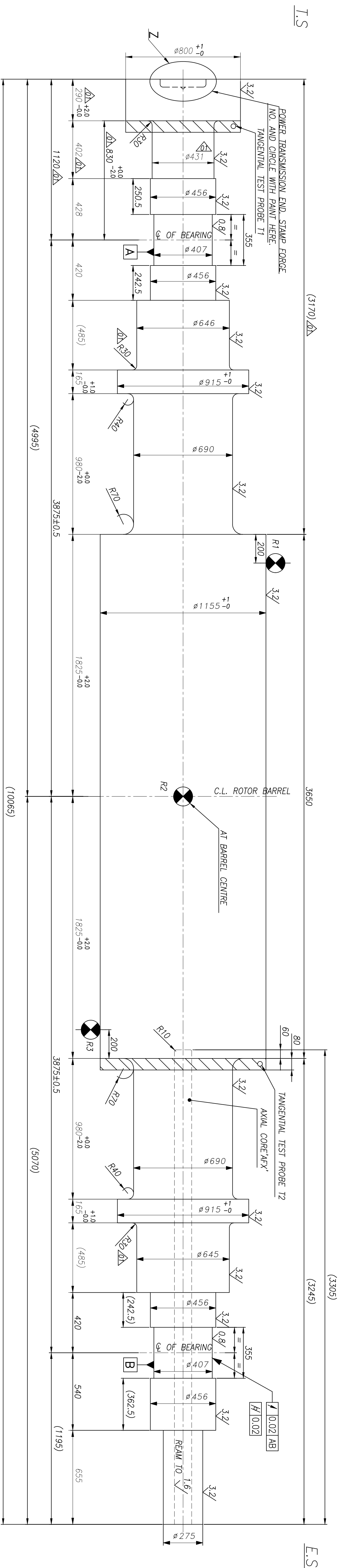
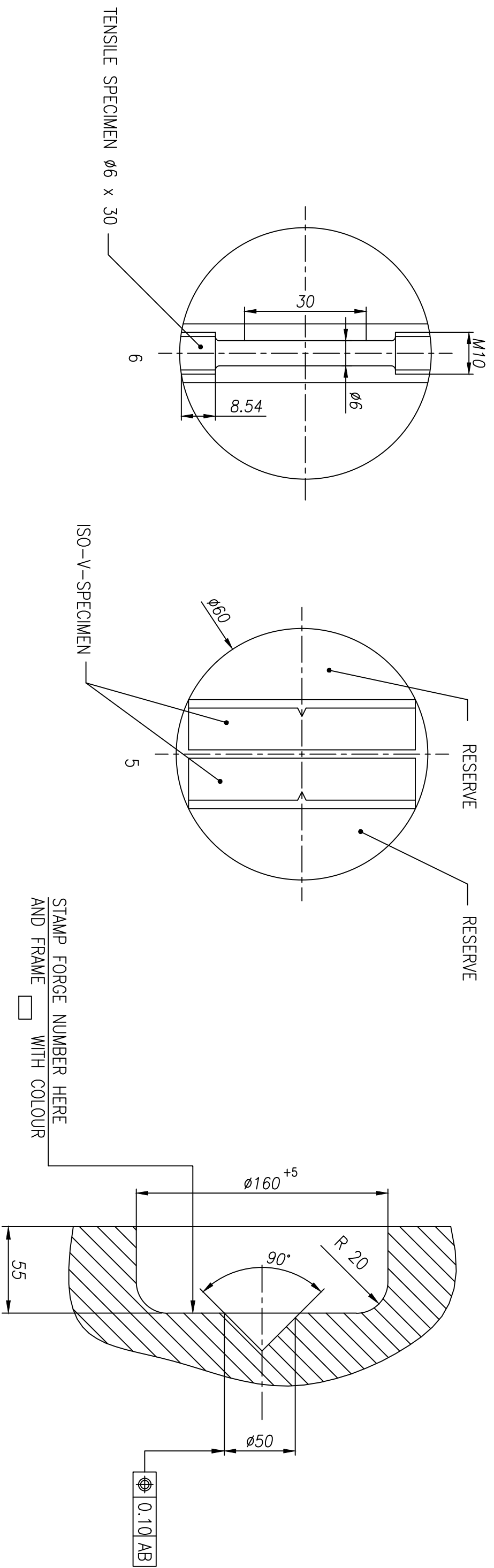


INGOT TOP

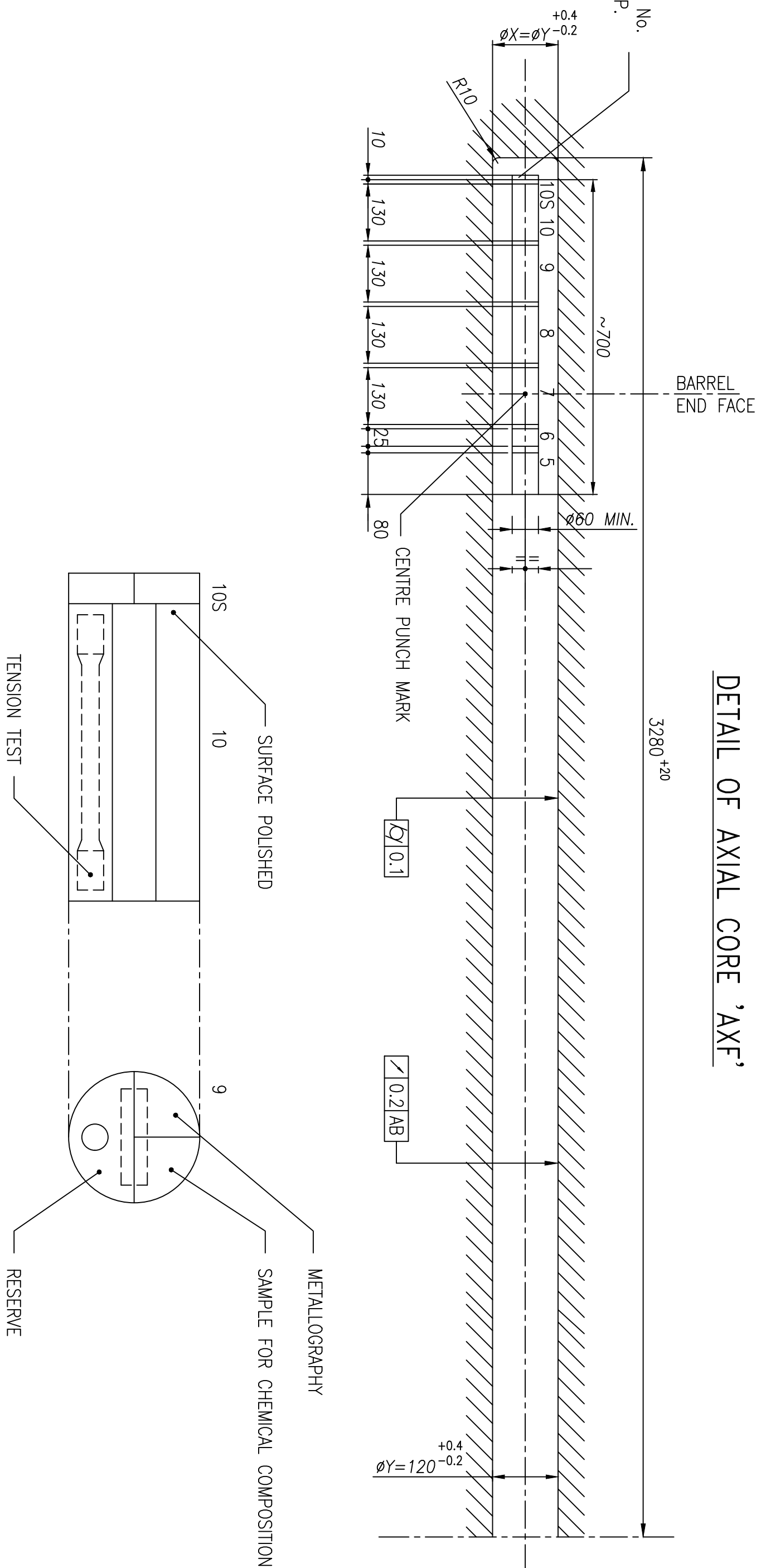


DETAIL-Z

CORE MARKED WITH IDENTIFICATION No.
AND AUTHORISED INSPECTION STAMP.



DETAIL OF AXIAL CORE 'AXF'



ITEM NO.	DESCRIPTION	DRAWING NO.	VAR. NO.	RAW MATERIAL SIZE OR CASTING DRG. NO. OR FORGING DRG. NO.	MATERIAL CODE	NET WT.	GROSS WT.
10S	SURFACE POLISHED						
10							
9	METALLOGRAPHY						
10S	SURFACE POLISHED						
10							
9	METALLOGRAPHY						

THE FOLLOWING CONDITIONS APPLY EXCEPT OTHERWISE STATED....

- REF. TO HY0230261 FOR UNSPECIFIED TOLERANCES.
- CHAMFER W/CD. SHARP EDGES 1:2 TO 1:0 AT 45°.
- INTERNAL W/CD. CORNER RADI 1 TO 0.7
- THE SURFACE ROUGHNESS WHEREVER NOT SHOWN SHALL BE TAKEN FROM THE SURFACE ROUGHNESS SHOWN OUT SIDE BACK SLASHES GIVEN AT THE TOP MOST RIGHT CORNER OF THE DRG.

TYPE OF PRODUCT
NAME OF CUSTOMER/PROJECT
TARI 1150-36Q

DEPT.	UNITD. DIMS. OR C/M/F	SCALE	WEIGHT (KG)	REF. TO ASSY DRG.	ITEM NO.	REV.
HY19471	1:15	43770				

DEPT.	UNITD. DIMS. OR C/M/F	SCALE	WEIGHT (KG)	REF. TO ASSY DRG.	ITEM NO.	REV.
HY19471	1:15	43770				

DEPT.	UNITD. DIMS. OR C/M/F	SCALE	WEIGHT (KG)	REF. TO ASSY DRG.	ITEM NO.	REV.
HY19471	1:15	43770				

DEPT.	UNITD. DIMS. OR C/M/F	SCALE	WEIGHT (KG)	REF. TO ASSY DRG.	ITEM NO.	REV.
HY19471	1:15	43770				

DEPT.	UNITD. DIMS. OR C/M/F	SCALE	WEIGHT (KG)	REF. TO ASSY DRG.	ITEM NO.	REV.
HY19471	1:15	43770				

DEPT.	UNITD. DIMS. OR C/M/F	SCALE	WEIGHT (KG)	REF. TO ASSY DRG.	ITEM NO.	REV.
HY19471	1:15	43770				

DEPT.	UNITD. DIMS. OR C/M/F	SCALE	WEIGHT (KG)	REF. TO ASSY DRG.	ITEM NO.	REV.
HY19471	1:15	43770				

DEPT.	UNITD. DIMS. OR C/M/F	SCALE	WEIGHT (KG)	REF. TO ASSY DRG.	ITEM NO.	REV.
HY19471	1:15	43770				

DEPT.	UNITD. DIMS. OR C/M/F	SCALE	WEIGHT (KG)	REF. TO ASSY DRG.	ITEM NO.	REV.
HY19471	1:15	43770				

DEPT.	UNITD. DIMS. OR C/M/F	SCALE	WEIGHT (KG)	REF. TO ASSY DRG.	ITEM NO.	REV.
HY19471	1:15	43770				

DEPT.	UNITD. DIMS. OR C/M/F	SCALE	WEIGHT (KG)	REF. TO ASSY DRG.	ITEM NO.	REV.
HY19471	1:15	43770				

DEPT.	UNITD. DIMS. OR C/M/F	SCALE	WEIGHT (KG)	REF. TO ASSY DRG.	ITEM NO.	REV.
HY19471	1:15	43770				

DEPT.	UNITD. DIMS. OR C/M/F	SCALE	WEIGHT (KG)	REF. TO ASSY DRG.	ITEM NO.	REV.
HY19471	1:15	43770				

DEPT.	UNITD. DIMS. OR C/M/F	SCALE	WEIGHT (KG)	REF. TO ASSY DRG.	ITEM NO.	REV.
HY19471	1:15	43770				

DEPT.	UNITD. DIMS. OR C/M/F	SCALE	WEIGHT (KG)	REF. TO ASSY DRG.	ITEM NO.	REV.
HY19471	1:15	43770				

DEPT.	UNITD. DIMS. OR C/M/F	SCALE	WEIGHT (KG)	REF. TO ASSY DRG.	ITEM NO.	REV.
HY19471	1:15	43770				

DEPT.	UNITD. DIMS. OR C/M/F	SCALE	WEIGHT (KG)	REF. TO ASSY DRG.	ITEM NO.	REV.
HY19471	1:15	43770				

DEPT.	UNITD. DIMS. OR C/M/F	SCALE	WEIGHT (KG)	REF. TO ASSY DRG.	ITEM NO.	REV.
HY19471	1:15	43770				

DEPT.	UNITD. DIMS. OR C/M/F	SCALE	WEIGHT (KG)	REF. TO ASSY DRG.	ITEM NO.	REV.
HY19471	1:15	43770				

DEPT.	UNITD. DIMS. OR C/M/F	SCALE	WEIGHT (KG)	REF. TO ASSY DRG.	ITEM NO.	REV.
HY19471	1:15	43770				

DEPT.	UNITD. DIMS. OR C/M/F	SCALE	WEIGHT (KG)	REF. TO ASSY DRG.	ITEM NO.	REV.
HY19471	1:15	43770				

DEPT.	UNITD. DIMS. OR C/M/F	SCALE	WEIGHT (KG)	REF. TO ASSY DRG.	ITEM NO.	REV.
HY19471	1:15	43770				

DEPT.	UNITD. DIMS. OR C/M/F	SCALE	WEIGHT (KG)	REF. TO ASSY DRG.	ITEM NO.	REV.
HY19471	1:15	43770				

DEPT.	UNITD. DIMS. OR C/M/F	SCALE	WEIGHT (KG)	REF. TO ASSY DRG.	ITEM NO.	REV.
HY19471	1:15	43770				

DEPT.	UNITD. DIMS. OR C/M/F	SCALE	WEIGHT (KG)	REF. TO ASSY DRG.	ITEM NO.	REV.
HY19471	1:15	43770				

DEPT.	UNITD. DIMS. OR C/M/F	SCALE	WEIGHT (KG)	REF. TO ASSY DRG.	ITEM NO.	REV.
HY19471	1:15	43770				

DEPT.	UNITD. DIMS. OR C/M/F	SCALE	WEIGHT (KG)	REF. TO ASSY DRG.	ITEM NO.	REV.
HY19471	1:15	43770				

DEPT.	UNITD. DIMS. OR C/M/F	SCALE	WEIGHT (KG)	REF. TO ASSY DRG.	ITEM NO.	REV.
HY19471	1:15	43770				

DEPT.	UNITD. DIMS. OR C/M/F	SCALE	WEIGHT (KG)	REF. TO ASSY DRG.	ITEM NO.	REV.
HY19471	1:15	43770				

DEPT.	UNITD. DIMS. OR C/M/F	SCALE	WEIGHT (KG)	REF. TO ASSY DRG.	ITEM NO.	REV.
HY19471	1:15	43770				

DEPT.	UNITD. DIMS. OR C/M/F	SCALE	WEIGHT (KG)	REF. TO ASSY DRG.	ITEM NO.	REV.
HY19471	1:15	43770				

DEPT.	UNITD. DIMS. OR C/M/F	SCALE	WEIGHT (KG)	REF. TO ASSY DRG.	ITEM NO.	REV.
HY19471	1:15	43770				

DEPT.	UNITD. DIMS. OR C/M/F	SCALE	WEIGHT (KG)	REF. TO ASSY DRG.	ITEM NO.	REV.
HY19471	1:15	43770				

DEPT.	UNITD. DIMS. OR C/M/F	SCALE	WEIGHT (KG)	REF. TO ASSY DRG.	ITEM NO.	REV.
HY19471	1:15	43770				

DEPT.	UNITD. DIMS. OR C/M/F	SCALE	WEIGHT (KG)	REF. TO ASSY DRG.	ITEM NO.	REV.
HY19471	1:15	43770				

DEPT.	UNITD. DIMS. OR C/M/F	SCALE	WEIGHT (KG)	REF. TO ASSY DRG.	ITEM NO.	REV.
HY19471	1:15	43770				

DEPT.	UNITD. DIMS. OR C/M/F	SCALE	WEIGHT (KG)	REF. TO ASSY DRG.	ITEM NO.	REV.
HY19471	1:15	43770				

DEPT.	UNITD. DIMS. OR C/M/F	SCALE	WEIGHT (KG)	REF. TO ASSY DRG.	ITEM NO.	REV.
HY19471	1:15	43770				

DEPT.	UNITD. DIMS. OR C/M/F	SCALE	WEIGHT (KG)	REF. TO ASSY DRG.	ITEM NO.	REV.
HY19471	1:15	43770				

DEPT.	UNITD. DIMS. OR C/M/F	SCALE	WEIGHT (KG)	REF. TO ASSY DRG.	ITEM NO.	REV.
HY19471	1:15	43770				

DEPT.	UNITD. DIMS. OR C/M/F	SCALE	WEIGHT (KG)	REF. TO ASSY DRG.	ITEM NO.	REV.
HY19471	1:15	43770				

DEPT.	UNITD. DIMS. OR C/M/F	SCALE	WEIGHT (KG)	REF. TO ASSY DRG.	ITEM NO.	REV.
HY19471	1:15	43770				

DEPT.	UNITD. DIMS. OR C/M/F	SCALE	WEIGHT (KG)	REF. TO ASSY DRG.	ITEM NO.	REV.
HY19471	1:15	43770				

DEPT.	UNITD. DIMS. OR C/M/F	SCALE	WEIGHT (KG)	REF. TO ASSY DRG.	ITEM NO.	REV.
HY19471	1:15	43770				

DEPT.	UNITD. DIMS. OR C/M/F	SCALE	WEIGHT (KG)	REF. TO ASSY DRG.	ITEM NO.	REV.
HY19471	1:15	43770				

DEPT.	UNITD. DIMS. OR C/M/F	SCALE	WEIGHT (KG)	REF. TO ASSY DRG.	ITEM NO.	REV.
HY19471	1:15	43770				

DEPT.	UNITD. DIMS. OR C/M/F	SCALE	WEIGHT (KG)	REF. TO ASSY DRG.	ITEM NO.	REV.
HY19471	1:15	43770				

DEPT.	UNITD. DIMS. OR C/M/F	SCALE	WEIGHT (KG)	REF. TO ASSY DRG.	ITEM NO.	REV.
HY19471	1:15	43770				

DEPT.	UNITD. DIMS. OR C/M/F	SCALE	WEIGHT (KG)	REF. TO ASSY DRG.	ITEM NO.	REV.
HY19471	1:15	43770				

DEPT.	UNITD. DIMS. OR C/M/F	SCALE	WEIGHT (KG)	REF. TO ASSY DRG.	ITEM NO.	REV.
HY19471	1:15	43770				

DEPT.	UNITD. DIMS. OR C/M/F	SCALE	WEIGHT (KG)	REF. TO ASSY DRG.	ITEM NO.	REV.
HY19471	1:15	43770				

DEPT.	UNITD. DIMS. OR C/M/F	SCALE	WEIGHT (KG)	REF. TO ASSY DRG.	ITEM NO.	REV.
HY19471	1:15	43770				

DEPT.	UNITD. DIMS. OR C/M/F	SCALE	WEIGHT (KG)	REF. TO ASSY DRG.	ITEM NO.	REV.
HY19471	1:15	43770				

DEPT.	UNITD. DIMS. OR C/M/F	SCALE	WEIGHT (KG)	REF. TO ASSY DRG.	ITEM NO.	REV.
HY19471	1:15	43770				

DEPT.	UNITD. DIMS. OR C/M/F	SCALE	WEIGHT (KG)	REF. TO ASSY DRG.	ITEM NO.	REV.
HY19471	1:15	43770				

DEPT.	UNITD. DIMS. OR C/M/F	SCALE	WEIGHT (KG)	REF. TO ASSY DRG.	ITEM NO.	REV.
HY19471	1:15	43770				

DEPT.	UNITD. DIMS. OR C/M/F	SCALE	WEIGHT (KG)	REF. TO ASSY DRG.	ITEM NO.	REV.
HY19471	1:15	43770				

DEPT.	UNITD. DIMS. OR C/M/F	SCALE	WEIGHT (KG)	REF. TO ASSY DRG.	ITEM NO.	REV.
HY19471	1:15	43770				

DEPT.	UNITD. DIMS. OR C/M/F	SCALE	WEIGHT (KG)	REF. TO ASSY DRG.	ITEM NO.	REV.
HY19471	1:15	43770				

DEPT.	UNITD. DIMS. OR C/M/F	SCALE	WEIGHT (KG)	REF. TO ASSY DRG.	ITEM NO.	REV.
HY19471	1:15	43770				

DEPT.	UNITD. DIMS. OR C/M/F	SCALE	WEIGHT (KG)	REF. TO ASSY DRG.	ITEM NO.	REV.
HY19471	1:15	43770				

DEPT.	UNITD. DIMS. OR C/M/F	SCALE	WEIGHT (KG)	REF. TO ASSY DRG.	ITEM NO.	REV.
HY19471	1:15	43770				

DEPT.	UNITD. DIMS. OR C/M/F	SCALE	WEIGHT (KG)	REF. TO ASSY DRG.	ITEM NO.	REV.
HY19471	1:15	43770				

DEPT.	UNITD. DIMS. OR C/M/F	SCALE	WEIGHT (KG)	REF. TO ASSY DRG.	ITEM NO.	REV.
HY19471	1:15	43770				

DEPT.	UNITD. DIMS. OR C/M/F	SCALE	WEIGHT (KG)	REF. TO ASSY DRG.	ITEM NO.	REV.
HY19471	1:15	43770				

DEPT.	UNITD. DIMS. OR C/M/F	SCALE	WEIGHT (KG)	REF. TO ASSY DRG.	ITEM NO.	REV.
HY19471	1:15	43770				

DEPT.	UNITD. DIMS. OR C/M/F	SCALE	WEIGHT (KG)	REF. TO ASSY DRG.	ITEM NO.	REV.
HY19471	1:15	43770				

DEPT.	UNITD. DIMS. OR C/M/F	SCALE	WEIGHT (KG)	REF. TO ASSY DRG.	ITEM NO.	REV.
HY19471	1:15	43770				

DEPT.	UNITD. DIMS. OR C/M/F	SCALE	WEIGHT (KG)	REF. TO ASSY DRG.	ITEM NO.	REV.
HY19471	1:15	43770				

DEPT.	UNITD. DIMS. OR C/M/F	SCALE	WEIGHT (KG)	REF. TO ASSY DRG.	ITEM NO.	REV.
HY19471	1:15	43770				

DEPT.	UNITD. DIMS. OR C/M/F	SCALE	WEIGHT (KG)	REF. TO ASSY DRG.	ITEM NO.	REV.
HY19471	1:15	43770				

DEPT.	UNITD. DIMS. OR C/M/F	SCALE	WEIGHT (KG)	REF. TO ASSY DRG.	ITEM NO.	REV.
HY19471	1:15	43770				

DEPT.	UNITD. DIMS. OR C/M/F	SCALE	WEIGHT (KG)	REF. TO ASSY DRG.	ITEM NO.	REV.
HY19471	1:15	43770				

DEPT.	UNITD. DIMS. OR C/M/F	SCALE	WEIGHT (KG)	REF. TO ASSY DRG.	ITEM NO.	REV.
HY19471	1:15	43770				

DEPT.	UNITD. DIMS. OR C/M/F	SCALE
-------	-----------------------	-------



TD 219
Rev 00

PLANT PURCHASING SPECIFICATION HYDERABAD

HY19471

Rev. No. 02

Page 1 of 9

TURBOGENERATOR ROTOR FORGINGS

GR: 26 Ni Cr Mo V 145

1.0 GENARAL :

This specification governs the quality requirements of rotor forgings, forged from Steel grade, 26 Ni Cr Mo V 145, in heat-treated and rough machined condition as per dimensions of the order drawing.

2.0 APPLICATION :

Turbo generator rotor forgings.

3.0 CONDITION OF DELIVERY :

Rotor forgings shall be supplied in hardened, tempered and rough machined as per drawing and finally stress relieved condition.

4.0 DIMENSIONS AND TOLERANCES :

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

5.0 MATERIAL MANUFACTURE :

The forging shall be made from basic electric arc furnace steel which shall be subsequently refined by vacuum carbon deoxidation process (VCD) or Electro Slag Remelted (ESR).

Sufficient discard from top and bottom shall be made from the ingot to ensure freedom from piping, segregation, and other injurious defects. However, in the Ingot a minimum of 5% discard from the bottom shall be made. The rotor shaft shall be intensively forged to ensure the homogeneity of material throughout the section.

It is important to maintain the central axis of the shaft forging, as far as possible, identical to that of the ingot. Press straightening, if necessary may be performed before heat treatment.

Revisions: Modified clause 5.0, 7.0, 8.1, 9.3, 9.4.5, 11.0, 12.0.			Issued : STANDARDS ENGINEERING & IPR COORDINATION DEPARTMENT		
Rev. No. 02	Amd. No.	Reaffirmed:	Prepared:	Approved:	Date of 1 st issue:
Dt. 10-Sep-18	Dt.	Year:	SE / ME & Labs	AGM / R&D and EC	AUG. 1983

Copyright and Confidential
The information on this document is the property of BHARAT HEAVY ELECTRICALS LIMITED.
It must not be used directly or indirectly in any way detrimental to the interest of the company.

RESTRICTED USE



The supplier shall submit the detailed manufacturing & testing plan (MTP) indicating the ingot dimensions, forging process, forging ratio, heat treatment plan, sketches showing test samples location and stages of inspection etc. for approval by BHEL before starting production. The approved MTP duly endorsed by BHEL representative shall be submitted along with the test certificates.

After Heat treatment, the forging shall be further machined to the drawing dimensions and surface finish called for on the drawing.

6.0 CLOCKING SYMBOL :

Before heat treatment, clocking symbols 3-6 -9-12, shall be stamped on the turbine end of the rotor forging. If the symbols are transferred during manufacture, they shall be restamped in the same clock position. The clock symbols shall be used for reference purposes in recording the position of defects, bore eccentricity etc.

7.0 CHEMICAL COMPOSITION:

The heat analysis of the steel shall conform to the requirements of the chemical composition given in the table 1

Steel making process	Element	C	Si	Mn	P	S	Cr	Mo	Ni	V	Al Total
VCD	Min	0.22	--	--	--	--	1.40	0.30	3.40	--	--
	Max.	0.28	0.07	0.40	0.007	0.007	1.80	0.45	3.80	0.15	0.010
ESR	Min	0.22	--	--	--	--	1.40	0.30	3.40	--	--
	Max.	0.28	0.25	0.40	0.007	0.005	1.80	0.45	3.80	0.15	0.010

7.1 Tramp Elements:

The contents of tramp elements shall be low enough to avoid temper embrittlement. The values actually obtained shall be reported in the test certificate and to be within the following limits.

Cu (max)	As (max)	Sb (max)	Sn (max)
0.15	0.020	0.015	0.0015

7.2 Small changes in the chemical composition are permitted after consulting BHEL, if the required functional properties are not impaired.

8.0 HEAT TREATMENT:

Forgings shall be hardened and tempered and stress relieved in vertical position or in horizontal condition with rotational movement so as to obtain uniform mechanical and magnetic properties along the longitudinal axis of the forging. The actual heat treatment cycles are to be selected by the manufacturer based on his experience. However, tempering temperature shall not be below 600°C.



TD 219
Rev 00

PLANT PURCHASING SPECIFICATION HYDERABAD

HY19471

Rev. No. 02

Page 3 of 9

Maximum number of reheat treatments permitted are two.

In case a straightening operation is to be taken up, after heat treatment the rotor forging shall be heat treated again.

8.1 RESIDUAL STRESS MEASUREMENT TEST:

The residual stress measurement shall be carried out as per BHEL standard AA0850150. As an alternative to AA0850150, residual stress measurement by blind hole method as per ASTM E 837 is also acceptable. The residual stresses shall not exceed 60 N/mm^2 at any point on the surface. However all other requirements like locations for RSM, acceptance norms etc. will be as per AA0850150.

9.0 SELECTON OF TEST SAMPLES & TESTS:

The test samples shall be selected and test shall be carried out as given below:

9.1 Mechanical Tests:

Tangential test pieces taken from the places indicated on the drawing (T1 & T2) shall be tested for the mechanical properties as given in the table 2.

9.2 The difference in the mechanical values obtained at both ends of the rotor (T1 & T2) should not be more than 8% of the minimum specified value or the individual values of 0.2% Yield strength and Tensile strength may only differ by 50 N/mm^2 .

9.3 The remaining test material at location T1 & T2 shall be left integral with the rotor for further testing at BHEL.

9.4 Axial Core Testing:

9.4.1 This testing is done to investigate the strength and brittle fracture properties of the rotor forging. The axial core shall be trepanned through the exciter end of the rotor. The dimensions, finish and tests to be carried out shall be as shown on the drawing. Axial trepanning shall be done only after ascertaining that the results of mechanical tests (T1 & T2) magnetic particle tests & Ultrasonic Tests acceptable.

9.4.2 The axial core shall be ground to finish 0.8 microns and shall be subjected to magnetic particle test. If indications are found. Tesa film print should be made and specimen shall be removed of metallographic examination.

9.4.3 Bore shall be reamed to finish 1.6 microns and shall be examined with boroscope. Bore shall be free from cracks, cavities and other discontinuities.

9.4.4 The axial core shall be sectioned as shown on the drawing and all pieces shall be stamped on the face (facing the body centre) with sample No. and Forge No.

HY19471	PLANT PURCHASING SPECIFICATION HYDERABAD	TD 219 Rev 00	
Rev. No. 02			
Page 4 of 9			

9.4.5 The following tests are to be carried out from the axial core and the results shall confirm the values given in table 2.

- Chemical Composition and microstructure tests from sample No. 10s.
- One tensile test with gauge length 50mm from sample No. 10.
- One tensile test from sample No. 6 on radial specimen (G.L=30 mm & dia = 6 mm) as shown in the ordering drg.
- Charpy impact test (at +20°C) on ISO-V specimens (radial orientation, as shown in the ordering drg.) taken from Sample No.5).
- Charpy impact test on four ISO-V specimens from sample No. 5 shall be carried out to determine FATT (50% crystallinity) as per any reputed national standard.

TABLE 2

Specimen Location	Specimen Orientation	Tensile Strength N/mm ² max.	0.2% Proof stress, N/mm ²	% Elongation (L=5d) min.	% Reduction in area min.	Charpy impact strength ISO-V Notch J min.	FATT °C max.
T1 & T2	Tangential	1000	730-830	15	50	100J at RT	--
AXIAL CORE	Longitudinal	1)	730	1)	1)		
	Radial	1)	730	1)	1)	100J at +20°C	≤-10

The following properties shall be achieved in the barrel area in the Radial direction:

0.2% Yield strength : 730 N/mm²
FATT : ≤+10 °C
Impact strength (at +20°C) : 70 J min*

- Actual values achieved shall be reported in test certificate.
- * Charpy Impact strength shall be tested on three ISO-V specimens as per IS:1757 or any reputed national standard. The minimum impact strength indicated is average of three values. However one of the three values can be permitted below the minimum specified value but in no case shall be lower than 2/3rd of the minimum value. All the three values shall be reported.



TD 219
Rev 00

PLANT PURCHASING SPECIFICATION HYDERABAD

HY19471

Rev. No. 02

Page 5 of 9

10.0 METALLOGRAPHIC TESTS:

10.1 Metallographic tests shall be carried out for detecting cracks, inclusions etc. for the cores as given below.

10.1.1 Indications resulting from MPI of the axial core (refer cl. 9.4.2)

10.1.2 Tensile samples from axial core which are having elongation values of less than 10% (refer cl. 9.4.5).

10.2 Sample No. 10 S as per clause 9.4.5 shall be studied for microstructure and it shall reveal tempered lower bainite

10.3 Actual micro photographs (X200) and metallographic report shall be enclosed to the test certificate.

11.0 MAGNETIC PERMEABILITY TEST:

Magnetic permeability test shall be conducted as per BS:6404 Part 4 – 1986 from the test material at the barrel ends or out of the axial core. The following values shall be obtained on the test piece.

Field strength	A/m	10,000	20,000	30,000
Field density	Tesla (min)	1.78	1.92	1.97

12.0 NON-DESTRUCTIVE TESTS:

12.1 ULTRASONIC TEST:

The forgings shall be subjected to ultrasonic testing as per BHEL corporate standard AA0850106.

12.2 MAGNETIC PARTICLE INSPECTION:

The magnetic particle test shall be carried out as per BHEL corporate standard AA0850106.

12.3 **Demagnetisation:** After completion of magnetic particle test, the rotor shall be demagnetized as per TG34976 Rev.00.

13.0 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 time, while the work on the contract is being performed, to all parts of the manufacturer's works.

Cutting of test pieces, marking of the test pieces and the testing shall be carried out in the presence of BHEL representative.

14.0 QUALITY PLAN:

14.1 Vendor shall follow the Quality Plan Ref. BHEL/QP/HY19471 Rev.02 attached as Annexure 'A' unless the conditions stipulated in cl. 14.2 & 14.3 are applicable.

14.2 In case Customer / Project related additional requirements are applicable in the enquiry / tender, vendor may be asked to submit a separate QP including such requirements.

14.3 In case of new vendors or first time supplies according to drawings mentioned in BHEL enquiry, QP shall be submitted for approval by BHEL.

HY19471	PLANT PURCHASING SPECIFICATION HYDERABAD	TD 219 Rev 00	
Rev. No. 02			
Page 6 of 9			

15.0 TEST CERTIFICATE:

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

- a) HY19471 Rev.02
- b) BHEL Order No.
- c) Item Description and Drawing No. of the forging
- d) Melt No. & Forge No. (Steel making and refining processes.)
- e) Results and Chemical with trace elements.
- f) Results of Mechanical Tests.
- g) Results of residual stresses.
- h) Report of Ultrasonic testing giving details of probe type and size, frequency, sensitivity, sketch showing the areas covered etc.
- i) Report of Metallographic test along with photo micrographs (original).
- j) Approved copy of MTP duly endorsed by BHEL representative.
- k) Boroscopic examination results.
- l) FATT value.
- m) Results of Magnetic permeability test.
- n) Results of axial core tests.
- o) Results of Magnetic particle inspection.
- p) Heat treatment charts duly endorsed by BHEL representative.
- q) Supplier's name.

15.2 The test certificate shall be attested by the Chief of Inspection/Chief Metallurgist of the supplier and BHEL inspector/representative.

16.0 MARKING:

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

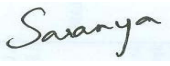
- a) HY 19471 Rev.02
- b) Forging No. and Melt No
- c) Drawing No.
- d) Manufacturer's Stamp.
- e) BHEL Inspectors Stamp.
- f) Clocking symbols
- g) Top and Bottom sides of ingot.

17.0 PACKING AND TRANSPORTATION:

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.

 BHARAT HEAVY ELECTRICALS LIMITED R.C.PURAM, HYDERABAD		STANDARD QUALITY PLAN FOR VENDOR ITEMS						QP. NO: HYQA/SQP/EM/1819/01 Rev. No. : 00 DATE: 05.09.2018 VALID UPTO: 05.09.2021 PAGE 1 OF 3					
ITEM: TURBOGENERATOR ROTOR FORGINGS						BHEL SPEC: HY19471 rev 02, Page 7 of 9							
SI No	Component & Operations	Characteristics	Class	Type Of Check	Quantum Of Check	Ref Document	Acceptance Norms	Format Of Record	* D	Agency			Remarks
										P	W	V	
1.	Melting	Chemical composition	Critical	Chemical	100%	Vendors standard	HY19471Rev.02	TC	✓	2	-	1	Steel melting & refining process shall be specified in TC (VCD or ESR)
2.	Forging	Forging Steps	Major	Visual	100%	-do-	Vendor's Std	TC	✓	2	-	1	Overall reduction ratio shall be mentioned in TC
3.	Preliminary Heat Treatment	Time Temp. Control	Major	Measure	100%	-do-	-do-	Internal Record	✓	2	-	1	
4.	Marking of Clocking Symbols		Major		100%		HY19471Rev.02			2	1	-	
6.	Quality Heat Treatment	Time Temp. Control	Major	Measure	100%	HY19471 Rev.02	HY19471Rev.02	TC	✓	2	-	1	Condition vertical/horizontal shall be specified in TC
7.	Ultrasonic test	Ultrasonic test	Major	Internal Defects	Whole volume	HY19471 Rev.02	HY19471 Rev.02	TC	✓	2	1	-	
8.	Magnetic particle test	Magnetic particle test	Major	Surface defects	Whole surface	HY19471 Rev.02	HY19471 Rev.02	TC	✓	2	1	-	
9.	Demagnetisation	Demagnetisation	Major		Each rotor	TG 34976	HY19471Rev.02		✓	2	-	1	
10.	Residual Stress Measurement	Residual Stress Testing	Major	Internal stresses	Each rotor	HY19471 Rev.02	HY19471Rev.02	TC	✓	2	1	-	
11.	Sampling for Mechanical Testing		Major		As per drg.	BHEL Drawing & Spec.	BHEL Drawing & Spec.		✓	2	1	-	

LEGEND:
P: - PERFORM, W: - WITNESS, V: - VERIFICATION,
INDICATING 1: - BHEL / BHEL NOMMNATED INSPECTION AGENCY, 2: - VENDOR / SUB VENDOR AS
APPROPRIATE AGAINST EACH COMPONENT / CHARACTERISTICS UNDER THE COLUMNS P, W & V.
* D: RECORDS IDENTIFIED WITH TICK (✓) SHALL BE ESSENTIALLY INCLUDED IN QA DOCUMENTATION.

PREPARED BY:

SARANYA S
Dy Manager/ QA

REVIEWED BY

D S SATPUTE
A.G.M. /QA

APPROVED BY

D S SATPUTE
A.G.M. /QA

Format no. : HYQA/QP/VSQP Rev.02

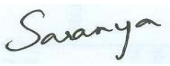
RESTRICTED USE



		BHARAT HEAVY ELECTRICALS LIMITED R.C.PURAM, HYDERABAD		STANDARD QUALITY PLAN FOR VENDOR ITEMS				QP. NO: HYQA/SQP/EM/1819/01					
				ITEM: TURBOGENERATOR ROTOR FORGINGS BHEL SPEC: HY19471 rev 02, Page 8 of 9				Rev. No. : 00 DATE: 05.09.2018 VALID UPTO: 05.09.2021					
								PAGE 2 OF 3					
SI No	Component & Operations	Characteristics	Class	Type Of Check	Quantum Of Check	Ref Document	Acceptance Norms	Format Of Record	* D	Agency P W V			Remarks
12	Mechanical Testing & Metallography	Tensile test Impact test Microstructure	Major	Mechanical & Metallo- graphy	Each rotor	HY19471 Rev.02	HY19471Rev.02	TC	✓	2	1	-	
13.	Magnetic permeability test		Major	Measure	Each rotor	HY19471 Rev.02	HY19471Rev.02	TC	✓	2	1	-	
14.	Trepanning of Axial core		Major			BHEL Drawing & Spec	BHEL Drawing & Spec		✓	2	-	-	If specified on the ordering drg.
15.	Axial core Mechanical Test	Chemical Composition, Tensile test ,Impact test , FATT & Microstructure	Major	Core properties	As per drg. & BHEL Spec	HY19471 Rev.02	HY19471 Rev.02	TC	✓	2	1	-	All tests as per Cl. 9.4 of HY19471 rev 02 shall be done if specified on the ordering drg.
16.	Finish Machining	Dimensions	Major	Measure	100%	Drawing	Drawing	TC	✓	2	1	-	
17.	Boroscopic & MPI of Axial Bore	Boroscopic & Magnetic particle test	Major	Boroscopic & MPI	100%	HY19471 Rev.02	HY19471 Rev.02	TC	✓	2	1	-	If axial bore test specified on the drg.
18.	Plugging of Axial Bore	Visual	Major	Visual check	Each rotor	BHEL Drawing & spec.	BHEL Drawing & Spec.			2	-	1	If axial bore test specified on the drg.
19.	Completeness of documents, test certificates, HT charts etc.		Major	Verificatio n	Each rotor	BHEL Drawing & spec.	BHEL Drawing & Spec.	Endorsement of all documents by TPIA		2	-	1	Third party inspection agency (TPIA) to endorse all test reports, HT charts etc.
20.	Marking preservation & Packing	Marking Preservation & packing	Major	Visual check	100%	BHEL drawing & spec.	BHEL drawing & spec.			2	-	1	

NOTES:

- This QP should be read along with BHEL Spec, BHEL drawings / approved drawings, data sheet, BOM and PO.

LEGEND: P: - PERFORM, W: - WITNESS, V: - VERIFICATION, INDICATING 1: - BHEL / BHEL NOMMNATED INSPECTION AGENCY, 2: - VENDOR / SUB VENDOR AS APPROPRIATE AGAINST EACH COMPONENT / CHARACTERISTICS UNDER THE COLUMNS P, W & V. * D: RECORDS IDENTIFIED WITH TICK (✓) SHALL BE ESSENTIALLY INCLUDED IN QA DOCUMENTATION.		PREPARED BY:  SARANYA S Dy Manager/ QA	REVIEWED BY  D S SATPUTE A.G.M. /QA	APPROVED BY  D S SATPUTE A.G.M. /QA
---	--	--	---	---

Format no. : HYQA/QP/VSQP Rev.02

RESTRICTED USE



		BHARAT HEAVY ELECTRICALS LIMITED R.C.PURAM, HYDERABAD		STANDARD QUALITY PLAN FOR VENDOR ITEMS ITEM: TURBOGENERATOR ROTOR FORGINGS BHEL SPEC: HY19471 rev 02, Page 9 of 9				QP. NO: HYQA/SQP/EM/1819/01 Rev. No. : 00 DATE: 05.09.2018 VALID UPTO: 05.09.2021					
								PAGE 3 OF 3					
SI No	Component & Operations	Characteristics	Class	Type Of Check	Quantum Of Check	Ref Document	Acceptance Norms	Format Of Record	*	Agency			Remarks
									D	P	W	V	

2. Latest revisions of specification / drawings as per P.O., approved drawings & bill of materials are applicable.
3. Any other tests/ checks indicated in specification, P.O., or drawing & any additional checks envisaged by BHEL/TPI to ensure workmanship, finish, aesthetics, etc. shall also be conducted and witnessed/verified by BHEL /TPI / customer as required.
4. All test certificates/ reports reviewed and certified by BHEL/TPI shall be submitted to BHEL as documentation package.
5. Drawing / Data Sheet shall prevail over Quality Plan in case of any contradiction between Quality Plan and Drawing / Data Sheet.
6. Any project / customer specific requirement, like QP approval & Customer/Consultant Inspection, which shall be notified have to be fulfilled by the vendor at the time of execution of order.
7. This QP shall not be applicable to the orders for which QP approval & Inspection by customer/consultant is required.
8. This SQP is not applicable for vendors supplying this item for the first time to BHEL.

MTC – Mill Test Certificate

TC – Test Certificate

IR – Inspection Report

COC – Certificate of Conformity

TPIA – Third Party Inspection Agency appointed by BHEL.

PO – Purchase Order

LEGEND:
P: - PERFORM, W: - WITNESS, V: - VERIFICATION,
INDICATING 1: - BHEL / BHEL NOMINATED INSPECTION AGENCY, 2: - VENDOR / SUB VENDOR AS
APPROPRIATE AGAINST EACH COMPONENT / CHARACTERISTICS UNDER THE COLUMNS P, W & V.
* D: RECORDS IDENTIFIED WITH TICK (✓) SHALL BE ESSENTIALLY INCLUDED IN QA
DOCUMENTATION.

PREPARED BY:


SARANYA S
Dy Manager/ QA

REVIEWED BY


D S SATPUTE
A.G.M. /QA

APPROVED BY


D S SATPUTE
A.G.M. /QA

Format no. : HYQA/QP/VSQP Rev.02

RESTRICTED USE





HYDERABAD

**TECHNICAL PRE-QUALIFICATION REQUIREMENT (PQR) FOR
GENERATOR ROTOR FORGING (35 Tonnes)**

PQR/EME/2024/002

REV NO: 01 DTD 20.06.2026

PAGE: 1 OF 1

S.No	Description of Pre-Qualification Required	Supporting Documents required to accept compliance	Vendor's Response Compiled (Yes/No)
1	Only Manufacturer's offers with in-house forging & heat treatment facility to manufacture rotor forging as per enquiry drawing & specification will be considered for this Tender Enquiry. Outsourcing of forging & heat treatment is not permitted.	a. Self-declaration confirming availability of in-house forging & heat treatment facilities. b. List of plant & machinery available for manufacturing the tendered item, at manufacturers' works including the heat treatment facility. c. Photographs of manufacturing facility to be submitted.	
2	Complete compliance to tender specification and drawing as per BHEL enquiry.	Clause by clause acceptance or signed & stamped copies of drawing & specification mentioned in BHEL enquiry.	
3.	a. Rotor forging manufacturer shall submit details of in-house steel melting & refining facility required for manufacturing the rotor forging. b. In case ingot is outsourced, rotor forging manufacturer shall provide details of the ingot supplier along with steel melting & refining facility. Rotor forging manufacturer shall have prior experience of manufacturing rotor forgings using ingots from the same supplier. Outsourcing of ingot, if required, is permitted only to the rotor forging manufacturer.	a. Details of steel melting & refining facility b. Details of ingot supplier along with documentary evidence of previous experience of procuring ingots and manufacturing rotor forgings using the same supplier.	
4	a. Rotor forging manufacturer to submit details of in-house machining facility to manufacture rotor forgings as per enquiry drawing. b. In case any machining operation is outsourced, details of machining source, works address and machining facilities shall be submitted. Outsourcing of machining, if any, is permitted only to the rotor forging manufacturer.	a. Details of in-house machining facility including the trepanning facility suitable for diameter and length of the axial bore. b. In case outsourced, details of machining source & work address and their machining facility.	
5	Testing facilities required to conduct all the tests as per specification mentioned in BHEL enquiry must be available with the firm. List of outsourced facilities, if any, to be submitted. Outsourced labs/firms should be Govt/NABL/ISO/IEC accredited.	1. Details of testing facilities available with the firm required for testing of said item along with list of outsourced facilities (if used) to be provided. Documentary evidence of NABL/other accreditation of outsourced labs to be submitted. 2. Photographs of in-house test facility to be submitted.	
6	a) Vendor to furnish QAP that shall be followed during manufacturing. b) Manufacturing process plan c) Vendor to furnish their organization chart	QAP, Manufacturing process plan and Organization chart duly signed and stamped.	
7	a) Rotor forging manufacturer should have experience of successfully manufacturing rotor forgings in material grade 26NiCrMoV145. b) Rotor forging manufacturer must have delivered at least three rotors in forgings of the above material grade in the last 7 years satisfying: i. Rotor forging weight ≥ 35 T ii. Rotor barrel diameter ≥ 1080 mm iii. Rotor forging length $\geq 9,000$ mm iv. Axial bore trepanned of diameter 120 mm & minimum length 3200 mm	a) Copies of POs and corresponding invoices including name of their customer, quantity of order, outline drawing with sizes including material acceptance certificate from their customer. b) Test certificate covering chemical, mechanical properties including axial core testing, NDT & dimension report (clearly establishing rotor forging weight, barrel diameter, rotor forging length, trepanned bore diameter & length of bore, measured run-out of the bore) of rotor forgings supplied in last 7 years from enquiry issue date is to be submitted.	
7	Special requirement for Rotor Forging: a. Axial bore is subjected to boroscopic inspection. b. Axial bore is subjected to MPI. c. Rotor Forging is subjected to Residual Stress measurement	a. Vendor shall have the facility for baroscopic inspection. If not available, vendor shall share the details of outsourcing vendor. b. Vendor shall have the facility for MPI on bore. If not available, vendor shall share the details of outsourcing vendor. c. Vendor shall have the facility for residual stress measurement. If not available, vendor shall share the details of outsourcing vendor.	