिकारक हो न किया जाय। 6.0 General Requirements: • Prerequisite requirement for approval of a new vendor is a successful Process qualification. Manufacturing process established during this shall be the basis for future manufacture. स्वत्वाधिकार एवं गोपनीय Manufacturing plan shall be prepared and submitted after successful process qualification. Manufacturing plan shall include specific information on manufacturing like rolling temperature, reduction ratio, heat treatment temperature, hardening method and soaking time, rate of heating and cooling etc. Test instructions for nondestructive and destructive testing are to be provided in the manufacturing and testing plan. Product and process qualification is mandatory for each of the supplier's manufacturing plants. For new supplier, process qualification shall be required for three purchase orders. If necessary, BHEL may ask for process qualification for verification of manufacturing reliability from regular suppliers also. requirement of renewed process qualification.

Any change in the agreed manufacturing plan shall be informed to BHEL. BHEL will review the

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संस्थान क्रय विनिर्देश (हीप - हरिद्वार)

PLANT PURCHASE SPECIFICATION (HEEP - HARIDWAR)

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7.0 Heat Treatment:

Hardening has to be done in accordance with EN 10269 + QT2 in line with Table B .1 (1020 - 1070°C /air or liquid quenching).

Tempering must be done at a temperature ≥ 650°C.

A fully transformed and tempered martensitic microstructure must be present over the entire cross

Hardening and tempering in bundles are not allowed. Suitable gaps between two bars are to be ensured during heat treatment for uniformity of properties.

If bars need to be straightened after the heat treatment, a stress relieving heat treatment shall be performed after completion of entire straightening process. Stress relieving is to be carried out at 20 -30°C below the tempering temperature with a subsequent slow cooling.

The lowest possible residual stresses shall be targeted. Distortion of the finish machined part due to residual stresses from the manufacturing process or heat treatment process shall not occur.

8.0 Properties and their verification:

8.1 Chemical Composition:

Heat analysis in weight %

С	Si	Mn	P	S	Cr	Мо
0.18 - 0.24	0.10 - 0.50	0.30 - 0.80	≤ 0.020	≤ 0.020	11.0 - 12.5	0.80 - 1.20

Ni	V		
0.30 - 0.80	0.25 - 0.35		

8.2 Properties and Microstructure:

The specimens shall be taken in the longitudinal direction in accordance with Attachment 1. The properties described below shall be determined at room temperature in the delivery condition, i. e. after the last heat treatment including any stress relieving heat treatment.

The metallographic investigations shall be performed on the hardest and softest bar with an area of at least 320mm² each. The areas to be investigated must be in the longitudinal direction. The longitudinal direction must be indicated in the documentation.

8.2.1 Mechanical Properties:

Hardness of the bars in a test unit shall be verified by Brinell hardness testing in accordance with ISO 6506 -1, HBW10/3000 or HBW 5/750 may be used.

The surface of the bar shall be prepared in the area of the hardness measurement so that the result is not affected by the surface condition

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Hardness testing shall be performed on 10% of each test unit but at least on 10 bars or on each bar if test unit is less than 10 bars. The greatest resulting difference in hardness shall not exceed 35HBW. Mechanical properties shall be determined on the hardest and softest bar determined in a test unit. Tensile testing shall be performed in accordance with ISO 6892 -1 or ASTM E8M (round specimen with $L_0 = 50$ mm and $d_0 = 10$ mm) or ASTM E8M (standard specimen in accordance with figure 8). Standard specimens Charpy (V-notch) in accordance with ISO 148 -1 shall be used for determining the absorbed impact energy.

The following properties must be achieved at room temperature:

0.2 % Proof Stress (N/mm²)	Tensile Strength (N/mm²)	Elongation After Fracture (%)	Reduction in area %	Impact Energy (J) ¹	Hardness HBW
≥ 700	900 - 1050	≥ 11	≥ 35	≥ 20	265 - 310

¹ Average of 3 specimens and minimum value for two specimens in accordance with EN10021, where the lowest value shall be at least 14 Joule.

8.2.2 Microstructure:

Microstructure must be uniform, without porosity, excessive segregation or other inhomogeneities.

8.2.2.1 Cleanliness:

The cleanliness shall be determined as per ASTM E45 method A. Acceptance criteria:

Inclusion: Thin Series

Type A, B, C: 2 max Type D: 2.5max

Inclusions: Heavy Series

Type A, B, C, D: 1.5max

Maximum Number and dimension of globular inclusions (type D)

IR (D) = n1 + 2.5n2, IR (D) is converted to an area of 160mm^2

 $IR(D) \leq 10$

n = number of globular inclusions

n1 (25-50 μm); n2 (51-75 μm)

Any material discontinuities present at the inclusion must also be accounted for in determining the size of the globular inclusion.

Inclusions > 75 μ m, inclusing any material discontinuities are not allowable.

8.2.2.2 Delta Ferrite content and grain size:

- Delta ferrite content shall be < 5%. The determination of delta ferrite content shall be performed based on analysis methods in accordance with ASTM E45 Method A, "Worst field method" with V=100:1.
- An average grain size of 4 or finer has to be achieved. Grain size shall be determined on the martensitic secondary grain structure in accordance with ASTM E112 or ISO643. A deviation of more than 2 grain sizes in size of individual's grains from the average grain size is not allowable.

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(HEEP - HARIDWAR)

8.3 Non-destructive Testing:

8.3.1 Test Scope:

The following Non-destructive inspection shall be performed in the as delivered condition:

- Visual inspection of all bars
- Ultrasonic examination of all bars in accordance with TWP1204. 100% of the volume must be tested in accordance with the recording level.

8.3.2 Recording level and acceptance criteria:

- Indications of surface defects such as rolled marks shall be ground out to investigate their depth at least at both ends, in the middle of the indication and at an interval of approx. 250mm.
- Surface defects with a depth extension of ≥ 1mm are not allowable, and these areas shall be cut out of the bar.
- Ultrasonic examination of all bars in accordance with TWP 1204.
- Defects above the recording level are not acceptable.
- It shall be confirmed in writing to the BHEL that bar sections containing defects above the recording level have been cut out of the bar.
- The acceptance of material at vendor's works does not relieve the supplier of his responsibility for defects discovered at later stages.

8.3.3 Material Identity Test:

An identity test must be conducted in the as – delivered condition on all bars.

9.0 Process Qualification:

In addition to testing as per clause 8.0 of this specification, following additional testing shall be performed in process qualification (see Attachment 2). All test results carried out during process qualification shall be submitted to BHEL for approval.

Tensile tests¹:

The strength values (0.2% Proof Stress and Tensile Strength) in the transverse direction (specimen orientation ZQ) shall not differ by more than 10% from the corresponding longitudinal values.

- The absorbed impact energy in the transverse direction (KQ 1 -3) should not differ by more than 25% from the values in the longitudinal direction (Kl at room temperature).
- **FATT:** Determination of FATT (fracture appearance transition temperature) in accordance with ASTM A370. The FATT should be preferably evaluated based on SEP 1670 (software) method. The test scope must include at least 10 specimens. FATT < 25°C is to be achieved.

In accordance with ISO 6892 -2, a tensile test (in longitudinal direction) has to be performed at 600°C. The following properties must be achieved:

0.2 % Proof Stress (N/mm²)	Tensile Strength (N/mm²)	Elongation After Fracture (%)	Reduction in area (%)
≥ 285	≥ 380	≥ 18	≥ 60

1 For case where standard specimens in transverse direction cannot be made: -

- For tensile test specimens, a round specimen with $L_0 = 5 \, d_0$ or a flat specimen with a proportionality factor of k= 5.65. Proportional specimens in accordance with Fig 8 shall be used if ASTM E8 is applied.
- An undersized specimen in accordance with ISO 148 -1 for impact test specimen. Undersize dimension to be reported.
- If dimension do not allow testing in the transverse direction, even with special specimen, testing will be carried out in the longitudinal direction only.

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09.06.17

जांचकर्ता Gopal CHECKED BY Krishnan

opal 09.06.17

PLANT PURCHASE SPECIFICATION (HEEP - HARIDWAR)

HW 10687 पृष्ठ **Page** of 8

Intergranular Fracture:

The fraction of Intergranular fracture shall be determined over the entire brittle fracture portion of the fracture surface of the impact test specimens tested at room temperature. The fraction of Intergranular fracture shall not exceed 10%. This test is not required for materials which indicate ≥90% ductile fracture at room temperature.

Magnetic Particle Test:

Performance of MT testing by the magnetic flux leakage method, alternating current phase shifted and a field strength of 20 - 65A/cm.

Distribution, type and size of grain structure in-homogeneities (e.g. segregation or delta ferrite) shall not result in MT indications.

10.0 Identification Marking:

All bars are to be marked with following information:

- Purchase Order Number
- Size
- Material Grade
- Supplier Identification

The details are to be clearly stamped and encircled by oil paint. Each bar shall be painted with gold colour on both ends. All the bars shall be suitably packed to protect them against corrosion and damage during transportation.

Bars having maximum and minimum hardness (from which test samples are taken) shall be clearly marked by oil paint for easy identification. Their respective hardness values shall also be punched on these bars.

11.0 Documentation:

Prior to, but in no case later than the delivery of the material, an inspection certificate as per EN 10204 shall be provided to BHEL in duplicate; this certificate must contain the following data:

- (a) Material code no and P.O. number
- (b) Material designation
- (c) Heat no., heat analysis and melting methods
- (d) Complete information on all heat treatments performed
- (d) Mechanical test results including hardness range and the metallurgical examination.
- (e) Results of non-destructive tests, UT inspection report
- (f) Confirmation of the material identity check
- (g) Confirmation of the dimensions and visual inspection

12.0 Cross Referred Standards:

EN10269, HW0993008, ISO 6506-1, ISO 6892, ISO 148-1, ASTM E8M, EN10021, ASTM E45, ASTM E112, ISO 643, TWP1204, ASTM A370, SEP1670, EN10204

13.0 Modification with respect to last revision:

Clause 8.3 modified.

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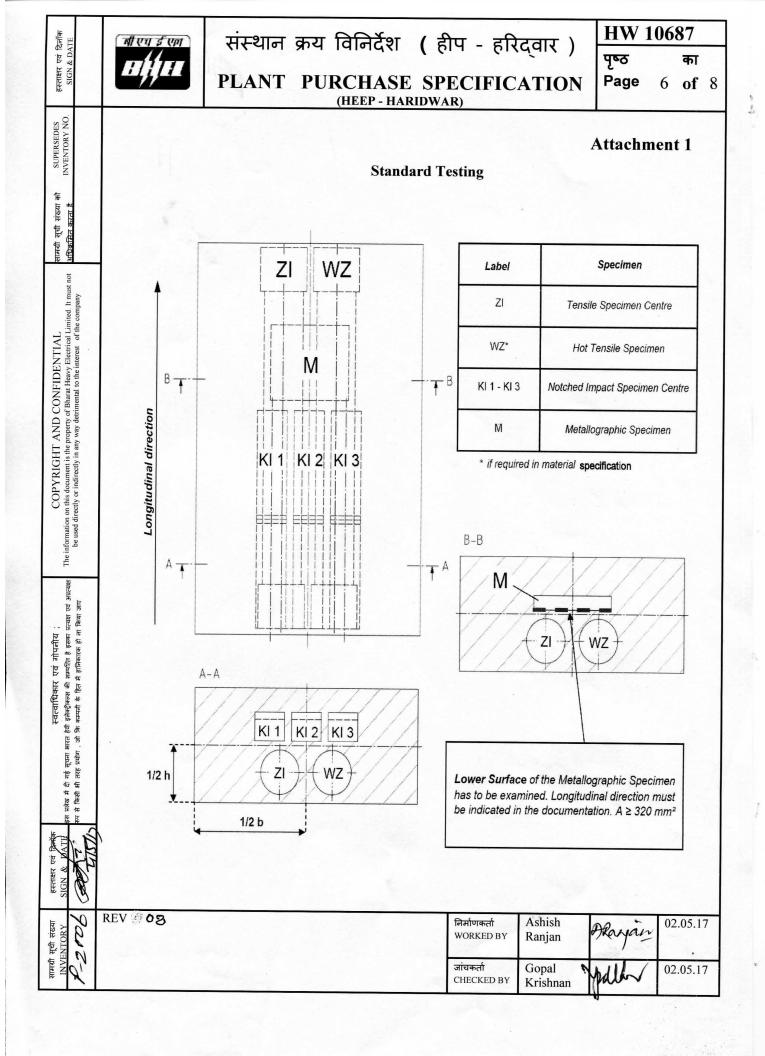
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Ashish Ranjan 09.06.17

जांचकर्ता CHECKED BY

Krishnan

09.06.17



हस्ताक्षर एवं दिनॉक SIGN & DATE HW 10687 संस्थान क्रय विनिर्देश (हीप - हरिद्वार) पृष्ठ का PLANT PURCHASE SPECIFICATION Page of 8 (HEEP - HARIDWAR) SUPERSEDES INVENTORY NO. Attachment 2, Page 1/2 **Process Qualification** ामग्री सूची संख्या Label Specimen ZI Tensile Specimen Centre The information on this document is the property of Bharat Heavy Electrical Limited. It must be used directly or indirectly in any way detrimental to the interest of the company. ZA Tensile Specimen Rim COPYRIGHT AND CONFIDENTIAL ZQ Tensile Specimen Transverse KI 11+12 KI 9+10 WZ* Hot Tensile Specimen T B KI 1 - KI 12 Longitudinal direction Notched Impact Specimen Centre (FATT) KI 5+6 KI 7+8 #KA 2-KA 1 - KA 3 Notched Impact Specimen Rim KQ 1 - KQ 3 Notched Impact Specimen Transverse -KA3-1+2-* if required in material specification $\overline{\mathbf{x}}$ आरत हेवी इलेक्ट्रीकरम की सम्पत्ति है इसका प्रत्यक्ष एवं अप्रत्यक्ष ग , जो कि कम्पनी के हित में हानिकारक हो ना किया जाए Note the notch positions of the notch impact specimens (see B - B and C - C). KQ1-B-B KQ2-KQ3 C-C A-A प्रलेख में दी से किसी भी KQ1 ZA WZ KQ2 1/2 h KQ3 1/2 b REV 08 निर्माणकर्ता Ashish 02.05.17 सामग्री सूची संख्या 8 WORKED BY Ranjan U जांचकर्ता Gopal 02.05.17 CHECKED BY Krishnan

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REV 08

निर्माणकर्ता Ashish 02.05.17 WORKED BY Ranjan जांचकर्ता Gopal 02.05.17

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HEAT RESISTANT STEEL BARS FOR TURBINE BLADES, GRADE: X12CrMoWVNbN10-1-1

1.0 General:

This specification governs the quality of Steel rectangular bars in steel grade X12CrMoWVNbN10-1-1, material no. 1.4906.

2.0 Application:

For machined/milled blades for Steam Turbine.

3.0 Condition of Delivery:

Rolled or Forged and Heat Treated.

4.0 Dimension and Tolerances:

Dimensional tolerance, straightness, twisting and bulging limits shall be as per HW0993008.

5.0 Manufacture:

Electro slag re-melted steel (ESR) shall be used.

The manufacturing process must ensure a homogenous grain structure over the entire length of the bar and the bar cross section.

6.0 General Requirements:

- Prerequisite requirement for approval of a new vendor is a successful Process qualification. Manufacturing process established during this shall be the basis for future manufacture.
- Manufacturing plan shall be prepared and submitted after successful process qualification. Manufacturing plan shall include specific information on manufacturing like rolling temperature, reduction ratio, heat treatment temperature, hardening method and soaking time, rate of heating and cooling etc. Test instructions for nondestructive and destructive testing are to be provided in the manufacturing and testing plan.
- Product and process qualification is mandatory for each of the suppliers manufacturing plants.
- For new supplier, process qualification shall be required for three purchase orders.
- If necessary, BHEL may ask for process qualification for verification of manufacturing reliability from regular suppliers also.
- Any change in the agreed manufacturing plan shall be informed to BHEL. BHEL will review the requirement of renewed process qualification.

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7.0 Heat Treatment:

Hardening:

 $1070 - 1100 ^{\circ}\text{C}$ / air or liquid quenching, cooled down to a temperature < $100 ^{\circ}\text{C}$ in the center of the bar.

Tempering:

A two-step tempering treatment must be performed as follows:

- The first tempering must be carried out at a temperature of 570°C and holding time of ≥ 4h. Air has to be used for cooling.
- Temperature of second tempering step has to be ≥ 700°C.

A fully transformed and tempered martensitic microstructure must be present over the entire cross section.

Hardening and tempering in bundles are not allowed. Suitable gaps between two bars are to be ensured during heat treatment for uniformity of properties.

If bars need to be straightened after the heat treatment, a stress relieving heat treatment shall be performed after completion of entire straightening process. Stress relieving is to be carried out at 20 -30°C below the tempering temperature with a subsequent slow cooling rate.

The lowest possible residual stresses shall be targeted. Distortion of the finish machined part due to residual stresses from the manufacturing process or heat treatment process shall not occur.

8.0 Properties and their verification:

8.1 Chemical Composition:

Heat analysis in weight %

С	Si	Mn	Р	S	Cr	Мо
0.11 -0.13	≤ 0.12	0.40 - 0.50	≤ 0.010	≤ 0.005	10.2 - 10.6	1.00 - 1.10
Ni	V	Nb	N	Al	W	
0.70 – 0.80	0.15 - 0.25	0.040 - 0.060	0.045 - 0.060	≤ 0.010	0.95 - 1.05	

Trace element content for Ti, Cu, As, Sb and Sn must be specified in the inspection certificate for information purposes.

8.2 Properties and Microstructure:

The specimens shall be taken in the longitudinal direction in accordance with Attachment 1. The properties described below shall be determined at room temperature in the delivery condition, i. e. after the last heat treatment including any stress relieving heat treatment.

The metallographic investigations shall be performed on the hardest and softest bar with an area of at least 320mm² each. The areas to be investigated must be in the longitudinal direction. The longitudinal direction must be indicated in the documentation.

8.2.1 Mechanical Properties:

Hardness of the bars in a test unit shall be verified by Brinell hardness testing in accordance with ISO 6506 -1, HBW10/3000 or HBW 5/750 may be used.

The surface of the bar shall be prepared in the area of the hardness measurement so that the result is not affected by the surface condition.

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Hardness testing shall be performed on 10% of each test unit but at least on 10 bars or on each bar if test unit is less than 10 bars. The greatest resulting difference in hardness shall not exceed 35HBW.

Mechanical properties shall be determined on the hardest and softest bar determined in a test unit. Tensile testing shall be performed in accordance with ISO 6892 -1 or ASTM E8M (round specimen with Lo

= 50mm and d₀ = 10mm) or ASTM E8M (standard specimen in accordance with Figure 8).

Standard specimens Charpy (V-notch) in accordance with ISO 148 -1 shall be used for determining the absorbed impact energy.

The following properties must be achieved at room temperature:

0.2 % Proof Stress (N/mm²)	Tensile Strength (N/mm²)	Elongation After Fracture (%)	Reduction in area %	Impact Energy (J) ¹	Hardness HBW
750 - 830	890-990	≥ 14	≥ 55	≥ 50	270 - 310

¹ Average of 3 specimens and minimum value for two specimens in accordance with EN10021, where the lowest value shall be at least 35 Joule.

Additionally, on the softest bar a tensile test in accordance with ISO 6892 - 2 has to be performed (in longitudinal direction) at 600°C. The following properties must be achieved:

0.2 % Proof Stress	Tensile Strength	Elongation After	Reduction in area (%)
(N/mm²)	(N/mm²)	Fracture (%)	
≥ 405	≥440	≥ 18	≥ 80

8.2.2 Microstructure:

Microstructure must be uniform, without porosity, excessive segregation or other inhomogeneities.

8.2.2.1 Cleanliness:

The cleanliness shall be determined as per DIN 50602 - K1. A minimum of 4 specimens per heat shall be used for determination of cleanliness.

Acceptance criteria:

Summary value K1: ≤ 2.0 (relating to 1000mm²)

8.2.2.2 Delta Ferrite content and grain size:

- Delta ferrite content shall be < 5%. The determination of delta ferrite content shall be performed based on analysis methods in accordance with ASTM E45 Method A, "Worst field method" with V=100:1.
- An average grain size of 3 or finer has to be achieved. Grain size shall be determined on the martensitic secondary grain structure in accordance with ASTM E112 or ISO643. A deviation of more than 2 grain sizes in size of individual's grains from the average grain size is not allowable.

Non-destructive Testing:

8.3.1 Test Scope:

The following Non – destructive inspections shall be performed in the as delivered condition:

- Visual inspections of all bars
- Ultrasonic examination of all bars in accordance with TWP 1204. 100% of the volume must be tested in accordance with the recording level.

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संस्थान क्रयँ विनिर्देश (हीप - हरिद्वार) HW 10663 भी एम ई एम स्ताक्षर एवं दिनॉव SIGN & DATE पृष्ठ हस्ताक्षर PLANT PURCHASE SPECIFICATION Page (HEEP - HARIDWAR) SUPERSEDES NVENTORY NO. 8.3.2 Recording level and acceptance criteria: INVENTORY Indications of surface defects such as rolled marks shall be ground out to investigate their depth at least at both ends, in the middle of the indication and at an interval of approx. 250mm. Surface defects with a depth extension of ≥ 1mm are not allowable, and these areas shall be cut संख्या out of the bar. Ultrasonic examination and acceptance of all bars in accordance with TWP 1204. सुन Defects above the recording level are not acceptable. मुज् It shall be confirmed in writing to the BHEL that bar sections containing defects above the recording level have been cut out of the bar. not The acceptance of material at vendor's works does not relieve the supplier of his responsibility for mation on this document is the property of Bharat Heavy Electrical Limited. It is used directly or indirectly in any way detrimental to the interest. of the compar defects discovered at later stages. 8.3.3 Material Identity Test: COPYRIGHT AND CONFIDENTIAL An identity test must be conducted on 100% of bars in the as – delivered condition. 9.0 **Process Qualification:** The following additional investigations shall be performed in process qualification (see Attachment 2): **Tensile tests:** The strength values (0.2% Proof Stress and Tensile Strength) in the transverse direction (specimen orientation ZQ) shall not differ by more than 10% from the corresponding longitudinal values. The smallest individual value for absorbed impact energy in transverse direction shall not be below 30J. For case where standard specimens in transverse direction cannot be made: -For tensile test specimens, a round specimen with $L_0 = 5 d_0$ or a flat specimen with a proportionality factor of k= 5.65. Proportional specimens in accordance with Fig 8 shall be used if ASTM E8 is applied. The An undersized specimen in accordance with ISO 148 -1 for impact test specimen. Undersize dimension to be reported. त्व If dimension do not allow testing in the transverse direction, even with special specimen, testing will be carried out in the longitudinal direction only. हानिकारक हो ना स्वत्वाधिकार एवं गोपनीय सम्पत्ति है इसका FATT: Determination of FATT (fracture appearance transition temperature) in accordance with ASTM A370. The FATT should be preferably evaluated based on SEP 1670 (software). The test के हित में scope must include at least 10 specimens. FATT < 25°C is to be achieved. इलेक्ट्रीकल्स की The fraction of Intergranular fracture shall be determined over the entire brittle fracture portion of the fracture surface of the impact test specimens tested at room temperature. The fraction of Intergranular fracture shall not exceed 10%. This test is not required for materials which indicate 節節 ≥ 90% ductile fracture at room temperature. Performance of MT testing by the magnetic flux leakage method, alternating current phase shifted मुड़े and a field strength of 20 - 65A/cm. स किसी Distribution, type and size of grain structure in-homogeneities (e.g. segregation or delta ferrite) shall not result in MT indications. All test results shall be submitted to BHEL for approval. हस्ताक्षर एवं

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संस्थान क्रय विनिर्देश (हीप - हरिद्वार) HW 10663 पुष्ठ त्व. Page SIGN PLANT PURCHASE SPECIFICATION (HEEP - HARIDWAR) SUPERSEDES INVENTORY NO 10.0 Identification Marking: All bars are to be marked with following information: - Purchase Order Number - Size - Material Grade संख्या - Supplier Identification स्वी The details are to be clearly stamped and encircled by oil paint. Each bar shall be painted with a band of colour orange - blue - orange on both ends. All the bars shall be suitably packed to protect them against corrosion and damage during transportation. Bars having maximum and minimum hardness (from which test samples are taken) shall be clearly marked by oil paint for easy identification. Their respective hardness values shall also be punched on Bharat Heavy Electrical Lim mental to the interest of the these bars. AND CONFIDENTIAL 11.0 Documentation: Prior to, but in no case later than the delivery of the material, an inspection certificate as per EN 10204 shall be provided to BHEL in duplicate; this certificate must contain the following data: (a) Material code no and P.O. number (b) Material designation (c) Heat no., heat analysis and melting methods (d) Complete information on all heat treatments performed (d) Mechanical test results including hardness range and the metallurgical examination. (e) Results of non-destructive tests, UT inspection report (f) Confirmation of the material identity check nsed (g) Confirmation of the dimensions and visual inspection The 12.0 Cross Referred Standard: HW0993008, ISO 6506 -1, ISO 6892 - 1, ISO 6892 - 2, ASTM E8M, ISO 148 - 1, EN10021, ASTM E45, ASTM E112, ISO 643, DIN50602, TWP 1204, ASTM A370, EN10204 जार हेवी इतेक्ट्रीक्ल्स की सम्पत्ति है इसका प्रत्यक्ष कि कम्पनी के हित में हानिकारक हो गा किया 13.0 Modification with respect to last revision: Clause 4.0 modified. Clause 9.0 modified. Clause 12.0 modified. गड़े तरह

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Ashish Ranjan

Krishnan

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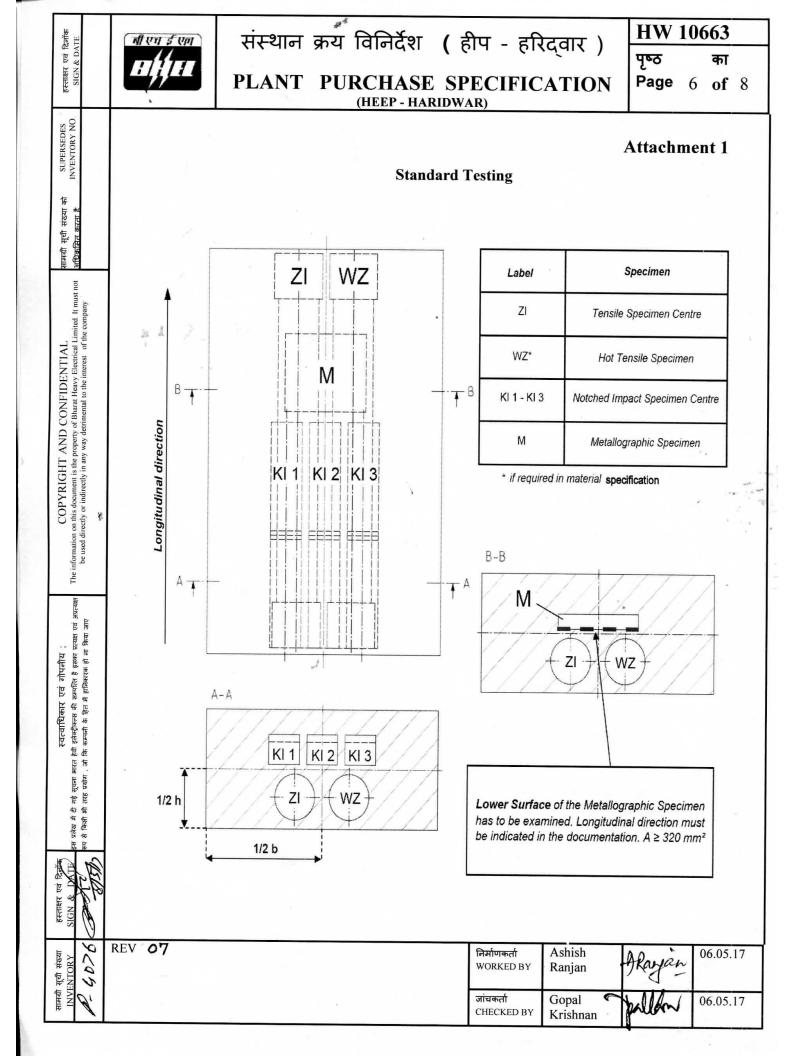
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इस प्रलेख में दी रूप से किसी भी	be indicated in the	documentation. A ≥ 320 mm²			***********	******		
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	12				Page 1 of 8					
SUPERSEDES INVENTORY NO.	5, Nov'13	<u>GRA</u>)	HEAT RESISTANT STEEL DE X19CrMoNbVN11-1 + QT FO	BARS FOR TURBINE BL OR SERVICE TEMPERAT	ADES TURE ≤ 540°C					
₩ anc	9367/05,	1.0 General:								
ति संख्या तकरता		This specifi	ication governs the quality of Steel re	ectangular bars in steel grade	X19CrMoNbVN11-1 +OT					
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		2.0 Application								
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NTI/	the co	3.0 Condition of								
TIDE	rest of		Forged and Heat Treated.							
ONF s is the	the inte		and Tolerances :							
VD Coument	ntal to		al tolerance, straightness, twisting and	hulging limits shall be as nor b	WINDOSOOS					
T Al	detrime	5.0 Manufactu		bulging innits shall be as per r	W0993008.					
UGH tion on	y way			e used Cast ingot is to be use	ad as initial material face					
PYR nforma	ly in ar	Degassed steel (e.g. vacuum degassed) shall be used. Cast ingot is to be used as initial material fo production of bars.								
COPYRIGHT AND CONFIDENTIAL The information on this documents is the property of Blattat Have Electrical Limited It mited not be used disease.	indirect		acturing process must ensure a hom	ogenous grain structure over	the entire langth of the					
to.			e bar cross section.	ogenous gram structure over	the entire length of the					
मि। प्रत्य सम्मान	ē	6.0 General Requ								
to the	5		isite requirement for approval of a	new vendor is a successful	d Drocoss muslification					
मं गोपनीय लम लिमिटेड की सम्पति है इसका प्रत्यक्ष किकामी के दिन से जनिकारक ने य	50		cturing process established during this							
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र एवं ग निस्कलम् जो कि	। भाय ।		cturing plan shall include specific in							
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गई सूच प से क्लि			cturing and testing plan.	active and destructive testing a	are to be provided in the					
ख मः प्रतिष्ठ			and process qualification is mandatory	for each of the cumplicate man						
डम प्रबंध										
			supplier, process qualification shall be							
			ary, BHEL may ask for process qualific	cation for verification of manu	acturing reliability from					
е 1		regular suppliers also. • Any change in the agreed manufacturing plan shall be informed to BHEL. BHEL will review the requirement of renewed process qualification.								
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TRANSLATED BY

संस्थान मानकीकरण समिति

APPROVED: PLANT STANDARDIZATION COMMITTEE

 $\mathsf{ISSUED}: \ TSX$

ASHISH RANJAN

ASHISH RANJAN

GOPAL KRISHNAN

J. Affanjan 115

DATE: 31.12.1985

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PREPARED: MTE

स्वीकृति

निर्माण

G.KRISHNAN

U. K. PANDA

P. K. BANSAL

TSX(MTE)-17-35

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CHANGE ADVICE NO.

सामग्री सूची संख्या INVENTORY NO.

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SUPERSEDES INVENTORY NO

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प्रत्यक्ष एवं 3 ना किया जाए

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संस्थान क्रय विनिर्देश (हीप - हरिद्वार)

PLANT PURCHASE SPECIFICATION

(HEEP - HARIDWAR)

HW 10670

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7.0 Heat Treatment:

Hardening: 1100 - 1130°C / air or liquid quenching

Tempering: 670 - 750°C, with holding time minimum 2 hours.

A fully transformed and tempered martensitic microstructure must be present over the entire cross section.

Hardening and tempering in bundles are not allowed. Suitable gaps between two bars are to be ensured during heat treatment for uniformity of properties.

If bars need to be straightened after the heat treatment, a stress relieving heat treatment shall be performed after completion of entire straightening process. Stress relieving is to be carried out at 20 - 30°C below the tempering temperature with a subsequent slow cooling.

The lowest possible residual stresses shall be targeted. Distortion of the finish machined part due to residual stresses from the manufacturing process or heat treatment process shall not occur.

8.0 Properties and their verification:

8.1 Chemical Composition:

Heat analysis in weight %

C	Si	Mn	Р	S	Cr	Мо
0.17 -0.23	≤ 0.50	0.40 - 0.90	≤ 0.025	≤ 0.015	10.0 - 11.5	0.50 - 0.80
Ni	V	Nb	N	В		Al
0.20 - 0.60	0.10 - 0.30	0.25 - 0.55	0.05 - 0.10	≤ 0.0015	≤ 0	.020
					to be aime	ed at ≤ 0.010

8.2 Properties and Microstructure:

The specimens shall be taken in the longitudinal direction in accordance with Attachment 1. The properties described below shall be determined at room temperature in the delivery condition, i. e. after the last heat treatment including any stress relieving heat treatment.

The metallographic investigations shall be performed on the hardest and softest bar with an area of at least 320mm² each. The areas to be investigated must be in the longitudinal direction. The longitudinal direction must be indicated in the documentation.

8.2.1 Mechanical Properties:

Hardness of the bars in a test unit shall be verified by Brinell hardness testing in accordance with ISO 6506-1, HBW10/3000 or HBW 5/750 may be used.

The surface of the bar shall be prepared in the area of the hardness measurement so that the result is not affected by the surface condition Hardness testing shall be performed on 10% of each test unit but at least on 10 bars or on each bar if test unit is less than 10 bars. The greatest resulting difference in hardness shall not exceed 35HBW.

Mechanical properties shall be determined on the hardest and softest bar determined in a test unit.

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11.05.17
Gopal
CHECKED BY
Krishnan
Ranjan
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11.05.17

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संस्थान क्रय विनिर्देश (हीप - हरिद्वार)

PLANT PURCHASE SPECIFICATION

(HEEP - HARIDWAR)

HW 10670 का Page of 8

Tensile testing shall be performed in accordance with ISO 6892 -1 or ASTM E8M (round specimen with Lo = 50mm and d_0 = 10mm) or ASTM E8M (standard specimen in accordance with figure 8).

Standard specimens Charpy (V-notch) in accordance with ISO 148 -1 shall be used for determining the absorbed impact energy.

The following properties must be achieved at room temperature:

0.2 % Proof Stress (N/mm²)	Tensile Strength (N/mm²)	Elongation After Fracture (%)	Reduction in area %	Impact Energy (J) ¹	Hardness HBW
≥ 780	900 - 1050	≥ 12	≥ 40	≥ 20	265 - 310

¹ Average of 3 specimens and minimum value for two specimens in accordance with EN10021, where the lowest value shall be at least 14 Joule.

8.2.2 Microstructure:

Microstructure must be uniform, without porosity, excessive segregation or other inhomogeneities.

8.2.2.1 Cleanliness:

The cleanliness shall be determined as per ASTM E45 method A. Acceptance criteria:

Inclusion: Thin Series

Type A, B, C: 2 max Type D: 2.5max

Inclusions: Heavy Series Type A, B, C, D: 1.5max

Maximum Number and dimension of globular inclusions (type D)

IR (D) = n1 + 2.5n2, IR (D) is converted to an area of 160mm^2

 $IR(D) \leq 10$

n = number of globular inclusions

 $n1 (25 - 50 \mu m); n2 (51 - 75 \mu m)$

Any material discontinuity present at the inclusion must also be accounted for in determining the size of globular inclusion.

Inclusion > 75 μm, including any material discontinuities, are not allowed.

8.2.2.2 Delta Ferrite content and grain size:

- Delta ferrite content shall be < 5%. The determination of delta ferrite content shall be performed based on analysis methods in accordance with ASTM E45 Method A, "Worst field method" with V=100:1.
- An average grain size of 4 or finer has to be achieved. Grain size shall be determined on the martensitic secondary grain structure in accordance with ASTM E112 or ISO643. A deviation of more than 2 grain sizes in size of individual's grains from the average grain size is not allowable.

8.3 Non-destructive Testing:

8.3.1 Test Scope:

The following Non – destructive inspections shall be performed in the as delivered condition:

- Visual inspections of all bars
- Ultrasonic examination of all bars in accordance with TWP 1204. 100% of the volume must be tested in accordance with the recording level.

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REV 07

निर्माणकर्ना Ashish 11.05.17 WORKED BY Ranjan जांचकर्ता Gopal 11.05.17 CHECKED BY Krishnan

SUPERSEDES INVENTORY NO.

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PLANT PURCHASE SPECIFICATION

HW 10670 पुष्ठ का **Page** of 8

(HEEP - HARIDWAR)

8.3.2 Recording level and acceptance criteria:

- Indications of surface defects such as rolled marks shall be ground out to investigate their depth at least at both ends, in the middle of the indication and at an interval of approx. 250mm.
- Surface defects with a depth extension of ≥ 1mm are not allowable, and these areas shall be cut out of the bar.
- Ultrasonic examination of all bars in accordance with TWP 1204.
- Defects above the recording level are not acceptable.
- It shall be confirmed in writing to the BHEL that bar sections containing defects above the recording level have been cut out of the bar.
- The acceptance of material at vendor's works does not relieve the supplier of his responsibility for defects discovered at later stages.

8.3.3 Material Identity Test:

An identity test must be conducted in the as – delivered condition. The inspection scope is:

Fixed lengths: 10%

In case that cut pieces are made from the bars then the marking must be performed directly after cutting to prevent any mix-up from occurring during the subsequent processes.

9.0 Process Qualification:

The following additional investigations shall be performed in process qualification (see Attachment 2):

Tensile tests:

The strength values (0.2% Proof Stress and Tensile Strength) in the transverse direction (specimen orientation ZQ) shall not differ by more than 10% from the corresponding longitudinal values.

Following properties must be achieved in transverse direction:

Elongation after fracture: ≥ 10%; Reduction of area: ≥ 25%

Absorbed impact energy ≥ 12J, where the lowest value shall be at least 10 Joule.

Additionally, 3 impact tests in transverse direction have to be performed at 100°C. For all value > 20J have to be achieved.

For case where standard specimens in transverse direction cannot be made: -

- For tensile test specimens, a round specimen with L₀ = 5 d₀ or a flat specimen with a proportionality factor of k= 5.65. Proportional specimens in accordance with Fig 8 shall be used if ASTM E8 is applied.
- An undersized specimen in accordance with ISO 148 -1 for impact test specimen. Undersize dimension to be reported.
- If dimension do not allow testing in the transverse direction, even with special specimen, testing will be carried out in the longitudinal direction only.

Tensile tests at 550°C:

A tensile test in longitudinal direction in accordance to ISO 6892 -2 has to be performed at 550°C and following properties must be achieved:

0.2 % Proof Strength (N/mm²)	Tensile Strength (N/mm²)	Elongation After Fracture (%)	Reduction in area %
≥ 475	≥ 520	≥ 16	≥ 55

3208 सुची

REV 07

निर्माणकर्ता WORKED BY Ashish Ranjan

11.05.17

Gopal 11.05.17 CHECKED BY Krishnan

त्व.

HW 10670 संस्थान क्रय विनिर्देश (हीप - हरिद्वार) बीएम ईएम Ta. पुष्ठ PLANT PURCHASE SPECIFICATION Page 5 (HEEP - HARIDWAR) SUPERSEDES INVENTORY NO. FATT: Determination of FATT (fracture appearance transition temperature) in accordance with ASTM A370. The test scope must include at least 10 specimens. FATT < 50°C is to be aimed. The fraction of Intergranular fracture shall be determined over the entire brittle fracture portion of the fracture surface of the impact test specimens tested at room temperature. The fraction of Intergranular fracture shall not exceed 10%. This test is not required for materials which indicate सूची संख्या ≥90% ductile fracture at room temperature. Performance of MT testing by the magnetic flux leakage method, alternating current phase shifted and a field strength of 20 - 65A/cm. Distribution, type and size of grain structure in-homogeneities (e.g. segregation or delta ferrite) shall not not result in MT indications. COPYRIGHT AND CONFIDENTIAL information on this document is the property of Bharat Heavy Electrical Limited. It mube used directly or indirectly in any way detrimental to the interest of the company All test results shall be submitted to BHEL for approval. 10.0 Identification Marking: All bars are to be marked with following information: - Purchase Order Number - Size - Material Grade - Supplier Identification The details are to be clearly stamped and encircled by oil paint. Each bar shall be painted with gold colour on both ends. All the bars shall be suitably packed to protect them against corrosion and damage during transportation. Bars having maximum and minimum hardness (from which test samples are taken) shall be clearly marked by oil paint for easy identification. Their respective hardness values shall also be punched on these bars. 11.0 Documentation: Prior to, but in no case later than the delivery of the material, an inspection certificate as per EN 10204 The shall be provided to BHEL in duplicate; this certificate must contain the following data: (a) Material code no and P.O. number (b) Material designation (c) Heat no., heat analysis and melting methods एव (d) Complete information on all heat treatments performed सम्पत्ति है इसका प्रत में हानिकारक हो ना ि स्वत्वाधिकार एवं गोपनीय (d) Mechanical test results including hardness range and the metallurgical examination. (e) Results of non-destructive tests, UT inspection report (f) Confirmation of the material identity check ो इलेक्ट्रीक्त्स की सम्प कम्पनी के हित में हा (g) Confirmation of the dimensions and visual inspection 12.0 Cross Referred Standard: EN10269, HW0993008, ISO 6506-1, ISO 6892, ASTM E8, ISO 148-1, EN10021, ASTM E45, TWP1204, 草匠 ASTM E112, ISO 643, ASTM A370, EN10204 प्रयोग स्चना माई पर 13.0 Modification with respect to last revision: Clause 4.0 modified. Clause 7.0 modified. Clause 12.0 modified.

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REV 07

निर्माणकर्ता Ashish WORKED BY Ranjan

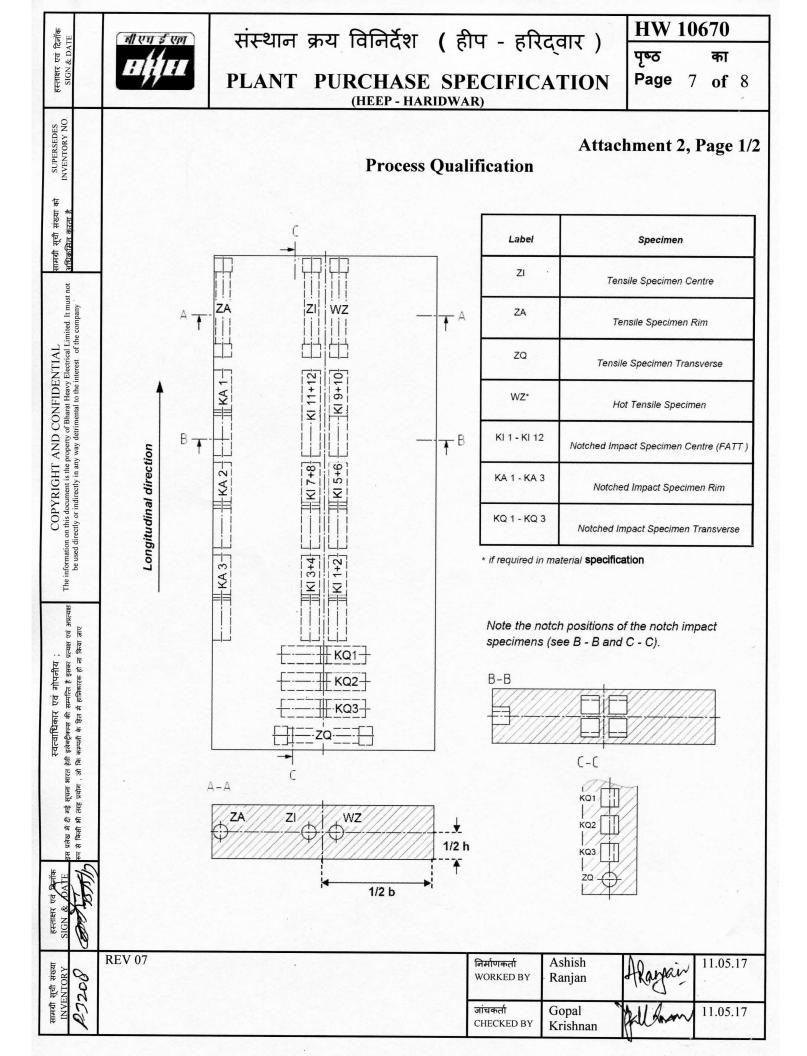
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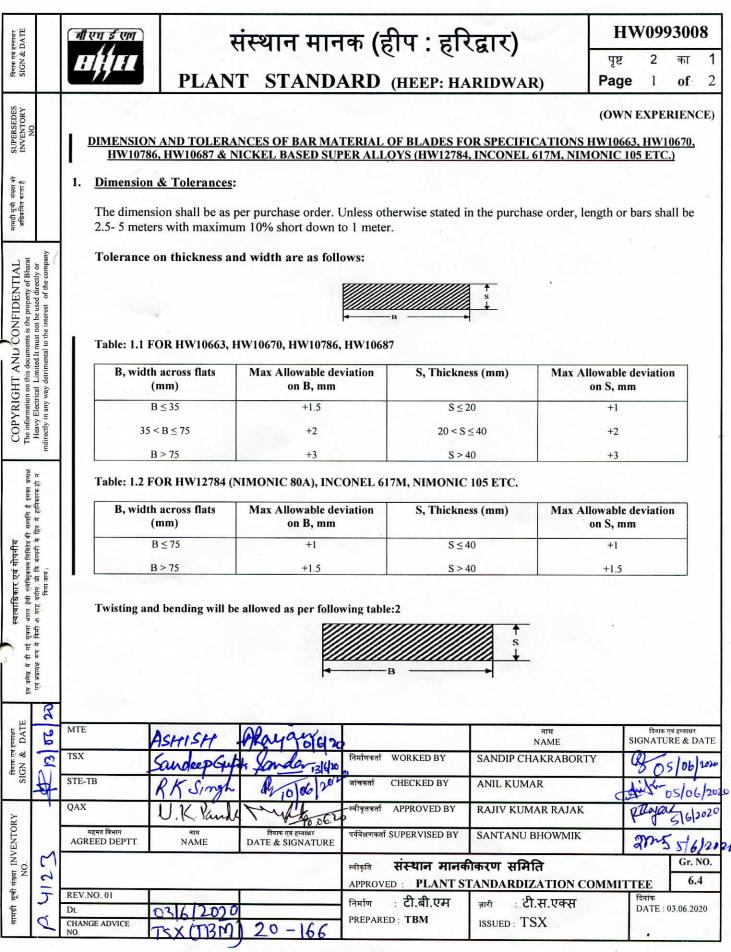
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संस्थान मानक (हीप : हरिद्वार)

PLANT STANDARD (HEEP: HARIDWAR)

HW0993008

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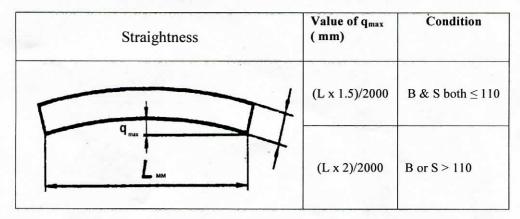
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Table:2

Condition	Bending	Twisting
B & S both ≤ 110	1.5 mm/meter	1.5 mm/meter
B or S > 110	2 mm/meter	2 mm/meter

Table 3: Straightness tolerances (qmax) for rectangular section bar



Bulging on the sides shall not be more than 0.01 X B & 0.02 X S respectively

Table 4: Out of section tolerance for rectangular section bar:

Out of section	Nominal Thickness (mm)	Tolerance(mm)
- ^u -	$10 < S \le 25$	u≤ 0.5
VIIIIIII	25 <s≤40< td=""><td>u≤ 1.0</td></s≤40<>	u≤ 1.0
s .	40 <s≤80< td=""><td>u≤ 1.5</td></s≤80<>	u≤ 1.5
В	S > 80	u≤ 3.0

Cross referred documents: HW10663, HW10670, HW10786, HW10687, HW12784 and EN10269.

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संस्थान क्रय विनिर्देश (हीप - हरिद्वार)

PLANT PURCHASE SPECIFICATION

पृष्ठ Page 1 of

HW 12784

(HEEP - HARIDWAR)

BAR MATERIAL FOR TURBINE BLADES, NiCr20TiAl

1.0 GENERAL:

The specification governs the quality of bars, rolled or forged for milled turbine blades in grade NiCr20TiAl (Material No. 2.4952).

2.0 APPLICATION:

Bars are required for blades used for turbine and compressor

3.0 CONDITION OF DELIVERY

Bars shall be supplied in hot rolled or forged and milled, heat treated condition. The bars should be straight and free from waviness.

4.0 DIMENSION AND TOLERANCES:

Dimension tolerance, straightness, twisting and bulging limits shall be as per HW0993008.

5.0 GENERAL REQUIREMENTS:

The manufacturer must demonstrate that it has implemented a quality system that meets the requirements stipulated in EN ISO 9000. The stipulations of the present purchasing specification apply for all the manufacturers' production shops, as well as their sub-suppliers. If the material is delivered for the first time, a process qualification according to clause 12.0 "Process qualification" must be performed. Separate process qualification is required for each facility of the manufacturer.

Before starting the production, the manufacturer shall provide BHEL a manufacturing and inspection sequence plan (MIP) for information after the successful process qualification. The MIP establishes the quality assured sequence of operations. Information on internal and external specifications is also given to BHEL in MIP. BHEL may view the manufacturer's internal MIP if he wishes to do so. The manufacturer has to inform BHEL about every change in the manufacturing or subcontractor process or inspection process. BHEL decides if a new qualification process is necessary. Subcontracting of any manufacturing steps is permissible only with BHEL written approval.

Also manufacturer shall submit test instructions for non-destructive and destructive testing which are performed as part of his own quality assurance measures. The test instructions shall include precise information on the tests, illustrated by sketch if necessary. General hints on other specification are not sufficient.

6.0 MANUFACTURING

6.1 Melting

The alloy shall be made by vacuum induction melting / electro-slag re-melting (VIM/ESR) or by

1	3	vacuur	n induction me	lting / vacuum a	rc re-melting (VIM / '	VAR) process.		
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हेवी इलेक्ट्रीकरम की सम्पत्ति है इसका प्रत्यक्ष एवं गोग , जो कि कम्पनी के हित में हानिकारक हो ना स्वत्वाधिकार एवं गोपनीय तरह E.

HW 12784 संस्थान क्रय विनिर्देश एवं हस्ताक्षर SIGN (हीप – हरिद्वार) बी एम ई एम पृष्ठ Page PLANT PURCHASE SPECIFICATION (HEEP - HARIDWAR) SUPERSEDES INVENTORY NO 6.2 Ingot Discard: Sufficient discard shall be made from each ingot to ensure freedom from piping, injurious segregation and other imperfections. 6.3 Forging: संख्या The ingot conversion shall be conducted in such a manner as to produce substantially uniform structure सूची सामग्री throughout the forged bar. The manufacturing process of the bars can be rolling or forging. 6.4 Heat Treatment: nation on this documents is the property of Bharat Heavy Electrical Limited. It must used directly or indirectly in any way detrimental to the interest of the company The forging shall be heat treated to get desired mechanical properties as per clause 7.2.1. Solution treatment: 8 h at 1050 - 1080°C, Air cooling AND CONFIDENTIAL 24 h at 845°C (± 10°C), Air cooling Stabilizing: Precipitation hardening: 16 h at 700°C (± 10°C), Air cooling The forming process and the solution treatment shall be chosen in such a way that over the whole cross section a homogeneous microstructure with a grain size of 3 to 6 according to ASTM E 122 will be reached. (See also 7.2.2) 7.0 PROPERTIES AND TESTS: COPYRIGHT 7.1 Chemical Composition: Heat analysis in weight % (according to EN 10269 table 1) shall be as follows: 0.04 - 0.10Si ≤ 0.30 Mn ≤ 1.00 P ≤ 0.010 S ≤ 0.010 Cr 18.0 - 21.0Ti 1.80 - 2.70Ni Rest Co ≤ 1.00 Fe ≤ 1.50 Al 1.0 - 1.8В ≤ 0.008 Cu ≤ 0.20 Ti + Al ≥ 3.50 अप्रत्यक्ष रूप से किसी भी तरह प्रयोग, जो कि कंपनी के हित में हानिकारक हो न किया जाए इस प्रलेख में दी गई सूचना भारत हेवी इलेक्ट्रिकल्स की सम्पत्ति है इसका प्रत्यक्ष एवं 7.2 Position of test pieces: Specimen extraction is performed as per attachment 1. The specimens are to be taken in longitudinal direction. The positions of the specimens given in the attachment are meant to serve only as an example. Details concerning the locations of specimens, both at bar material and at bar material made of semi स्वत्वाधिकार एवं गोपनीय finished parts, are to be agreed upon by BHEL and must be given in the MIP, including a sketch of the specimen location. 7.2.1 Mechanical Properties: It shall be ensured that the required mechanical properties are achieved throughout the entire bar cross section. The uniformity of the strength of the bars of a given delivery (per melt and heat treatment batch = test unit) shall be verified by a hardness test per EN ISO 6506-1. HBW 10/3000 or HBW 5/750 shall be used. Any other hardness test method shall be subject to prior agreement with BHEL. The hardness test shall be performed on 10% of each test unit, however on at least 10 bars, or if the test unit comprises less than 10 bars on every bar. Mechanical properties shall be determined on the hardest and softest bar indentified by this test. Tensile testing shall be conducted according to EN 10002 resp. ASTM E8M (preferred round tension test DATE हस्ताक्षर एवं दिनांक specimen with L₀ = 50 mm and d₀ = 10 mm) or ASTM E8 (Standard specimen per fig. 8). Impact testing U shall be performed with standard-test pieces with V-notch according to EN 10045. The following properties must be demonstrated at room temperature by the following tests: 201 REV निर्माणकर्ता 03 NVENTORY NO Ashish WORKED संख्या 0

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HW 12784 दिनांक एवं हरताक्षर SIGN क्रय विनिर्देश संस्थान (हीप – हरिद्वार) बीएम ईएम पृष्ठ & DATE PLANT PURCHASE SPECIFICATION Page (HEEP - HARIDWAR) 0.2% Tensile Elongation Reduction in Impact Hardness proof Strength Strength (Lo=5d) area Energy (%) (%) (1) **HBW** N/mm² N/mm² 明 ≥ 600 1000 - 1300 ≥ 17 ≥ 17 $\geq 20^{1}$ ≥ 260 1) Average of 3 Charpy V-notch specimens. Limited.It must In addition a short time creep rupture test according to DIN EN 10291 or other agreed standard has to be mation on this documents is the property of Bharat Heavy Electrical Limited. It is used directly or indirectly in any way detrimental to the interest. Of the company carried out, using the following parameters: Test temperature: T = 750°C **Proof stress** $\sigma_o = 310 \text{ MPa}$ AND CONFIDENTIA The following values have to be reached: Creep rupture time $t_m \ge 100 h$ Elongation $A_u \ge 4\%$ Reduction of area Z₁₁ ≥ 4 % COPYRIGHT If no creep rupture is occurred after 100 h, the proof stress can be increased for further 30 MPa after every 24 h, until the creep rupture occurred. 7.2.2 Grain Size Check: The metallographic examination has to be carried out at the beginning and at the end of the hardest and not be softest bar and in each case in the corner and in the center of the cross section. A substantially homogeneous microstructure with a grain size 3 -6 according to ASTM E 112 has to be achieved in the cross section. A grain size DUPLEX ALA 3 according to ASTM E 930 is acceptable provided, that a grain size of 1 is not exceeded. A deviating microstructure has to be documented according to ASTM E 1181 इस प्रलेख में दी गई सूचना भारत हेवी इलेक्ट्रिकल्स की सम्पत्ति है इसका प्रत्यक्ष एवं तथा रूप से किसी भी तरह प्रयोग, जो कि कंपनी के हित में हानिकारक हो न किया जा and to be approved by the BHEL. Reduction of amount of testing can be agreed with the BHEL. For this purpose the manufacturer has to provide adequate results. 7.2.3 Outer and Inner Quality / NDE: स्वत्वाधिकार एवं गोपनीय 7.2.3.1 Scope of Inspection: Following NDE shall be performed in delivery condition: Visual inspection of all bars verification test of all bars Complete ultrasonic inspection (UT) of all bars according to EN 10308 type 1a (table 1) or other agreed standard (e.g. AMS STD 2154) has to be carried out. The calibration block and the HYCHE reference block have to be manufactured out of materials with similar acoustic properties and similar surface conditions. The test has to be performed only by employees with level 2 certified according to EN 473 or SNT-TC-1A. DATE हस्ताक्षार एवं दिनांव 100% PT of all bars without the face areas according to EN 571-1. It is permitted to carry out a UT with a double transducer probe in the near surface area instead of PT. J

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HW 12784 क्रय विनिर्देश दिनांक एवं हरताक्षार SIGN संस्थान (हीप – हरिद्वार) भी एम ई एम का & DATE Page PLANT PURCHASE SPECIFICATION (HEEP - HARIDWAR) 7.2.3.2 Criteria for registration and decision: a) Regarding UT inspection quality class 3 according to EN10308 (table 3) shall be applied. The decision limit for loss of back wall echo is 3 dB for all bar dimensions. The recording level is defined with > 1mm d_{eq} . All indication $d_{eq} \le 1$ mm are acceptable. सामग्री सूची संख्या को b) PT: Indications ≥ 5 mm are unacceptable. Indications-free grinding excavations with depths ≤ 1mm are acceptable. 8.0 MARKING: Limited It must Blades are to be marked as per attachment 2 and specification AA0400310. The information on this documents is the property of Bhazat Heavy Electrical Limited It in not be used directly or indirectly in any way detrimental to the interest of the company 9.0 DOCUMENTATION: The supplier shall supply four copies of the test certificate 3.1 as per EN10204 unless and otherwise COPYRIGHT AND CONFIDENTIAL stated on the order. The test certificate shall bear the following information: · Order no. Specification no. / Material Designation Heat Number, heat analysis and melting method Complete information of all heat treatments performed Results of mechanical testing, including a list with all measured hardness Photos of microstructure with results of the grain size determination & creep test report Results of non destructive testing Confirmation of the material identification check Confirmation of the dimensional and visual check 10.0 CLEARANCE FOR DELIVERY: The total results of the tests / checks carried out are the deciding factor for clearance for delivery, and hence shall be intimated to BHEL in advance. In case of nonconformance, BHEL evaluates the total results taking into consideration intended use of the material and examines accordingly the acceptability da of deviation (if any). No material shall be delivered, if deviated, without acceptance by BHEL. The इस प्रलेख में दी गई सूचना भारत हेथी इलेक्ट्रिकल्स की सम्पत्ति है इसका प्रत्यक्ष। त्यक्ष रूप से किसी भी तरह प्रयोग, जो कि कंपनी के हित में हानिकारक हो न किया clearance, however, does not relieve the supplier of his responsibility for the hidden / unreported nonpermissible defects which are found later. 11.0 DEVIATIONS: स्वत्वाधिकार एवं गोपनीय Deviations from this Purchase Specification, which arise during manufacturing, may be submitted to BHEL in writing, giving full details of the deviation. Acceptance of concession request will be at the sole discretion of BHEL. 12.0 PROCESS QUALIFICATION: A qualification review, performed jointly by the BHEL and supplier, is required before starting production for the first order. This initial process qualification is required for each fabrication facility of the manufacturer. The fabrication and inspection parameters stipulated during this phase form the basis of the manufacturing and inspection sequence plan (MIP) which the supplier prepares at his own responsibility. Manufacturing is commenced after the check of conformity by the purchaser and depends on the results of the qualification review, If necessary; the manufacturing parameters are to be further optimized. DATE दिनांक Unless otherwise stipulated by the purchaser, the process qualification shall also be required for the हस्ताक्षर एवं SIGN & 0 first three orders in addition. If desired, a process qualification can also be called for as verification of the reliability of fabrication. REV 03 निर्माणकर्ता NVENTORY NC Ashish WORKED BY 0 पामग्री सूची संख्या Ranjan जांचकर्ता CHECKED BY Gopal

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