



**BHARATH HEAVY
ELECTRICAL LIMITED
RAMACHANDRAPURAM
HYDRABAD-502032
ANDHRA PRADESH, INDIA**

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ENQUIRY**PURCHASE
DEPARTMENT**

SUPPLIER CODE:	Enquiry No.	Enq. Date	No. of Items	DUE DATE OF QUOTATION
Name&Address	B508IT8A1864SR1	26-DEC-08	001	23-JAN-09

Enq. Sl. No	Indent (MPR) No.	Material Code	Drawing No. Description & Specification	Unit Code	Unit	Quantity	Delivery Schedule	
							Date	Quantity
001	IT8P1854 001 IT8P1856 001 IT8P1858 001 IT8P1860 001 IT8P1862 001 IT8P1864 001	ST9507350080	ROTOR SPEC: HY19473 REV:01 AMND: VAR:00 DRG:11020162903 VAR:00 REV:03	01	NOS	6.000	31-AUG-09	6.000

Remarks: 1) Vendor shall submit the filled format of ANNEXURE-I (Check list for Techno-Commercial terms) of this enquiry, duly signed and stamped, along with their technical bid. 2) All necessary documents of this enquiry has sent by E-mail on dated : 26/12/2008.	TEST CERTIFICATE REQ: YES GUARANTEE RAQ: YES SAMPLE REQ: NO	For and on-behalf of Bharat Heavy Electricals Limited SAMBASIVARAMI REDDY G DY MANAGER / PURCHASE TC & GT
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ANNEXURE - I

TWO PART BID SYSTEM

ENQUIRY NO : B508IT8A1864SR1, Dtd:26/12/2008. DUE DATE: 23/01/2009.

This is a mandatory document to be filled and attached to your technical bid for evaluation
(Otherwise your bid will be disqualified)

CHECKLIST OF GENERAL TERMS & CONDITIONS OF ENQUIRY

Sl. No.	Terms & Conditions	Supplier confirmation	Deviations / Remarks
1.	<p>Two Part Bid shall consist of:</p> <ul style="list-style-type: none">• Techno commercial Bid, with all technical specification & scope and all applicable Commercial Terms and Conditions including applicable duties/taxes/other charges, except the price, AND• Price Bid, containing ONLY the price and duties/taxes/other charges applicable and should not contain any technical and commercial terms and conditions. <p>a) Technical bid and price bid should be submitted in separate sealed covers – putting them in third cover.</p> <p>b) The details like Tender No, Due Date, Technical Bid or Price Bid, as the case may be, shall be clearly super-scribed on each cover. The third cover containing both technical and price bid covers should be super-scribed with Tender No, Due date and Supplier name.</p> <p>c) Techno-commercial Bid will be opened first and after freezing technical and commercial conditions only, the Price Bid will be opened.</p> <p>d) The date for the Price Bid opening shall be intimated to all the Techno-commercially qualified bidders before the Price Bid is opened.</p> <p>e) The bidder (s) will also be informed, if their Tehno-commercial bid is not acceptable</p>		
2.	<p>Revised offers :</p> <p>a) The bidders will be allowed to submit the impact due to changes in technical scope /commercial terms.</p> <p>b) Revised offers will not be accepted unless asked for/ or any changes in specification/drawings.</p>		
3.	<p>Offer validity should be 90 days minimum from date of Technical bid opening.</p>		
4.	<p>Quoted PRICES (after placement of P.O) shall be FIRM and valid till complete execution of the Order without any escalation/increase for any reason whatsoever.</p>		
5.	<p>Payment Terms:</p> <ul style="list-style-type: none">• For Indian vendors: 100% payment within 90 days (45 days incase of SSI Units) from the date of dispatch of materials.• For Foreign vendors: 100% payment against irrevocable LC (LC will be opened 30 days prior to dispatch schedule).		
6.	<p>Packing :- Packing & forwarded charges if any shall be included in your quoted price.</p>		
7.	<p>Terms of Delivery: The items are to be quoted on Ex-WORKS / FOR – BHEL STORES for Indian vendors and FOB – Nearest Port for Foreign vendors.</p> <p>Delivery Period: _____ weeks/months from the date of LOI/PO Delivery shall be strictly quoted w.r.t. the date of LOI/PO only and not linking to any other aspects like approval of drawing/data sheelts/QP etc.</p>		

	Please note that delivery is the essence of the tender. Offers of best delivery schedules will be preferred.		
8.	Third Party Inspection: (Mandatory) <ul style="list-style-type: none"> 1. The vendor shall submit the test procedure and quality plan for approval immediately on placement of order. These items shall be inspected by M/s LLOYDS (Inspection agency). 2. Inspection charges shall be inclusive in your offer. 		
9.	Guarantee: Materials should be guaranteed for a period of 18 months from date of supply or 12 months from the date of assembly, whichever is later.		
10.	Penalty: <ul style="list-style-type: none"> a) Penalty (Not Liquidated Damages) will be levied @ 0.5% per week of delayed supply (w.r.t Delivery clause) not exceeding 10% of Total Order value b) No grace period allowed for calculating penalty period. c) Delivery for penalty purpose is w.r.t LR date/ Excise invoice date/ Third party inspection clearance certificate date. 		
11.	<ul style="list-style-type: none"> a) Price Bids Shall be evaluated on landed cost basis i.e., TOTAL COST TO BHEL (after considering CENVAT or VAT benefit, if any) and w.r.t the finalised Technical Scope and Commercial conditions only. b) In case BHEL decides to load the vendor/vendors on any deviations on Commercial condition(s) whatsoever, it shall in advance intimate such criteria for loading to the concerned vendors before price bid opening c) In case of Multiple items, BHEL has the right to evaluate and arrive at the lowest bidder on Individual item / Total basis at its discretion, and in the interests of BHEL. 		
12..	If you are new supplier, please indicate the source of Raw material in your technical bid.		
13.	BHEL reserves the right to increase / decrease the quantity indicated in the enquiry.		
14.	Supply should strictly confirm to BHEL drawings / specifications. All tests should be carried out as per BHEL drawings / specifications. All Test certificates, guarantee certificates and Pre inspection reports (PIR) should be furnished along with dispatch documents.		
15.	<ul style="list-style-type: none"> a) In case of first time supply to BHEL Hyderabad, vendor should comply with the requirements of HY0800099 (first-piece qualification) and HW0850197 (thermal stability test). However, these requirements can be reviewed based on the reference list of the vendor. b) Radial Trepan core shall be tested by the supplier as per BHEL specification HW0850196 and as mentioned in the drawing. c) Residual stress measurement shall be done as per BHEL specification HW 0850397. d) Vertical heat treatment is mandatory. e) Vendor should specifically confirm all clauses of the relevant specifications for every item quoted. f) Reference list along with documentary evidence shall be provided along with techno-commercial bid for evaluation. 		
16.	BHEL may choose for placing repeat order for additional quantity, as and when required, with the acceptance of vendor.		
17.	BHEL reserves all rights for rejecting any or all offers without assigning any reason therefore in the interests of BHEL.		
18.	Vendors shall submit offers within the due date. If, no communication is received from any vendor within the due date, it will be deemed that the vendor can not meet our delivery / technical requirements.		

NOTE TO VENDORS:

- a) For new vendors supplying rotors for the first time to BHEL Hyderabad, the clause 16 of the above should be confirmed specifically.
- b) Vendors to indicate their response to each of the above clauses either by 'YES' or "NO" in the Supplier confirmation column.
- c) Vendors, if taking deviations from the specified conditions, may indicate the same clearly in deviation column and if needed on a separate sheet, with reasons for such deviation and in such a case BHEL reserves the right to reject the offer summarily or load the vendor suitably – solely at its discretion and in its interests.
- d) Commercial Conditions quoted in any place other than this format, including stated in Vendor's General Terms and conditions enclosed, if any, shall be summarily ignored and be invalid for evaluation of the Preferred Bidder.
- e) Who ever desires to send offers on their own risk (complete in all respect) via E-mail have to send the scanned copies of offers duly signed and stamped, to the common E-mail address – tenderbox@bhelhyd.co.in. Offers sent to any other E-mail ID or in-complete offers or offers without signature and stamp of the vendors shall be treated as un-solicit and will not consider for evaluation purpose.
- f) In case of regret, same letter shall be given in open condition (not in sealed cover) or by E-mail to gsrreddy@bhelhyd.co.in.
- g) Vendors to note that the above are specific Terms & conditions only, and in respect of other terms and conditions, BHEL's General Terms & conditions will apply and the same can be obtained upon making a request.

Signature of the supplier with stamp.



**PLANT PURCHASING
SPECIFICATION
HYDERABAD**

HY 19473

Rev. No. 01

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ALLOY STEEL FORGINGS FOR STEAM TURBINE ROTORS

GR: 30 Cr Mo Ni V 511

(Material No.1.6946)

1.0 GENERAL :

This specification governs the technical requirements of steam turbine rotors forged out of steel grade 30 Cr Mo Ni V 511.

2.0 APPLICATION :

Steam turbine rotors having diameters up to 1400 mm..

3.0 CONDITION OF DELIVERY :

The rotor forgings shall be supplied in heat treated and rough machined condition..

4.0 COMPLIANCE WITH NATIONAL STANDARD :

There is no national standard covering this grade of material. However, guidance is taken from KWU TLV 9190/05/06 (June2001).

5.0 DIMENSIONS AND TOLERANCES :

The rotor forgings shall be supplied to the dimensions shown on the ordering drawing. The tolerance shall be as follows unless otherwise specified in the drawing/order.

Upto 500 mm - + 1 mm

Over 500 mm - + 2 mm

6.0 MANUFACTURE :

6.1 The steel shall be made from basic electric furnace and shall be subsequently refined by Vacuum Carbon Deoxidation (VCD) or Electro Slag refining (ESR) process.

6.2 Sufficient discard from Top and Bottom shall be made from the ingot to ensure freedom from piping, segregation and other injurious defects.

6.3 The forging process adopted shall ensure homogeneity of material throughout the section.

**Revisions: Revised as per MOM dtd 30.06.2003
between MES and ST Engg.**

**Issued :
STANDARDS ENGINEERING
DEPARTMENT**

Rev. No	Rev. Date:	Revised:	Prepared:	Approved:	Date:
01	SEPT.03	MES	MALTS. ENGG	AGM(E&CC)	SEP .93.

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6.4 It is important to maintain the actual centre of the forging, as far as possible identical with the centre of the ingot.

6.5 Press straightening, if necessary, may be performed before heat-treatment.

6.6 **CLOCKING SYMBOL :**

Before heat-treatment, clocking symbols 3-6-9-12 shall be stamped on the rotor. If the symbols are transferred during manufacture, they shall be restamped in the same clock wise position. The clocking symbols shall be used for reference purposes in recording the position of defects, etc. The clocking symbols shall be encircled with oil paint for easy identification.

6.7 After heat-treatment, the forging shall be rough machined to the dimensions and surface finish shown on the ordering drawing.

6.8 Before starting the production, the manufacturer shall submit Manufacturing and Inspection Sequencing plan (MIP) in accordance to the specification HY 0652099 of BHEL Hyderabad.

7 **CHEMICAL COMPOSITION:**

The chemical composition of the material shall be as follows:

Element		C	Si	Mn	Cr	Mo	Ni	V	P	S	Al (Total)
Heat analysis	Min	0.27	-	0.30	1.10	1.00	0.50	0.25	-	-	-
	Max.	0.31	0.10	0.80	1.40	1.20	0.75	0.35	0.007	0.007	0.010

7.1 **Tramp Elements:** The tramp elements shall be within following limits.

$$\text{Cu} = 0.12 \text{ max.}$$

$$\text{As} = 0.02 \text{ max.}$$

$$\text{Sb} = 0.02 \text{ max.}$$

$$\text{Sn} = 0.015 \text{ max.}$$

7.2 Small deviations in chemical composition are permissible only after approval from BHEL, provided that the specified properties are not impaired.



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8.0 HEAT TREATMENT:

8.1 The rotor forging shall be heat treated vertically followed by oil or mist quenching. The heat treatment shall be done to obtain tempered upper bainitic structure uniformly through-out the cross section free of ferrite in the centre. The hardening temperature shall be between 940°C and 960°C but 950°C shall be the target. The tempering temperature shall be selected suitable to achieve the 0.2 % yield strength with the possible toughness. It shall be between 690 and 710° C.

Actual heat treatment cycle followed shall be reported in test certificate

8.2 The minimum amount of residual stresses are to be aimed by controlling the rate of cooling and also duration of tempering treatment. The residual stresses are not allowed to be more than 60N/mm² on any point. The residual stresses are to be measured on the heat treatment contour according to KWU 'Ring Core' method. The locations of residual stress measurement shall be 120° apart from each other on the periphery of the rotor and in a spiral line at three places. In lieu of KWU-Ring core method residual stress measurement may be carried out by 'Blind hole method' as per ASTM E. 837 However, all the other conditions such as location of tests, acceptance criteria' etc remains same.

8.3 In case the required properties have not been obtained, reheat-treatment of the forging is to be carried out. The maximum number of reheat-treatments permitted are two. However, retempering is not considered as reheat treatment.

9.0 SELECTON OF TEST SAMPLES:

9.1 The location of the test pieces shall be shown on the ordering drawing. The test samples shall not be removed before heat treatment.

9.2 The test samples are to be clearly identified with identification number. The association with the forging is to be conformed by BHEL inspector/ Lloyd's. The balance material shall be delivered along with the forging.

10. MECHANICAL PROPERTIES:

10.1 The mechanical properties, when tested on the tangential or radial test pieces shall conform to the following at room temperature.

Tensile Strength N/mm ² Max.	0.2% proof Stress N/mm ²	% Elongation L=5d Min.	% Reduction in area Min.	Impact Strength J Min.
850	550 - 700	15	40	24

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Axial core testing: If specified on the ordering drawing, the axial core shall be taken out by trepanning and the following properties shall be obtained on the samples taken in radial direction.

0.2% Proof Stress : :530 N/mm² Min.
Impact Strength

(Average of 3 samples) : : 55 J min. at +80⁰ C
ISO-V notch

FATT : : ≤ +80⁰ C,

T: Tangential Test piece : : Q Radial test piece.

Note: a) Tensile test shall be carried out as per IS :1608 or any National Standard.

b) Impact test shall be carried out as per IS:1757 ISO-V notch or any National standard the minimum impact strength value specified above is the average of three samples at the same location. Only one value is permitted below the specified min. value, but in no case shall be lower than the 2/3 of the same. All values shall be reported in certificate..

c) The location of tensile and impact specimens shall be in a distance of 40mm from the heat treated surface.

11.0 NON-DESTRUCTIVE TESTS: (outer and Inner quality)

11.1 UT- EXAMINATION:

Ultrasonic test and evaluation shall be carried out as per siemens PA standard 14/24. 51

11.2 Magnetic particle test:

Magnetic particle test and evaluation shall be carried out as per siemens standard PA 14/24. 51

12.0 METALLOGRAPHIC TEST:

Metallurgical test shall be conducted on samples taken from broken tensile test pieces. photo micrographs at 500x shall show tempered upper bainitic structure and the photomicrograph (original) shall be submitted to BHEL along with test certificates.



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13. THERMAL STABILITY TEST:

If mentioned in the drawing or purchase order, Thermal Stability test shall be carried out at 30⁰ C Below the tempering temperature according to BHEL, Hardwar Standard . A and D type swings will not be considered when they are explainable due to surface effect. In case of occurrence of B type swing the test shall be conducted till no more stresses are left to be released. C type swing greater than or equal to 0.05 mm shall not be allowed. BHEL Hyderabad reserves right to participate for verification

14. FIRST PIECE QUALIFICATION TESTS:

When ever the supplies are made for the first time to BHEL the requirements of BHEL specification HY0800099 shall also be applicable in addition to this specification.

15. INSPECTION AT SUPPLIER'S WORKS:

BHEL representative shall have all reasonable facilities offered to him, at any time, by the supplier to satisfy himself that the material is being furnished in accordance with this specification. The representative shall have free access at all times while the work on the contract is being performed, to all parts of the manufactures works.

16. TEST CERTIFICATE:

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

- a) HY 19473 Rev .01
- b) BHEL Order No.
- c) Item Description and Drawing No. of the forging.
- d) Supplier's Name.
- e) Melt No. and Forge No.
- f) Results of chemical analysis alongwith trace elements.
- g) Results of Mechanical Tests & FATT (if applicable)
- h) Results of residual stresses.
- i) Report of ultrasonic testing giving details of probe type and size, frequency, sensitivity, sketch showing the areas covered etc.
- j) Report of Metallographic test alongwith microphotographs (original).
- k) Actual Heat treatment charts
- l) Results of thermal stability test, if called for in the drawing/purchase order.
- m) Report magnetic particle inspection.
- n) Copy of approved MIP duly attested by BHEL representative.

**PLANT PURCHASING
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16.2 The certificate shall be attested by chief of inspection/chief metallurgist of the supplier and BHEL representative.

17.0 MARKING :

The following details shall be punched clearly on one end of the forging.

- a) HY 19473 Rev.01
- b) Forging No. and Melt No.
- c) Drawing NO.
- d) Manufacturer's Stamp.
- e) BHEL Inspector's stamp
- f) Clocking symbols.
- g) Top and Bottom sides of ingot.

18. PACKING AND TRANSPORTATION:

Rotor forgings shall be properly protected from corrosion and damage during transit, journal portions shall be protected with anti-corrosive compound.

19. REJECTION AND REPLACEMENT:

In the event of any forging proving defective in machining, testing erection and operation such forging shall be rejected notwithstanding any previous acceptance. The supplier shall replace the rejected forging at his own cost.

20. CROSS REFERRED STANDARDS:

- 1 TLV 9190/05/06
- 2 HY 06520999 (for MIP)
- 3 HY0850188 (UT & MPI)
- 4 HW0850197 (Thermal stability test)
- 5 HY0800099 (First piece qualification)



**PLANT STANDARD
HYDERABAD**

HY0230261

REV. NO. 03

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LIST OF APPLICABLE STANDARDS ON LIMITS, FITS AND TOLERANCES

1.0 SCOPE:

The standard covers the list of applicable standards on Limits, Fits and Tolerances. These standards are applicable unless or otherwise specified.

2.0 LIST OF APPLICABLE STANDARDS:

SL. NO.	STANDARD NO.	TITLE
1.	AA0230201 -	Limits and Fits (Tolerance grade, Position and Class).
2.	AA0230202 -	Limits and sizes for commercial bolts and nuts.
3.	AA0230204 -	Guide for selection of Fits.
4.	AA0230206 -	Standard limits for Shafts (upto 500 mm).
5.	AA0230207 -	Standard limits for Shafts (above 500 mm and upto 3150 mm).
6.	AA0230208 -	Allowable deviations for dimensions without specified tolerances (linear and angular).
7.	AA0230402 -	Permissible deviations for untoleranced dimensions of castings.
8.	AA0230403 -	Tolerancing system ISO Metric Screw Threads
9.	AA0621101 -	Tolerances and Machining allowances for Flame cutting.
10.	AA0621104 -	General tolerances for welding constructions for length and angles.
11.	AA0621105 -	General tolerances for welded structures – form and position.

Revisions:

Issued :

Withdrawn standards deleted (2 Nos.).

STANDARDS ENGINEERING DEPARTMENT

Rev. No. 03

Amd. No.

Reaffirmed:

**Prepared:
MANAGER
(STDS. ENGG.)**

Approved:

AGM (E&CC)

Date of 1st issue:

Dt. OCT. 06

Dt.

Year:

MAY, 1992

HY0230261

REV. NO. 03

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**PLANT STANDARD
HYDERABAD**



NOTE:

1) AA 023 02 08

Medium class of deviation is applicable, if the same is not mentioned on the drgs./specs.

2) AA 023 04 02

Tolerance class 5 is applicable, if the same is not mentioned on the drgs./specs.

3) AA 062 11 04

Accuracy class A is applicable if the same is not mentioned on the drgs.

4) AA 062 11 05

Accuracy class E is applicable, if the same is not applicable on drgs.

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PLANT STANDARD
HEEP-HARDWAR

HW 0850197

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SIGN & DATE

SUPERSEDES INVENTORY No.

BASED ON TWF.M.151, 6/96

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HEAT-STABILITY TEST

1.0 SCOPE:

This specification is valid for heat stability test for H.P and I.P rotor shaft forging of steam turbine.

2.0 REFERENCE DOCUMENTS:

Assistance has been taken from SEP 1950, 5/87.

3.0 REASON FOR TESTING :

- The heat stability test gives information of proper heat-treatment in respect of
- unsymmetrically distributed residual stresses remaining after the tempering operation, which may get relaxed during the service time and thus may cause bending of rotor (B type deflection).
 - A rotationally symmetrical microstructure (C-Type deflection)

4.0 SHAFTS TO BE TESTED :

The heat stability test is carried out on shafts only, which have a service temperature of > 450°C. The rotors which have to work at temperature much lower than 150 °C from tempering temperature, insignificant stresses will be released & hence no stability test is required. In addition to these for low service temperature, the shafts are of material having excellent hardenability.

A heat stability test will be carried out in case of

- prototypes
- new suppliers
- special service conditions or service stresses(decision by design/calculation department)

SUPERCEDES THE REV SHEET UNDER THE SAME NO. 301 CHANGE ADVISED TO TSK-MTE-98-452 NAME ALS - SIGN [Signature] - DATE 28.1.99

SIGN & DATE

21/1/99

INVENTORY No.

P-22

TSX	R. BHATIA	R.Bhatia/29-1-99	DRAWN	NAME	SIGN & DATE
QAX	TSK with	[Signature]	WORKED	A.K.SARKAR	[Signature] 12.1.99
STE	A.S.	[Signature]	CHECKED	J.P.MEENA	[Signature] 12.1.99
AGREED DEPT	NAME	SIGN & DATE	SUPERVISED	V.B.ARORA	[Signature] 12.1.99
REVISION :			APPROVED: PLANT STANDARDIZATION COMMITTEE		
			PREPARED: MTE	ISSUED: STANDARDS DIVISION	DATE: 29.1.99

6.48



PLANT STANDARD
HEEP-HARDWAR

HW 0850197

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SIGN & DATE

INVENTORY No.

21/2/99

P-22

5.0 TYPES OF DEFLECTION:

The possible types of deflection which can appear during the heat stability test are represented in Annexure : 01 (REFER SEP-1950)
5/87

6.0 PERFORMANCE OF TEST :

The heat stability test is carried out in the rotational symmetrically machined condition after the completed heat-treatment operation as per the cycle given in Annexure:02.

6.1 Rate of heating up and Temperature Cycle:

About 50°C / hr

6.2 Testing Temperature:

Tempering temperature minus 30°C.

In special cases other temperatures can be agreed upon.

The testing temperature should lie above the service temperature as high as possible to assure that during the later turbine operation possibility of rotor deflection is avoided. The cycle (Ref. Ann:02) marked as firm/dark line is mandatory i.e. one dip of about 150 °C is essential as shown in sketch.

6.3 Cooling Rate:

To avoid new stresses during cooling from testing temperature to room temperature a cooling rate of about 15°C/h till approximately 200°C is to be applied; than a quicker cooling rate can be used.

Ⓒ SUPERCEDES THE OLD DRS SHEET UNDER THE SAME N - 301 CHANGE ADV. NO. JSK-MTE-98-452 NAME AKS - SIGN [Signature] - DATE 23-1-99

REVISION :

WORKED BY	AKSARKAR	[Signature]	12-1-99
CHECKED BY	JPMEENA	[Signature]	12-1-99



PLANT STANDARD
HEEP-HARDWAR

HW 0850197

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SIGN & DATE

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INVENTORY No.

2/2/99

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6.4 Location of Deflection:

On the coupling a clockwise numbering is to be provided in direction of power run which makes possible the fixing of an appeared deflection on the circumference.

6.5 Readings:

Temperature, deflection and location of deflection are to be checked each hour and documented.

7.0 ACCEPTANCE CRITERIA :

A and D type deflections are caused by radiation and have no influence on the later turbine operation; here exists convection only. These are acceptable.

In case of detection of B - type deflections the cycling of testing temperature shall be continued till the rotor becomes stable, i.e. after the temperature dip of about 150 °C the deflection of the shaft shall lie approximately at the same level in each case at the end of the holding times at testing temperature. After reaching heat stability the shaft is acceptable, independent of the value of the B-type deflection.

C-type deflections ≥ 0.05 mm are not acceptable.

Ⓒ SUPERCEDES THE OLD DRG SHEET UNDER THE SAME NO. B.3.4
CHANGE ADV. CE NO. TSX-MTE-98-452
NAME AKB SICH DATE 12-1-99

REVISION :

WORKED BY	AUSARKAR	<i>[Signature]</i>	12-1-99
CHECKED BY	JP MEENA	<i>[Signature]</i>	12-1-99



PLANT STANDARD

HEEP—HARDWAR

HW 0850197

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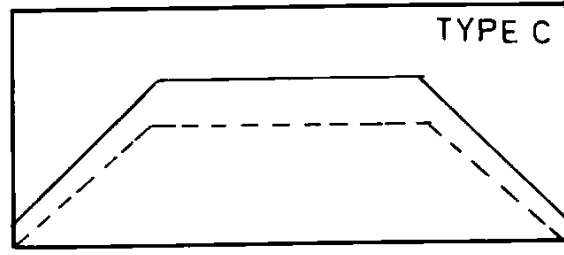
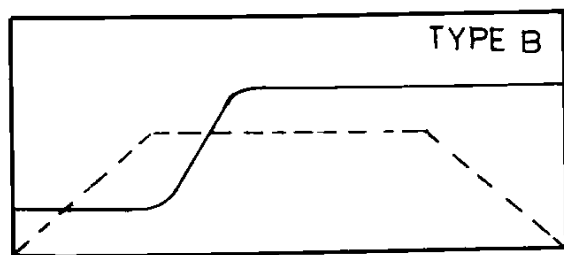
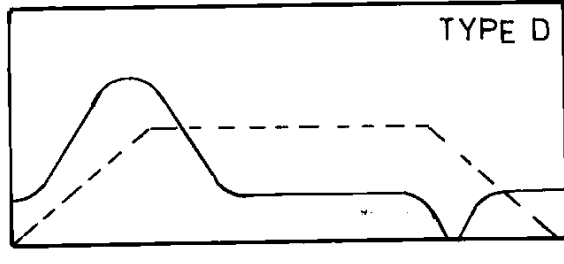
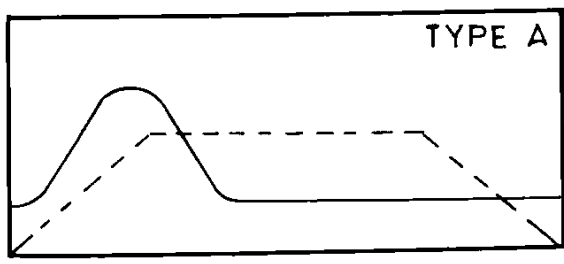
ANNEXURE-01

SIGN & DATE

SUPERSEDES INVENTORY NO.

TYPES OF DEFLECTION

ECCENTRICITY
TEMPERATURE



TIME

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SIGN & DATE

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①

SUPERCEDES THE OLD Dwg. SHEET
 UNDER THE SAME NO. OR
 CHANGE ANY OF NO. TSX-MTE-98-452
 NAME AKS SIGN [Signature] DATE 29.1.99

WORKED BY	A.K.SARKAR	<u>[Signature]</u>	12.1.99
CHECKED BY	J.P.MEENA	<u>[Signature]</u>	12.1.99



PLANT STANDARD

HEEP--HARDWAR

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ANNEXURE-02

SIGN & DATE

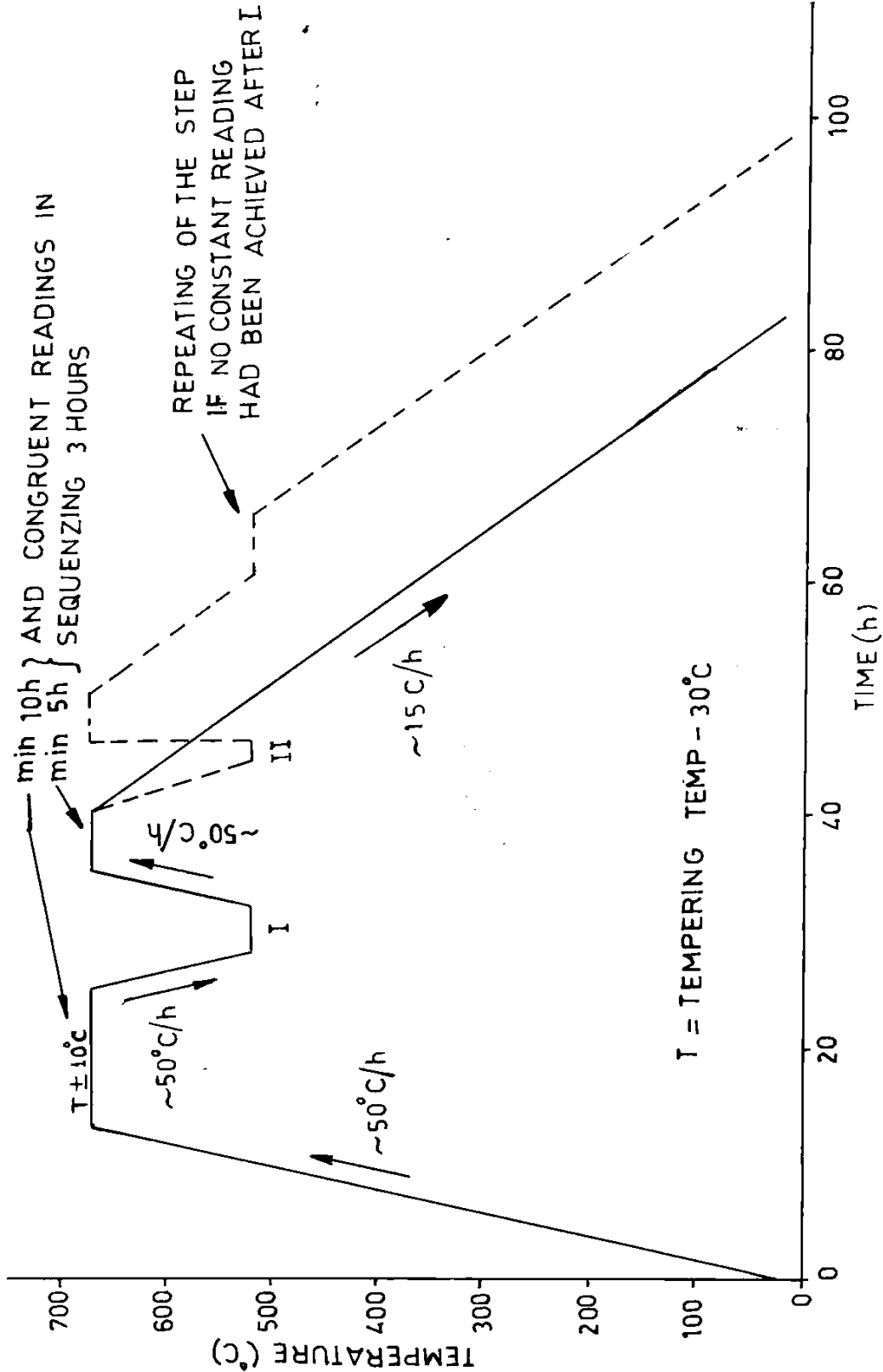
SUPERSEDES INVENTORY NO

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SIGN & DATE

INVENTORY NO

HEAT STABILITY CYCLE



APPROVED BY: *[Signature]*
DATE: 12-01-99
SUPERSEDES BY: *[Signature]*
DATE: 12-01-99
DRAWN BY: *[Signature]*
DATE: 12-01-99
CHECKED BY: *[Signature]*
DATE: 12-01-99
INVENTORY NO: P-22
SIGN & DATE: 12-01-99

WORKED BY	A.K.SARKAR	<i>[Signature]</i>	12-01-99
CHECKED BY	J.P.MEENA	<i>[Signature]</i>	12-01-99



PLANT STANDARD

HW 0850197

PAGE 6 OF 6

ANNEXURE - I

RECORD OF CHANGES

SIGN & DATE

INVENTORY NO
SUPERSEDES

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REV CODE	NO OF CHGS	DOCU NO	SHEET NO	SIGN	DATE	REV CODE	NO OF CHGS	DOCU NO	SHEET NO	SIGN	DATE
C	-	TSX-MTE-98-452	SUPERSEDES OLD SPEC. UNDER THE SAME NUMBER	<i>[Signature]</i>	12.1.99						

(C) SUPERCEDES THE OLD DRAW SHEET UNDER THE SAME NUMBER CHANGE ADVISED BY TSX-MTE-98-452 NAME AKS S.L.N DATE 12.1.99

DISTRIBUTION OF PRINTS

DEPTT	TGE	STE	AME	DME	HGE	HTE	ACE	HXE	MTE	MRL	IN-SUL SYS	HLE	TSX	THC	PPX	MCX	CSX
		✓							✓	✓			✓				
DEPTT	AIX	OSX	CCX	FAX	TFX	TLX (J&T)	TTX-GTX	TTX-ST	TTX-HT	TTX-EM	WT	QAX	QCX	PCM	WC 202	WC 205	WC 227
								✓				✓	✓				
DEPTT	FBM BL II	HTM WC276	STM WC236	TLM WC832	ACM WC291	CIM WC330	FGM WC356/361	SUM WC370	WWM WC386	HXM WC390	WEX WC 6100	ESX	TRX	TAX	AVP	BP GFE	HY
																✓	4

SIGN. & DATE
[Signature] 21/2/99

INVENTORY NO.
P-22

REVISION	DRAWN	WORKED	CHECKED
		A.K.SARKAR <i>[Signature]</i>	12.1.99
		J.P.MEENA <i>[Signature]</i>	12.1.99



SIGN & DATE
SUPERSTORES INVENTORY NO.
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RESIDUAL STRESS MEASUREMENTS ON
TURBINE GENERATOR AND SPINDLE
ROTOR SHAFTS.

- 1. GENERAL: This standard covers the requirement of residual stress measurement on the rotor shafts.
- 2. PURPOSE: Due to normal heat-treatment of turbine, generator and spindle rotor shafts, compressive stresses on the surface and correspondingly tensile stresses inside are generated. Since the turbine, generator and spindle rotor shafts are stressed inside with tensile stresses during the operation, the residual stresses are disadvantageous.

Therefore, minimum residual stresses are to be aimed at.

The cooling rates from tempering temperatures are not given in the purchasing specifications of turbine, generator and spindle rotor shafts, hence it is specified that the residual compressive stresses shall not exceed $60N/mm^2$ at any place on the surface of the rotor shaft.

- 3. METHOD:
 - 3.1 The stress measurement shall be carried out according to ring core method*, so that the uniform judgement of the results can be ensured by supplier and BHEL.

*Equipment used for this is patented and supplied by KWU - Muelheim-Ruhr, West Germany.

Prior permission of BHEL is to be sought for use of alternate method for determining residual stresses.

- 3.2 The residual stress measurement shall be carried out after heat treatment at 3 places on surfaces with heat-treatment contour. The locations for measurement on the surface are given in annexure 1, 2 and 3. The measurement shall be carried out at the specified

Revision :		Approved : PLANT STANDARDIZATION COMMITTEE		TI 6-48
H Sharma	Gupta	Issued	Date	
H. SHARMA	K. K. GUPTA	STANDARDS DIVISION		



SIGN & DATE

SUPERVISOR'S
INVENTORY NO.

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SIGN & DATE

INVENTORY NO.

points that shall be 120° apart from each other on the periphery.

3.3 In case residual stress measurement is required to be carried out on the supply contour, of the shaft as per the ordering drawing, prior permission from BHEL shall be obtained in each such case, whether enough surface allowance is available at the proposed location for testing. If necessary, definite locations can be specified by BHEL.

3.4 In case the repeat heat treatment or tempering is required and carried out, the residual stress measurement shall also be repeated.

3.5 BHEL reserves the right to ask the supplier to test on additional locations in case of variations in the obtained test results. The new test locations shall be mutually agreed.

4. TEST RESULTS: The test results are to be furnished on a certificate as per annexures 1, 2, 3 for turbine, generator and spindle shafts respectively.



PLANT STANDARD
HEEP — HARDWAR

HW 0850397

PAGE 3 OF 6

SIGN & DATE

SUPERSEDES INVENTORY NO.

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WORKS CERTIFICATE

ANNEXURE - 1

PURCHASER

DISPATCH NO.

ORDER NO.

IDENTIFICATION NO.

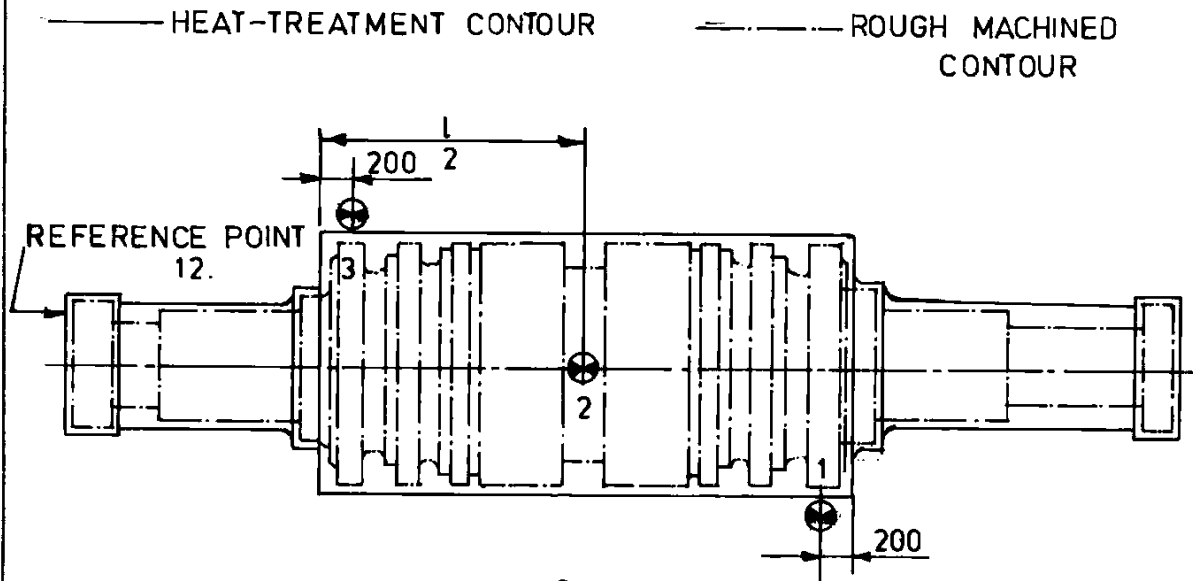
ITEM DESCRIPTION

MATERIAL

HEAT-TREATMENT

RESIDUAL STRESS MEASUREMENT

MEASURING PROCESS: RING CORE METHOD



MEASURING PLACES 1,2,3 AT 120° APART

MEASURING PLACES	1	2	3	4	5	6	
REFERENCE POINTS		(b)					CLOCK POSITION
SPECIFIED	60 N/mm ² max.	60 N/mm ² max.	60 N/mm ² max.				Kg/mm ²
σ_t (TANGENTIAL) (b)							Kg/mm ²
σ_a (AXIAL)							Kg/mm ²

DATE

FIRM

DEPARTMENT

SIGN & DATE

INVENTORY NO.



PLANT STANDARD
HEEP — HARDWAR

HW 0850397
PAGE 4 OF 6

WORKS CERTIFICATE

ANNEXURE - 2

PURCHASER

DISPATCH NO.

ORDER NO.

IDENTIFICATION NO.

ITEM DESCRIPTION

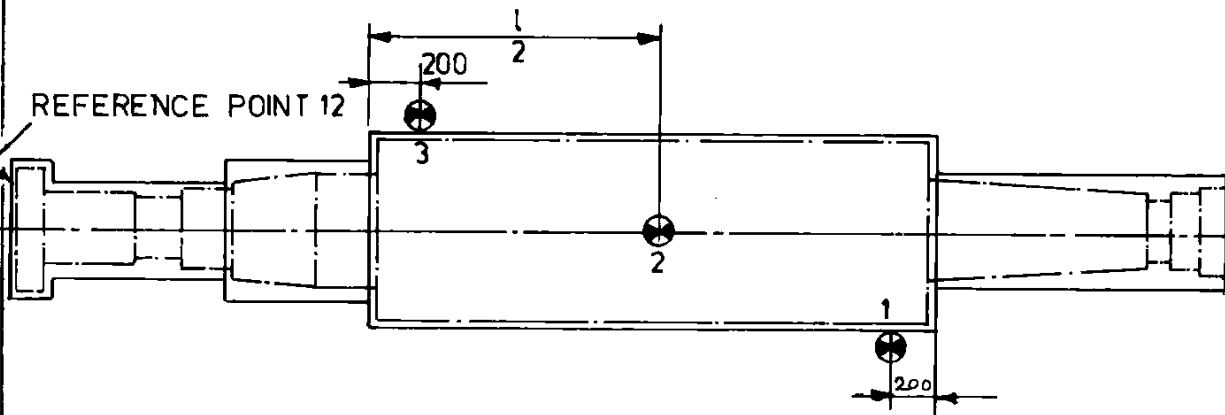
MATERIAL

HEAT-TREATMENT

RESIDUAL STRESS MEASUREMENT

MEASURING PROCESS: RING CORE METHOD

———— HEAT-TREATMENT CONTOUR ———— ROUGH MACHINED CONTOUR



MEASURING PLACES 1, 2, 3 AT 120° APART

MEASURING PLACES	1	2	3	4	5	6	
REFERENCE POINTS		(b)					CLOCK POSITION
SPECIFIED	60N/mm ² max.	60N/mm ² max.	60N/mm ² max.				Kg/mm ²
σ_t (TANGENTIAL) (b)							Kg/mm ²
σ_a (AXIAL)							Kg/mm ²

DATE

FIRM

DEPARTMENT

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SUPERSEDES INVENTORY NO.

SIGN & DATE

SIGN & DATE

INVENTORY NO.



PLANT STANDARD
HEEP — HARDWAR

HW0850397

PAGE 5 OF 6

SIGN & DATE

SUPERSEDES INVENTORY NO.

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SIGN & DATE

INVENTORY NO.

WORKS CERTIFICATE

ANNEXURE - 3

PURCHASER

DISPATCH NO.

ORDER NO

IDENTIFICATION NO.

ITEM DESCRIPTION

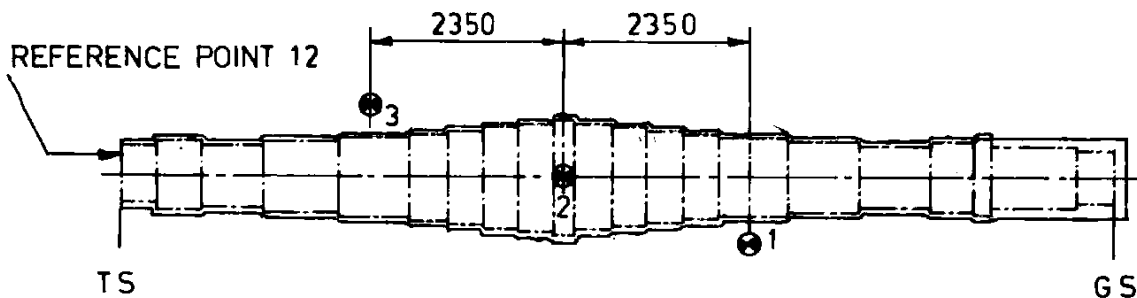
MATERIAL

HEAT-TREATMENT

RESIDUAL STRESS MEASUREMENT

MEASURING PROCESS: RING CORE METHOD

———— HEAT-TREATMENT CONTOUR - - - - - ROUGH MACHINED CONTOUR



MEASURING PLACES 1,2,3 AT 120° APART

MEASURING PLACES	1	2	3	4	5	6	
REFERENCE POINTS		(b)					CLOCK POSITION
SPECIFIED		60N/mm ² max.	60N/mm ² max.	60N/mm ² max.			Kg/mm ²
G_t (TANGENTIAL) (D) G_a (AXIAL)							Kg/mm ²
							Kg/mm ²

DATE

FIRM

DEPARTMENT

RECORD OF CHANGES AND
DISTRIBUTION OF PRINTS

HW 085 03 97
PAGE 6 OF 6

DISTRIBUTION OF PRINTS

DEPTT.	MARK FOR DISTR	DEPT W.C.No.	MARK FOR DISTR
TGE	✓	202	✓
STE	✓	205	✓
AME	✓	227	✓
DME	✓	FBM BL II	✓
HGE	✓	HTM	✓
HTE	✓	STM	✓
ACE	✓	WEX	✓
HXE	✓	ESX	✓
MTE	✓	632	✓
EPX MRL	✓	ACM	✓
QAX	✓	CIM	✓
HLE	✓	FBM-BL-V	✓
SYE	✓	SUM	✓
TSX	✓	WWM	✓
THC	✓	INSV. SYSTEM	✓
PPX	✓	BL. VII	✓
MCX	✓	HY	✓
CSX	✓	BP	✓
AIX	✓		
KWX			
MSX			
CCX			
FAX			
TFX	✓		
TLX	✓		
TTX	✓		
TTX-ST	✓		
TTX-HT	✓		
TTX-EM	✓		
WT	✓		
OCX	✓		
PCM	✓		

RECORD OF CHANGES

CHG	QTY	DOCU No.	CHANGE IN SHEET NO.	SIGN	DATE	CHG	DOCU No.	CHANGE IN SHEET No.	SIGN	DATE
a	1	TSX(MTE) -93-477	STANDARD REAFFIRMED WITHOUT ANY CHANGE	<i>jsf</i>	7-28	✓				
b	6	TSX(MTE) -96-47	3, 4, 5	<i>jsf</i>	3-19	✓				

INVENTORY No.	SIGN & DATE	SUPERSEDS INVENTORY No.	DUPPLICATE INVENTORY No.	SIGN & DATE
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TD-218 Rev 00

**PLANT STANDARD
HYDERABAD****HY 080 00 99****REV.NO. 00****PAGE 1 OF 4****PROCEDURE FOR FIRST PIECE QUALIFICATION OF STEAM TURBINE ROTOR FORGINGS****1.0 SCOPE**

This testing procedure is valid for all turbine shafts and turbine shaft parts at the supplier works for quality assurance and/ or supplier qualification. These tests are in addition to the tests already specified in the order drawing and specification.

2.0 REFERENCED DOCUMENTS

EN 10291, PA 14/24.21 of SIEMENS.

3.0 INSPECTION PERSONNEL

Inspections and correction of the punching is only allowed for qualified and named personnel.

4.0 TESTING**4.1 General**

If tangential and axial cores are given in the order drawing, it is essential that the purchaser is contacted and an agreement is reached with reference to the taking of the specimens. If tangential or axial cores are not specified in the order drawing, same is to be mutually agreed between the BHEL and the manufacturer before placement of purchase order.

4.2 Testing at the tangential core

For the determination of the basic mechanical properties tangential cores are planned (see order drawing).

The creep rupture properties are to be determined from specimens of a separate additional tangential core.

The test position can be seen in attachment 1; the specimens shall be taken from the middle of the core at the maximum radial depth.

Revisions :**Issued :****STANDARDS ENGINEERING DEPARTMENT****Rev.No.****Rev.Date****Revised****Prepared
MATLS
ENGG.****Approved
DGM / TS****Dt.of 1st Issue****00****OCT. 2003**



Testing specimens according to EN 10291, section 7

The following requirements are to be fulfilled:

1. $T = 560^{\circ}\text{C}$,
Initial stress $\sigma_o = 230 \text{ MP}_a$,
Rupture time $t_u = >1000\text{h}$
2. $T = 560^{\circ}\text{C}$,
Initial stress $\sigma_o = 127 \text{ MP}_a$,
Plastic elongation $A_p 1000\text{h} < 0.3\%$
Plastic elongation $A_p 3000\text{h} < 0.5\%$
3. $T = 530^{\circ}\text{C}$,
Initial stress $\sigma_o = 210 \text{ MP}_a$,
Plastic elongation $A_p 1000\text{h} < 0.27\%$

4.3 Testing at the axial core

The testing position is to be seen at attachment 1.

Testing specimens according to EN 10291, section 7

The following requirements are to be fulfilled:

1. $T = 560^{\circ}\text{C}$,
Initial stress $\sigma_o = 230 \text{ MP}_a$,
Rupture time $t_u = >1000\text{h}$
2. $T = 560^{\circ}\text{C}$,
Initial stress $\sigma_o = 127 \text{ MP}_a$,
Plastic elongation $A_p 1000\text{h} < 0.3\%$
Plastic elongation $A_p 3000\text{h} < 0.5\%$
3. $T = 530^{\circ}\text{C}$,
Initial stress $\sigma_o = 210 \text{ MP}_a$,
Plastic elongation $A_p 1000\text{h} < 0.27\%$.



TD-218 Rev.00

**PLANT STANDARD
HYDERABAD****HY 080 00 99****REV.NO. 00****PAGE 3 OF 4****5.0 Test report**

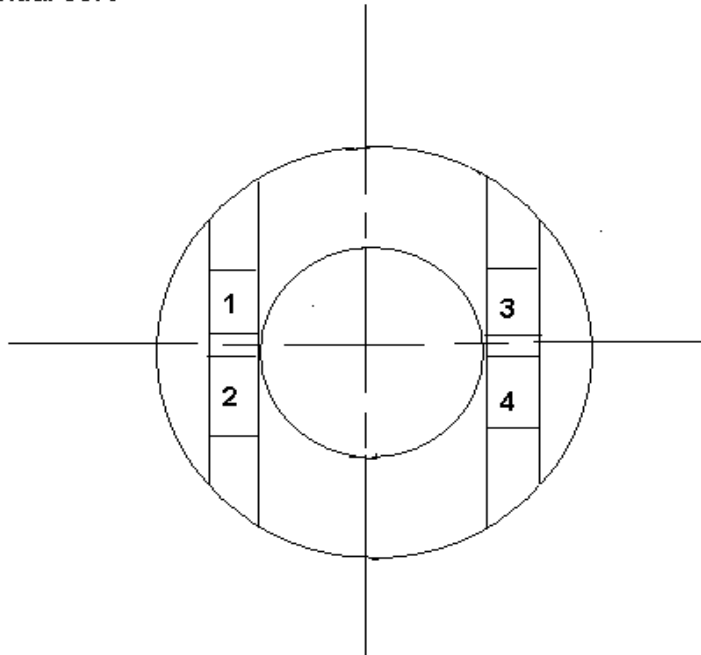
The test report has to included the following results according to EN 10291 section 11.1:

- Testing temperature
- Initial stress σ_0
- Rupture time t_U
- Rupture elongation A_U (for specimen 1)
- Rupture reduction area Z_U (for specimen 1)
- Plastic elongation A_P for 1000h and 3000h (for specimen 2)
- Plastic elongation A_P for 1000h (for specimen 3)

At continuous elongation measurement the whole creep curve is to reported.

6.0 DEVIATIONS

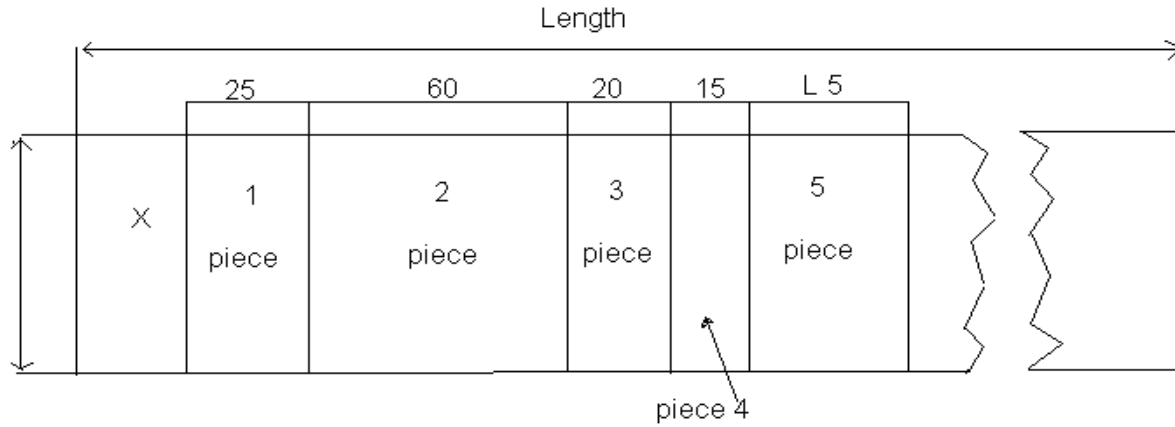
Any deviation has to be reported to BHEL for review and acceptance.

ATTACHMENT-1**Test position in the tangential core****Supplier testing****3 creep-rupture test specimens according to EN 10291 (specimen 4 for reserve)**



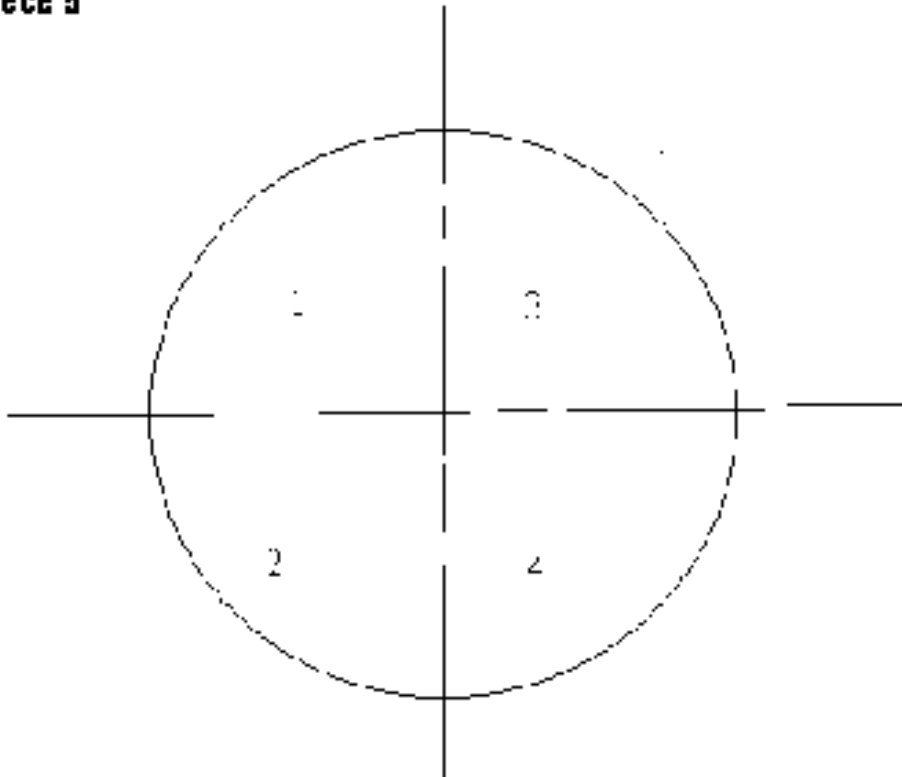
Test Position in the axial Core

Marking

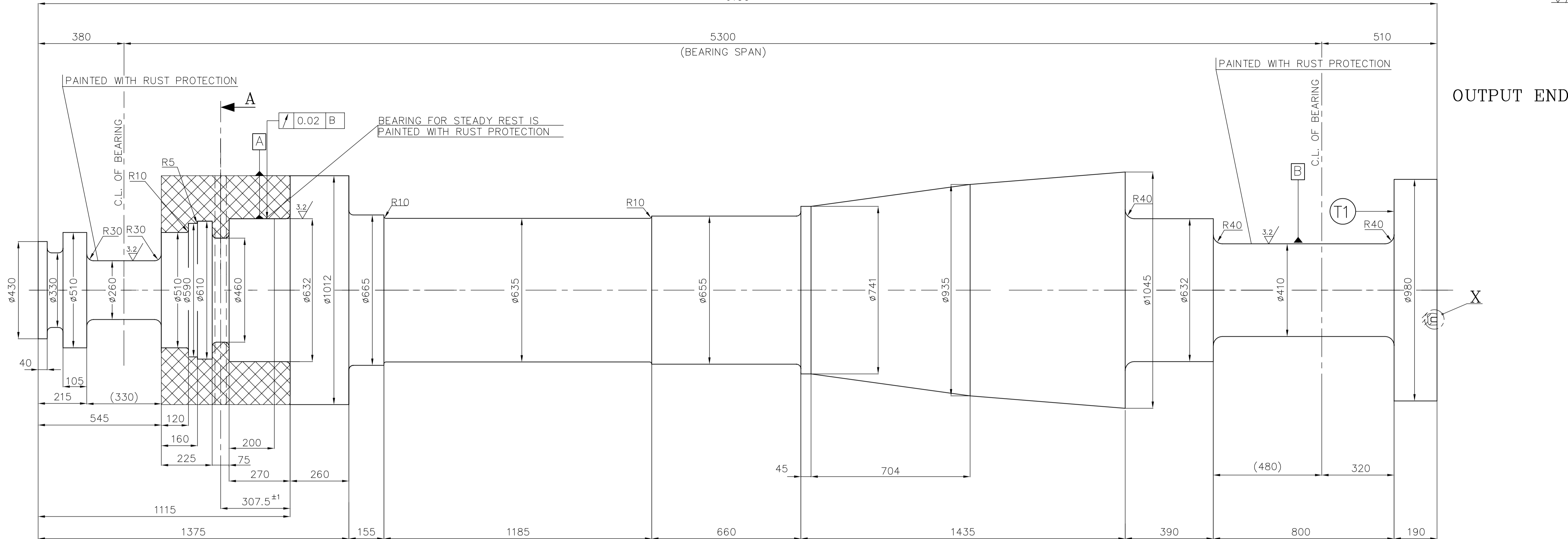


L 5... The length of piece 5 depends on the length of the creep-rupture specimens.

Piece 5



3 Creep rupture test specimens according to EN 10291 (specimen 4 for reserve)



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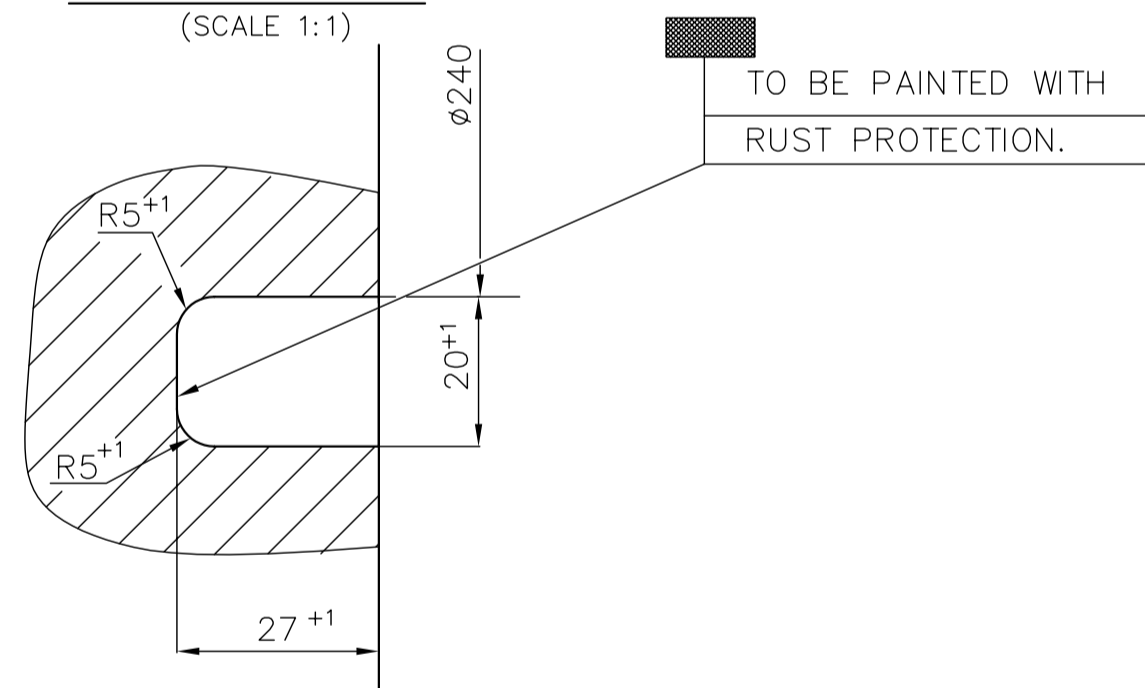
GENERAL DIMENSIONAL LIMITS, FITS & TOLERANCES AS PER HY0230261

INVENTORY NO

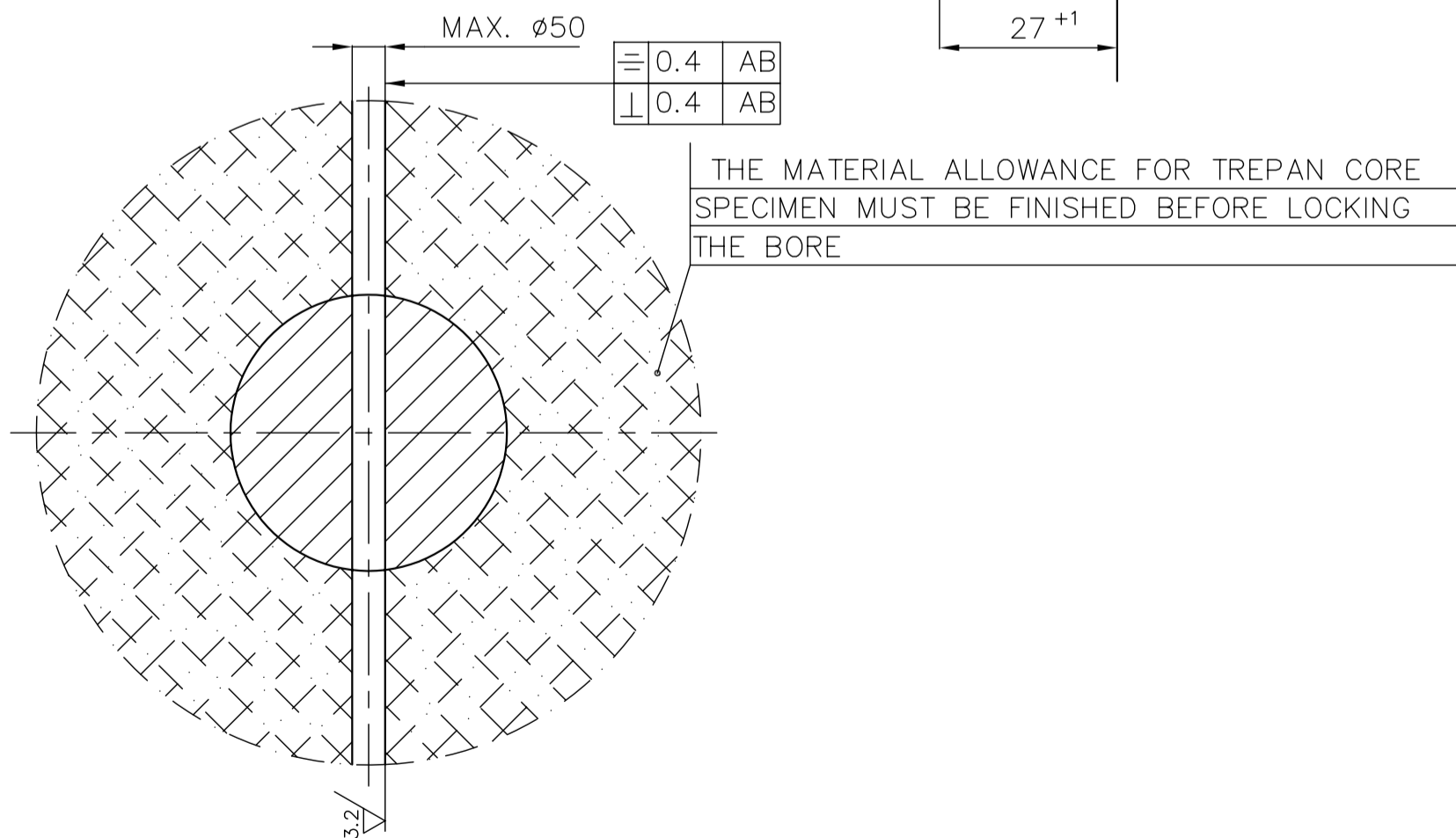
17-03-2007 09:44:24

DETAIL - X

(SCALE 1:1)



SECTION-A-A



NOTES:

1. ROTOR TO BE SUPPLIED AS PER PLANT PURCHASE SPECIFICATION : HY 19473.
2. UNMENTIONED RADII = R20
3. ALL DIMENSIONS INCLUDE FINISH ALLOWANCE.
4. PERMISSIBLE RADIAL RUNOUT DEVIATION IN RELATION TO STEADY REST BEARING: 1mm.
5. IDENTIFICATION NO. TO BE STAMPED AT THE PLACE MARKED WITH [] AS PER PLANT PURCHASE SPECN. AND FRAMED WITH COLOUR.
6. AT THE PLACES MARKED T1 & T2 SUPPLIER SHALL LOCATE TANGENTIAL TEST SAMPLES FOR MECHANICAL TESTING AND GET THE RESULTS APPROVED BY BHEL. PART OF TEST SAMPLES SHALL BE LEFT INTEGRAL WITH ROTOR FOR RETESTING PURPOSES AT BHEL.
7. RADIAL TREPAN CORE :-
 - a) AFTER SATISFACTORY TESTING OF RADIAL TREPAN CORE THE HOLE SHALL BE FITTED WITH A SHRUNK PLUG BY THE SUPPLIER ON FULL LENGTH.
 - b) THE SHRUNK PLUG MATERIAL SHALL BE SAME AS THAT OF ROTOR.
 - c) THE MAXIMUM RADIAL HOLE DIA IS 50mm AND THE SHRUNK PLUG SHALL BE MACHINED ACCORDINGLY WITH AN OVER SIZE OF 0.06-0.07mm. THE SURFACE FINISH OF PLUG ALSO SHALL BE 3.2
 - d) THE ROTOR SHALL BE HEATED TO 400°C (MIN.) FOR SHRINKING THE PLUG.
 - e) THE DIMENSIONS AND SURFACE FINISH OF PLUG AND TREPAN CORE SHALL BE CHECKED AND RECORDED.
 - f) THE RADIAL TREPAN CORE SHALL BE TESTED BY THE SUPPLIER AS PER BHEL SPECFN. HW 0850196. THE SUPPLIER SHALL SUBMIT TO BHEL THE TEST CERTIFICATE WITH ALL TEST RESULTS AND SAMPLING PLAN THE REMAINING AXIAL CORE DULY MARKED WITH IDENTIFICATION SHALL BE SENT TO BHEL.
 - g) FURTHER PROCESSING OF THE FORGING SHALL CONTINUE ONLY AFTER THE RADIAL CORE HAS BEEN TESTED AND APPROVED BY BHEL.
 - h) AFTER TESTING RADIAL CORE, THE ROTOR SHALL BE MACHINED TO THE THE REQUIRED DIMENSIONS AS INDICATED.
8. THERMAL STABILITY TEST SHALL BE DONE AS PER BHEL SPECFN. HW 0850197.
9. THE RESIDUAL STRESS MEASUREMENT SHALL BE DONE AS PER BHEL SPECFN. HW 0850397.
10. MATERIAL CODE: ST950 73 50 080.

TYPE OF PRODUCT OR NAME OF CUSTOMER/PROJECT **K30-16 (MODIFIED)**

DRN.	DSR	NAME	SIGN.	DATE	NO. OF VAR.
CHD.	MRB			17-05-95	NA
APPD.	NAN			17-05-95	NA

DEPT.	UNTOL.	DIMS.	SCALE	WEIGHT (KG)	REF. TO ASSY. DRG.	ITEM NO.	NO. OF ITEMS
415			1:10 (1:1)	19000	-N.A.-	-N.A.-	-N.A.-
TITLE				CARD CODE	DRAWING NO.		
ROTOR (BZ)				N.A.	1-102-01-62903 03		
					SHT. No 1		NO. OF SHT. 1

