



संस्थान क्रय विनिर्देश (हीप - हरिद्वार)

HW19468

पृष्ठ का

**PLANT PURCHASE SPECIFICATION
(HEEP - HARDWAR)**

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TURBINE SHAFT FORGING WITH HEAT STABILITY TEST

GRADE: X12CrMoWVNbN10-1-1

1.0 GENERAL:

This specification governs the quality of Turbine shaft forging of steel grade X12CrMoWVNbN10-1-1, Material No. 1.4906.

2.0 APPLICATION:

For forging of Turbine shafts.

3.0 CONDITION OF DELIVERY:

Heat-treated and machined condition as per the ordering drawing.

4.0 DIMENSION AND TOLERANCES:

Forging shall be supplied to the dimensions and tolerances as per the ordering drawing.

5.0 MANUFACTURING:

5.1 GENERAL REQUIREMENTS:

Before starting the production, the manufacturer shall submit a manufacturing plan for BHEL approval. Manufacturing plan shall contain information details as per Annexure 1. Inspection shall be as per BHEL approved quality plan.

5.2 MELTING AND FORGING:

Vacuum degassed steel with low silicon content (e.g. VCD Steel) or re-melted steel (ESR) shall be used and shall be thoroughly forged. The use of any other secondary steel treatment shall be agreed upon in advance with BHEL in each individual case.

5.3 HEAT TREATMENT

A vertical liquid quenching shall be carried out. In the center of the rotor a complete transformation in the martensite phase must be achieved. The hardening temperature shall lie between 1070°C and 1100°C. A two-step tempering, also in vertical condition shall be performed. The temperature of the 2nd tempering temperature shall be higher than the temperature of 1st tempering temperature and shall be minimum 690°C.

Any change in heat treatment temperature to be agreed and approved by BHEL in each individual case.

The duration of tempering as well as the controlled cooling rate are to be chosen to achieve minimum residual stresses. The residual stresses shall not exceed 60N/mm² at any point on the surface.

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संस्थागत एवं गोपनीय
यह दस्तावेज संस्था की संपत्ति है। इस दस्तावेज में दी गई जानकारी को सीधे या अप्रत्यक्ष रूप से किसी भी प्रकार से उपयोग नहीं किया जाना चाहिए।

SUPERSEDES INVENTORY
NO. P-3757

SUPRESEDES INVENTORY
TLV9258 04, July'11

TSX	D. GANGWAR	नाम NAME	दिनांक एवं तिथि SIGNATURE & DATE
PSC	G. KRISHNAN	अनुवाद TRANSLATED BY	
QAX	U. K. PANDA	निर्माण WORKED BY	SUBODH RANA 21/08/18
STE	D. K. RAY	जांच CHECKED BY	ASHISH RANJAN 21/8/18
अनुमोदित विभाग AGREED DEPTT.	नाम NAME	पर्यवेक्षणकर्ता SUPERVISED BY	GOPAL KRISHNAN 21/8/18
स्वीकृति APPROVED : PLANT STANDARDIZATION COMMITTEE		Gr. NO. 2.60	
REV. NO.	07	निर्माण PREPARED : MTE	दिनांक DATE : 14.10.2000
DI.	24-02-21	ISSUED : TSX	
CHANGE ADVICE NO.	TSX(MTE)-21-30		

SUPERSEDES INVENTORY NO.
 07

6.0 PROPERTIES AND TESTS:

6.1 CHEMICAL COMPOSITION

6.1.1 Heat analysis in weight %

C	Si	Mn	P	S	Cr	Mo
0.11 - 0.13	≤ 0.12	0.40 - 0.50	≤ 0.012	≤ 0.005	10.2 - 10.6	1.00 - 1.10

Ni	W	V	Al	N	Nb
0.70 - 0.80	0.95 - 1.05	0.15 - 0.25	≤ 0.010	0.045 - 0.060	0.04 - 0.06

The percentage of the tramp elements Cu, As, Sb and Sn shall be recorded in the test certificate for BHEL information. Slight deviation in chemical composition are permissible after agreement with BHEL, provided service properties are not affected.

6.1.2 Product Analysis

A product analysis shall be carried out in accordance with specification AA0850155 and shall be documented. The product and heat analysis have to demonstrate that material can be regarded as chemically homogenous (with the exception of small deviations).

6.2 MECHANICAL PROPERTIES

Tensile testing shall be carried out as per ISO 6892-1. Impact testing to be carried out as per ISO 148-1.

6.2.1 Tangential or Radial Specimens:

The manufacturer shall test Tangential or Radial test specimens taken from locations indicated on the drawing. The difference between the individual values of 0.2% Proof Strength and Tensile strength values from different locations as indicated in drawing shall not differ by more than 50 N/mm².

The test rings shall not be cut free before quality heat treatment. The location of tensile and impact specimens must be at a distance of 40mm from the heat-treatment surface and shall be indicated.

The following properties shall be achieved at room temperature:

0.2% Proof Strength (N/mm ²)	Tensile strength (N/mm ²)	% Elongation after fracture A (%)	% Reduction of Area (%)	Absorbed impact energy (KV ₂) (J)
700 - 800	≤ 1000	≥ 13	≥ 40	≥ 30 *

* Average of 3 Charpy V-notch specimens

6.2.2 Axial Core:

An axial core of diameter ≥ 60 mm is to be taken out from the journal area of the shaft. The location of the axial core is shown in the order drawing. The position of the shaft in the forged ingot shall be such that the axial core lies on the topside of ingot.

Position and number of specimens shall be in accordance with the AA0850155.

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स्वतंत्रतापूर्वक रूप से प्रतिलिखित
 इस दस्तावेज़ में दी गई जानकारी भारतीय भारी विद्युत उपकरण लिमिटेड की संपत्ति है। इसे किसी भी रूप में सीधे या अप्रत्यक्ष रूप से, कंपनी के हितों के विरुद्ध उपयोग नहीं किया जाना चाहिए।

Page no. and
SIGN & DATE
 10/05/21

REV. NO. 07	(SUPERSEDES)	निर्मापकर्ता WORKED BY ASHISH RANJAN	24.02.2021
INVENTORY P-3254		जांचकर्ता CHECKED BY GOPAL KRISHNAN	24.02.2021

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Following properties shall be achieved in radial direction:

0.2% Yield Strength	FATT (°C)*	Absorbed impact energy (KV ₂) at 20°C (J)
≥ 700 N/mm ²	For information only	≥ 30**

*) FATT in accordance with SEP 1670

***) Value from Absorbed Impact Energy – Temperature Curve

6.2.3 Inner ring Sample:

The manufacturer has to test the inner ring segments (if required) from locations indicated on the order drawing.

Following properties have to be achieved:

0.2% Proof Strength (N/mm ²)	FATT* (°C)	Absorbed impact energy (KV ₂) at 20°C (J)
≥ 700	For information	≥ 30**

*) FATT in accordance with SEP 1670

***) Value from Absorbed Impact Energy – Temperature Curve

6.2.4 Testing:

The axial core and the inner rings must be clearly marked, so that their original position can be allocated to the shaft easily. Traceability of the trepanned core of the forging shall be confirmed by the stamp of the manufacturer's authorized inspector in the area of the identification number.

If for any reason the axial core is to be taken from input end (bottom end), the existing drawing shall not be valid. The sampling of the trepanned core will then be done according to a new drawing.

6.2.5 Radial Core

In special cases the BHEL reserves the right to take one or more radial cores instead of the axial core or in addition to it. The position of the cores will be specified individually.

6.2.6 Reduced Fracture Deformations

In case of reduced values for fracture deformations during tensile testing, the manufacturer must perform retests and must provide verification that these are caused by local impurities only.

6.3 Outer and Inner Quality / NDE

6.3.1 UT – Inspection

Ultrasonic examination of rotor shaft shall be carried out as TLV511500001 (latest issue). The evaluation and acceptance of ultrasonic testing of shaft shall be as per TLV3930 12 (latest issue).

6.3.2 Magnetic Particle Examination

Magnetic particle examination and evaluation shall be carried out as per TLV511500001 (latest issue). The evaluation and acceptance of magnetic particle testing of shaft shall be as per TLV3930 12 (latest issue).

6.4 Residual Stress Measurement:

The residual stresses are to be proved at every delivery according to AA0850150 by a qualified method (e.g. the KWU–Ring Core method / ASTM E837). The residual stresses shall not exceed 60N/mm² at any point on the surface.

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आवृत्ति संख्या एवं गोपनीय संख्या

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INVENTORY NO.

REV. NO.	(SUPERSEDES)	निर्माणकर्ता WORKED BY	ASHISH RANJAN	24.02.2024
07		जांचकर्ता CHECKED BY	GOPAL KRISHNAN	24.02.2024



संस्थान क्रय विनिर्देश (हीप - हरिद्वार)

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अतिरिक्त संख्या

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स्वायत्ताधिकार एवं गोपनीय
इस दस्तावेज में की गई सूचना भारत भारी वैद्युतनिर्माणाधीन स्वामित्व में है। इसका प्रयोग एवं प्रसारण के बिना भारत भारी वैद्युतनिर्माणाधीन की लिखित अनुमति के बिना नहीं किया जा सकता।

हस्ताक्षर एवं तारीख
SIGN & DATE

सामग्री सूची संख्या
INVENTORY NO.

6.5 HEAT STABILITY TEST

Heat stability test shall be carried out at 30°C below tempering temperature in accordance with specification AA0850152.

The occurrence of A- and D-type deflections can be ignored if it can be proved that they are caused by surface influences. If B-type deflections occur, the shaft shall be heated up and down as long as no further stresses will release. C-type deflections ≥ 0.05 mm are not acceptable. BHEL reserves the right to repeat the heat stability test.

7.0 DIMENSIONS & TOLERANCES:

Dimensions and tolerances shall be as per purchase order / ordering drawing. The manufacturer has to carry out the following dimensional inspection in delivery condition:

- All outer diameters and outer length dimensions of the rotor and the surface roughness of the journal area with limited reference value and actual value are to be written down.
- The length, the diameter and the surface roughness of the axial bore are to be measured according to Annexure 2.

8.0 MARKING:

The supplier shall mark each shaft at location shown in the respective drawing. Following information has to be punched at reference clock position number 12 and is to be bordered with oil paint.

- BHEL Purchase order number
- BHEL order drawing number with their revision number
- BHEL specification number with their revision number
- Heat Number
- Supplier reference identification

This shall be confirmed with authorized work inspector's stamp next to the identification.

9.0 DOCUMENTATION:

The supplier shall furnish 4 copies of test certificates in accordance to EN10204 B, unless otherwise stated on the order.

The test certificates shall bear the following information:

BHEL Reference:

- a) Purchase Order No.
- b) Drawing number with their revision number
- c) Purchase Specification number with their revision number

Supplier's Reference:

- a) Name of supplier
- b) Material Identification
- c) Melt Number & melting process

REV 07

निर्माणाधीन
WORKED BY

Ashish
Ranjan

21.08.2018

जांचकर्ता
CHECKED BY

Gopal
Krishnan

21.08.2018

P-3754

संस्थान क्रय विनिर्देश (हीप : हरिद्वार)

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संस्थापक एवं कोषाधीन
के बीच के अंतर्गत अन्य सभी अधिकार सुरक्षित हैं। इस दस्तावेज़ को किसी भी रूप में प्रसारित करने से पूर्व
आपकी अनुमति के बिना नहीं किया जा सकता है।

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- a) Details of steel ingot & forging process:
Dimension, ingot weight, forging process and Forging reduction ratio (F_{max}/F_{end} at the largest diameter)
- b) Details of heat treatment, method of cooling, actual time and temperature sequence, soaking time, heating and cooling rate.

Test Results:

- a) Melt analysis along with tramp elements.
- b) Product analysis
- c) Result of residual stress measurement
- d) Mechanical test results (all individual values & test piece locations are to be indicated).
- e) Ultrasonic examination results
- f) Results of the MPI of axial and if applicable radial bores
- c) Heat Stability test results
- d) Dimensional report

10.0 CLEARANCE FOR DELIVERY:

The entire results of test performed are deciding factors for the clearance of the delivery. BHEL shall evaluate the total results with respect to intended operational requirements for the forging and judge accordingly the permissibility of deviations, if any.

The clearance does not relieve the manufacturer from the responsibility for hidden impermissible defects, which may be found later on.

11.0 DEVIATIONS:

Deviations from this Purchase Specification, which arise during manufacturing, shall be submitted to BHEL in writing, giving full details of the deviation. Acceptance of concession request will be at the sole discretion of BHEL. BHEL has right to reject material in case of any deviation from specified properties even if testing is not explicitly specified.

12.0 PACKING & DISPATCH:

Before dispatch, the forging shall be suitably packed to prevent corrosion and damage during transit. Support points shall be protected against corrosion and mechanical damage. Axial bore shall be sealed air tight by means of a plastic plug (polycarbonate). The details are given in Annexure-03. Prior to sealing, the whole surface of the bore shall be protected with water displacing slushing oil (dewatering fluid). BHEL must be informed about the used product.


13.0 CROSS REFERRED STANDARDS:

- | | | | |
|--------------------|---------------|---------------|-----------------|
| 1. AA0850150 | 2. ASTM E 837 | 3. AA0850155 | 4. TLV511500001 |
| 5. TLV3930 part 12 | 6. EN10204 | 7. ISO 6892-1 | 8. ISO 148-1 |



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10/09/21

P-3754

दिनांक एवं समय DATE		संस्थान क्रय विनिर्देश (हीप - हरिद्वार) PLANT PURCHASE SPECIFICATION (HEEP - HARDWAR)	HW 19468 पृष्ठ का Page 6 of 8
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सुपरसेडिज INVENTORY NO.	भारतीय स्टील संकाय भारतीय स्टील लि.	Annexure 1 CONTENT / DETAILS OF MANUFACTURING PLAN To confirm that the order requirements comply with the quality-assured manufacturing process, the following information shall be given to the purchaser:	
COPYRIGHT AND CONFIDENTIAL The information on this document is the property of Tata Steel Heavy Electrical Limited. It must not be used directly or indirectly in any way detrimental to the interests of the company.	स्वत्वाधिकार एवं गोपनीय इस दस्तावेज की सभी सूचनाएं और संशोधन की सुरक्षा गोपनीय है।	<ol style="list-style-type: none"> 1 Melting, Steel Treatment, Ingot Pouring <ul style="list-style-type: none"> • heat analysis, method of melting, ladle treatment, method of deoxidation, method of degassing • method of ingot pouring, number and weight of melts in the ingot • ingot weight and average diameter, L/D ratio 2 Forging Process <ul style="list-style-type: none"> • force of the press, forging weight • portion of top scrap, portion of bottom scrap • number of forgings in the ingot, • final forging contour, forging sketch • detailed forging sequence with sketch of forging dimensions • special forging procedures are to be reported • total straightening forging ratio 3 Preliminary Heat Treatment <ul style="list-style-type: none"> • heating rate • holding temperatures and holding times • cooling rates • method of temperature measurement 4 Internal Tests and Inspections before Quality Heat Treatment 5. Quality Heat Treatment <ul style="list-style-type: none"> • sketch of heat treatment contour including position in the ingot and position of specimens (If no heat treatment sketch is made, a UT inspection sketch and a specimen's position sketch shall be available and the heat treatment allowances shall be reported.) • heat treatment: vertical • heating rates • holding temperatures and holding times • cooling rates • method of cooling, dipping or spraying • method of temperature measurement 6 Tests and inspections after Heat Treatment <ul style="list-style-type: none"> • mechanical tests with sketch of specimen position (distance to heat treatment contour) • residual stress measurement, position of test spots and method of measurement • surface condition after machining for NDE • surface crack inspection according to TLV • ultrasonic inspection • dimensional check 7 Heat Stability Test <ul style="list-style-type: none"> • position of bearing and measuring areas • method of heating • surface anti-rust coating 8 Final Inspections, Documentation & Dispatch 	

दिनांक एवं समय DATE	सुपरसेडिज INVENTORY NO.	REV 07	निर्माकर्ता WORKED BY	Ashish Ranjan		21.08.2018
दिनांक एवं समय DATE	सुपरसेडिज INVENTORY NO.		जांचकर्ता CHECKED BY	Gopal Krishnan		21.08.2018

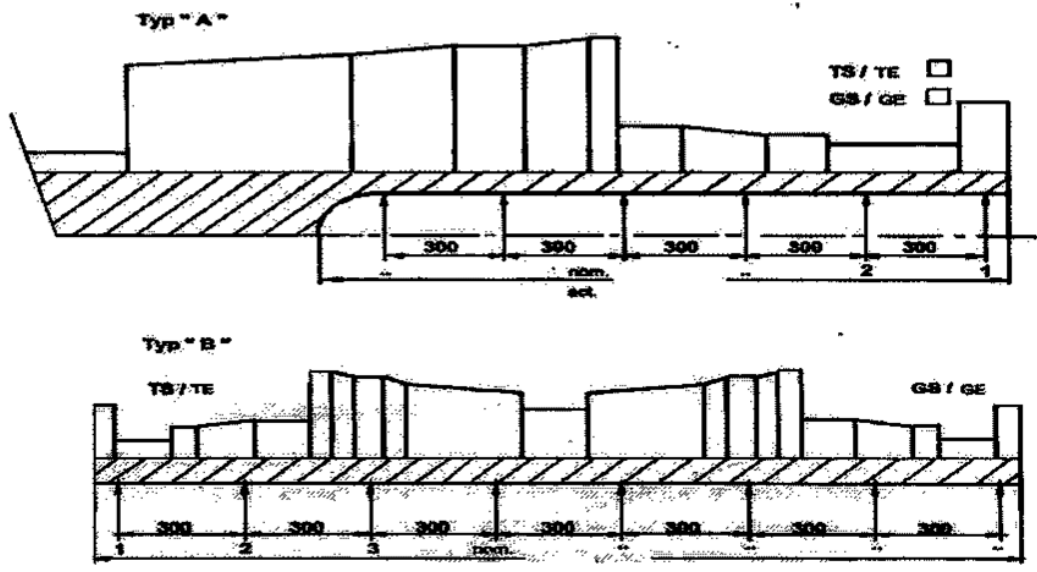
Annexure - 02

IP/HP Turbine Shaft: Inspection of Axial Bore

Test Record:

Job Name:	PO No:
Drawing No.:	Material Spec.:

Roughness: Nom./Act.
Diameter : Nom.



Measuring Point	Diameter	Measuring Point	Diameter


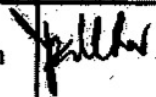
Remarks:

Date:

Signature

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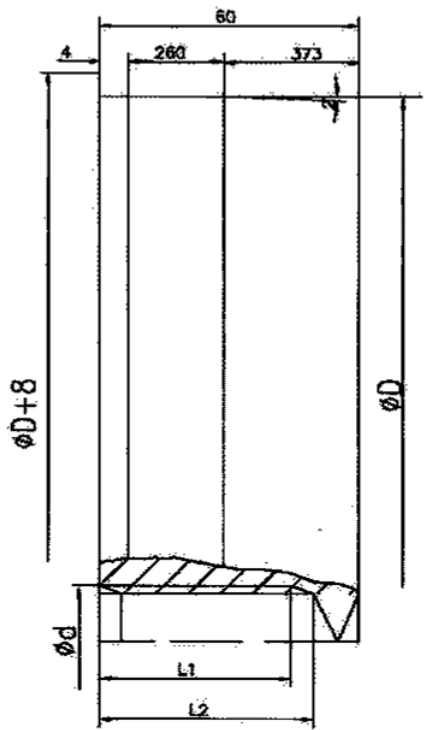
REV : 07

निर्माणाकर्ता WORKED BY	Ashish Ranjan		21.08.2018
जांचकर्ता CHECKED BY	Gopal Krishnan		21.08.2018

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 23354

Annexure - 03

Plugs for trepanning bores in turbine and generator rotors



$\text{ØD (fit of plug)} = \text{bore diameter of rotor} + 0.25 \text{ tolerance} + 0.05$

Thread dimensions	Ød	l ₁	l ₂
Ød ≤ 60mm	M16	31	40 ⁺¹
Ød > 60 - ≤ 130MM	M20	31	42 ⁺¹
Ød > 130	M27	31	44 ⁺²

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प्रो. सं. / री. सं.
 23/8/18

संस्थान क्रय विनिर्देश INVENTORY NO 23754	REV 07	निर्माता WORKED BY Ashish Ranjan	जांचकर्ता CHECKED BY Gopal Krishnan	21.08.2018 21.08.2018
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