



**SPECIFICATION FOR SHAFT/THRUST COLLAR FORGINGS FOR
HYDROGENERATOR**

1. GENERAL:

- 1.1 Shaft/ Thrust collar forgings for Hydrogenerators shall be procured in rough machined condition, as per requirements given in this specification and forging drawing made for individual project.

2. CONDITION OF DELIVERY :

Normalised/ Normalised & Tempered.

Rough machining of the forgings shall be carried out unless otherwise specified on the order/drawing.

3. DIMENSION AND TOLERANCES :

The dimensions and tolerances shall be as specified on the order/drawing. Wherever these are not specified, the machining allowances and tolerances shall be as specified below :

For rough machined drawings: +2/-0 on outside diameter and +0/-2 on inside diameter.

4. MANUFACTURE :

Forgings shall be manufactured from steel produced by the open hearth, electric or such other process as may be agreed to between BHEL and the manufacturer.

The steel for this forging shall be vacuum degassed to protect the forgings from harmful effects of hydrogen and other gases.

The steel shall be fully killed. Sufficient discard shall be made from each ingot to ensure freedom from pipe, segregation and other defects.

The amount of hot working and finishing temperature shall be such as to ensure complete soundness and adequate uniformity of structure and mechanical properties after heat treatment. The forgings shall not be overheated.

The minimum reduction ratio when forgings are made out of ingots shall be 4:1, for all ruling sections unless otherwise agreed between BHEL & supplier before placement of order.

गोपनीय एवं अधिकार सुरक्षित
इस प्रपत्रा पर दी गई जानकारी भारत हेवी इलेक्ट्रिकल्स लिमिटेड की सम्पत्ति है इसे प्रत्यक्ष या अप्रत्यक्ष रूप से कम्पनी के हितों को नुकसान पहुँचाने के लिए कदापि उपयोग नहीं किया जावे

संशोधन : 07

हाइड्रोजनरेटर इंजीनियरिंग विभाग
भारत हेवी इलेक्ट्रिकल्स लिमिटेड

तैयारकर्ता

अनुमोदनकर्ता

जारी करने की दिनांक

(KRISHNA CB)

Ritesh
Rajbhiye

-Sd-
H.S.DUGGAL

-Sd-
M.C.NATH

19/06/2001

(B.K.SINGH)



**PRODUCT STANDARD
HYDRO GENERATOR**

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5. HEAT TREATMENT :

Forgings shall be normalised at suitable temperature to give the mechanical properties specified.

6. FINISH:

As mentioned in the drawing.

7. FREEDOM FROM DEFECTS :

Forgings shall be free from defects such as cracks, flakes, seams, segregation, harmful non-metallic inclusions and other defects which may affect the utility of the forgings.

8. CHEMICAL COMPOSITION :

The melt analysis of steel and permissible variation in the composition of the forgings from the melt analysis shall be as follows:

Element	Melt analysis Percent		Permissible Variation, Percent
	Min.	Max.	
Carbon	0.24	0.32	± 0.02
Silicon	0.10	0.35	± 0.03
Manganese	1.30	1.70	± 0.10
Sulphur	--	0.035	+ 0.006
Phosphorus	--	0.035	+ 0.006

Notes :

Elements not quoted above shall not be added to the steel, other than for the purpose of finishing the heat and shall not exceed the following limits:

Element	Percent, Max.
Nickel	0.30
Chromium	0.30
Copper	0.30
Molybdenum	0.15
Vanadium	0.05
Tin	0.05

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9. TEST SAMPLES:

9.1 Test samples should be cut from the heat treated forgings by cold process only and shall receive no further heat treatment.

Test samples shall be cylindrical in shape.

- (a) Radial test piece shall be taken from one end of the forging.
- (b) Tangential test piece shall be taken from other end of the forging.
- (c) Test piece diameter shall be 16mm min. (as per IS-1608:1995, amd. No. 1, May2002, table5)

Test piece shall be cut as below:

- (i) For solid forgings: At a distance of one – third radius or one-sixth diagonal from the outer surface.
- (ii) For hollow forgings: Midway between the inner and outer surface of the wall thickness.

10. MECHANICAL PROPERTIES:

The test pieces shall show the following properties for all ruling sections. Test methods are specified below:

10.1	Tensile test	: IS: 1608
10.2	Hardness test (Brinell)	: IS: 1500
10.3	Charpy Impact Value (2mm U-Notch)	: IS: 1499
10.4	Mechanical properties	
	i. Tensile strength (in any direction)	560 N/mm ² Min
	ii. Yield strength (in any direction)	335 N/mm ² Min
	iii. Elongation 5.65 √ so gauge length	Radial - 10% Min Tangential - 12% Min
	iv. Charpy impact value (2 mm U notch)	Radial - 23 joules Min Tangential - 29 joules Min
	v. Hardness (Brinell) for reference only	156 -212

11. N.D.T.

11.1 Each forging shall be tested ultrasonically in accordance with BHEL Standard No. AA0850101 after final completion of all operation on the forging.
All transition zones shall be subject to magnetic particle test as per above standard, before application of antirust compound.

11.2 Boroscopic test for central hole in case of shaft forging shall be carried out to AA0850101 before application of antirust compound.



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12. TEST CERTIFICATES:

Three copies of test certificates shall be supplied unless otherwise stated on the order. In addition, the supplier shall ensure to enclose one copy of the test certificate along with their dispatch documents to facilitate quick clearance of the material. The following details shall be furnished in the test certificate

- i) Reduction Ratio.
- ii) Dimensional Inspection.
- iii) Details of heat treatment.
- iv) Chemical composition including trace elements.
- v) Result of mechanical tests.
- vi) Result of ultrasonic test.

13. INSPECTION AT SUPPLIER'S WORKS:

Tests and inspection are to be conducted in the presence of purchaser's representative. The representative shall have free access at all times while the work on the contract is being performed. All facilities without charge to be provided to purchaser during inspection including provision of test specimen and its testing. If necessary supplier shall make necessary arrangement for carrying out the test elsewhere.

14. REJECTION AND REPLACEMENT:

In the event of any forging proving defective in the course of preparation, machining, testing or erection such forging shall be rejected, notwithstanding any previous certification of satisfactory testing and /or inspection.

The supplier shall undertake to replace the rejected forgings at his own cost and the rejected forgings shall be sent back to the supplier after fulfilling the commercial terms and conditions.

15. PACKING AND MARKING :

The shaft forging shall be properly protected with anticorrosive compounds. Forgings shall be suitable packed to prevent corrosion and damage transit.

16. DOCUMENT TO BE SUBMITTED ALONG WITH OFFER:

Manufacturing process chart comprising of manufacturing sequence, forging sequence, heat treatment cycle with stage wise test schedule.

NOTE: WITHOUT THIS DOCUMENT, OFFER WILL BE CONSIDERED INCOMPLETE.

Rev. 00 – Prepared by- H.S.Duggal, Approved by- M.C.Nath (19th June, 2001)

Rev. 01 – Clause 2, 4, 7 & 13 – Modified. Clause 14, 15 & 16 added

Rev. 02 – Clause 11.2 added.

Rev. 03 – Clause 1.2 modified

Rev. 04 – Clause 9 modified (7th September, 2004)

Rev. 05 – Clause 10.4(iii), (iv) updated (8th March, 2005)

Rev. 06 – Clause 1.2 deleted

Rev. 07 – Clause ~~10.4~~.(iv) updated

पोपनीय एवं अधिकार सुरक्षित
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FIRST ANGLE PROJECTION

(ALL DIMENSIONS ARE IN .mm)

DRG.NO. 3 254 01 14702

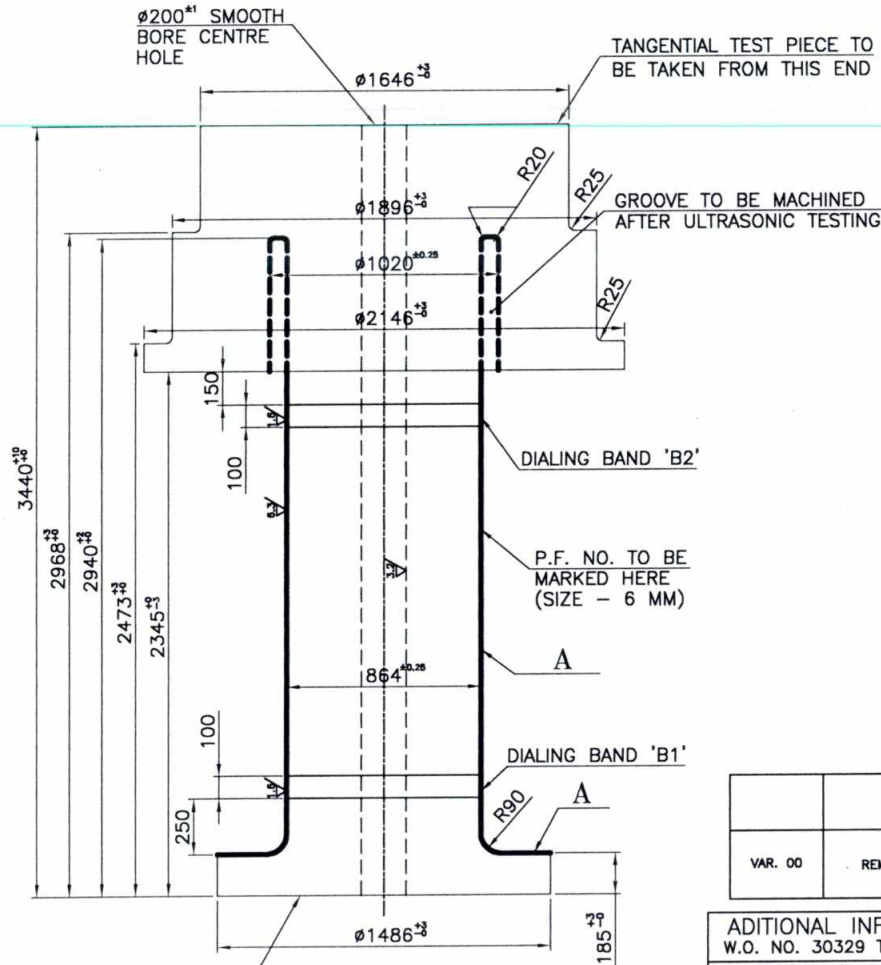
TECHNICAL REQUIREMENTS:

- P.F. NOS. ARE TO BE STAMPED AT PLACE SHOWN ON DRAWING AND RESTAMPED JUST AFTER MACHINING.

PALAMURU RANGAREDDY STAGE-1		KALESHWARAM LINK-II PKG-2		KALESHWARAM LINK-IV PACKAGE-1	
UNIT NO.	P.F. NO.	P.F. NO.	P.F. NO.	P.F. NO.	P.F. NO.
1	310841	1	310853	1	311529
2	310842	2	310854	2	311530
3	310843	3	310855	3	311531
4	310844	4	310856	4	311532
5	310845				
6	310846				
7	310847				
8	310848				
- SURFACE FINISH SHALL BE 6.3 MICRONS ALL OVER EXCEPT OTHERWISE STATED.
- ALL FACES SHALL BE PARALLEL AND SQUARE TO THE AXIS.
- INSPECTION SHALL BE CARRIED OUT IN THE PRESENCE OF BHEL/THIRD PARTY/CUSTOMER.
- SHAFT FORGING, INCLUDING THE BORE, SHALL BE PAINTED WITH ANTI-RUST PAINT TO BP0690084.
- 6 COPIES OF TEST CERTIFICATES SHALL BE SUBMITTED. THE P.F. NOS. OF THE FORGINGS AND THE CAST NOS. OF THE BILLETS SHALL BE QUOTED ON THE CORRESPONDING COPIES OF THE TEST CERTIFICATES.
- CENTRAL HOLE OF DIAMETER $\phi 200$ IS FINAL FINISHED AND THIS DIAMETER SHALL BE COAXIAL AND CONCENTRIC WITH MAIN DIAMETER $\phi 864$.
- WELD REPAIR & COLD WORKING OF THE FORGING IS NOT PERMISSIBLE AT ANY STAGE.
- SHAFT FORGING SHALL BE AS PER PRODUCT STANDARD HG10035.
- MACHINING BAND B1 & B2 SHALL BE USED FOR RESETTING SHAFT AT BHEL WORKS. THEY SHALL BE DIALLED WITHIN 0.05 MM.
- PORTIONS OF SHAFT MARKED 'A' ARE FINAL FINISHED AND THESE DIAMETERS SHALL BE CO-AXIAL AND CONCENTRIC. THESE PORTIONS SHALL BE ADEQUATELY PROTECTED TO AVOID DAMAGE DURING TRANSPORT/HANDLING.

IMPORTANT NOTES FOR SUPPLIER:

- THE SUPPLIER IS TO CONFIRM COMPLIANCE TO THE DRAWING AND PRODUCT STANDARD HG10035 CLAUSE-BY-CLAUSE. ANY DEVIATION SHALL BE CLEARLY BROUGHT OUT IN THE OFFER.
- CLAUSE-BY-CLAUSE COMPLIANCE OF QA PLAN NO. QSP/HG/104 (TWO SHEETS) SHALL BE CONFIRMED BY THE SUPPLIER.
- OFFERS NOT MEETING THE ABOVE REQUIREMENTS, MAY BE REJECTED IN THE FIRST INSTANCE ITSELF.



VAR. 00	REMARKS	VAR. NO.	ITEM NO.	DESCRIPTION	DWG. NO.	IT. NO.	MATL. CODE.	UNIT WT.	QTY.
				001 BOTTOM SHAFT FORGING			HG10035	33023	
						VAR	MATL. SPCN.		

ADDITIONAL INFORMATION
W.O. NO. 30329 TO 36-A-23154

STATUS OF DRAWING

DISTRIBUTION OF PRINTS

TEX-1 HGM-1
HGE-1

उत्पाद का प्रकार या ग्राहक / परियोजना का नाम
TYPE OF PRODUCT OR NAME OF CUSTOMER/PROJECT (IRRIGATION & CAD DEPT, GOVT. OF TELANGANA)

नाम NAME	हस्ता. SIGN	दि. DATE	NO. OF VAR
काया DRN	LU	15.01.21	वेर की संख्या
चुन CHD	ILA	15.01.21	
स्वीकृत APPD	RG	15.01.21	

सिमा टैग DEPT HGE	UNTO DIMS 32500001404	SCALE उतुपात NTS	भार व.ग. WEIGHT(kg) 33023	उसे. ड्रा.ग का संदर्भ REF TO ASSY DRG	मद क. ITEM NO.	मद संख्या NO. OF ITEM
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TITLE शीर्षक BOTTOM SHAFT FORGING	DRAWING NO. 3 254 01 14702	पुन. REV 02
पृष्ठ सं. SHT NO. 01	पृष्ठों की सं. NO. OF SHT 01	

THE INFORMATION ON THIS DOCUMENT IS THE PROPERTY OF
BHARAT HEAVY ELECTRICALS LTD.,
IT MUST NOT BE USED DIRECTLY OR INDIRECTLY IN ANY WAY DETRIMENTAL TO THE INTEREST OF THE COMPANY.

REF. DRG. NO.

SIGN. DATE

INVENTORY NO.

RADIAL TEST PIECE TO
BE TAKEN FROM THIS END

REV	DATE	ALTERED	REV	DATE	ALTERED
02	05.07.21	CHECKED ILA APPROVED RG	01	11.03.21	CHECKED NK APPROVED RG
ZONE		PF NO. ADDED FOR KALESHWARAM LINK-IV PACKAGE-1.	ZONE		PF NO. ADDED IN KALESHWARAM LINK-II PKG-2.



QUALITY ASSURANCE DEPARTMENT

QA PLAN FOR: FORGINGS
QA PLAN NO: QSP/HG/104

DATE: 13/10/1993

PI NO: 240311833
REVISION: 01SHEET 1 of 2
DATE: 14/01/2016

SL. NO.	COMPONENT/ASSY/ OPERATION	CHARACTERISTICS	CLASS	TYPE	QUANTUM OF CHECK	REF. DOC.	RECORD FORMAT	INSPECTION AGENCY	REMARKS
1.0	Forging stock (ingot or bloom)	a) Material certification	Major	Review	100%	Spec/ Drawing	TC	Supplier/BHEL/ Customer	
		b) Material identification	Major	Review	100%	Spec/ Drawing	TC	Supplier/BHEL/ Customer	
1.2	Forging	a) Visual and process checks	Major	Review	100%	Approved forging process	Supplier QC record	Supplier/BHEL/ Customer	
		b) Heat treatment	Critical	Heat treatment	100%	Spec	TC	Supplier/BHEL/ Customer	
		c) Marking of test samples as per drawing	Major	Review	100%	Drawing	Supplier QC record	Supplier/BHEL/ Customer	
		d) Chemical analysis	Major	Chem	Sample	Spec	TC	Supplier/BHEL/ Customer	
		e) Mechanical analysis	Major	Mech	Sample	Spec	TC	Supplier/BHEL/ Customer	
		f) Ensure proof marking for availability of machining allowance	Major	Dimensional	100%	Drawing	Supplier QC record	Supplier/BHEL/ Customer	
		g) Marking of PF nos., etc. before rough machining	Major	Review	100%	Drawing	Supplier QC record	Supplier/BHEL/ Customer	
		h) Visual & dimensional checks of rough machined forgings	Major	Visual/ Dimensional	100%	Drawing	Supplier QC record	Supplier/BHEL/ Customer	

PREPARED BY: -SD-

CHECKED BY: -SD-

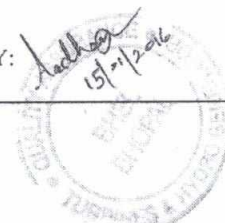
APPROVED BY: -SD-

DATE: 13/10/1993

REVISION 01: 1) "Important note" has been added. 2) The "Type" field was blank for 1.2 c) & 1.2 g). 3) The "Record format" field was blank for Sl. No. 1.2 c). 4) The format has been updated.

PREPARED BY: *[Signature]* 14/01/2016CHECKED BY: *[Signature]* 14/01/16APPROVED BY: *[Signature]* 15/01/2016

DATE: 14/01/2016

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8



QUALITY ASSURANCE DEPARTMENT

QA PLAN FOR: FORGINGS

QA PLAN NO: QSP/HG/104

DATE: 13/10/1993

PI NO: 240311833

REVISION: 01

SHEET 1 of 2

DATE: 14/01/2016

SL. NO.	COMPONENT/ASSY/ OPERATION	CHARACTERISTICS	CLASS	TYPE	QUANTUM OF CHECK	REF. DOC.	RECORD FORMAT	INSPECTION AGENCY	REMARKS
		i) UT on forging and boroscopic examination	Major	NDT	100%	Drawing	TC	Supplier/BHEL/ Customer	
		j) Final marking of PF nos., heat nos., identification, etc.	Major	Review	100%	Drawing	TC	Supplier/BHEL/ Customer	
		k) Painting, preservation, and packing	Major	Review	100%	Drawing	TC	Supplier/BHEL/ Customer	

ABBREVIATIONS: NDT - Non Destructive Testing, Mech - Mechanical, Chem - Chemical, Elec - Electrical, Spec - Specification, TC - Test Certificate, QC - Quality Control

IMPORTANT NOTE: Some of the above-mentioned tests may be witnessed by the customer. This shall be intimated at a later date.

PREPARED BY: -SD-

CHECKED BY: -SD-

APPROVED BY: -SD-

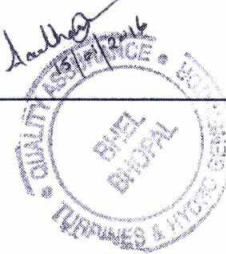
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PREPARED BY: *[Signature]* 14/01/2016CHECKED BY: *[Signature]* 14/01/16APPROVED BY: *[Signature]* 14/01/2016

DATE: 14/01/2016

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 BHOPAL	TECHNICAL PRE-QUALIFICATION REQUIREMENTS (TPQR)	DOC. NO.: HGG-2034 DATE: 07-05-2021 REV.: 04 PAGE 01 OF 01
	HYDRO GENERATOR ENGINEERING DIVISION	

Bottom Shaft Forging

The bids are invited from manufacturer or their authorized representative for supply of shaft forging as per BHEL drawing, purchase specification and quality plan.

Following are the Technical Pre-Qualification Requirements (TPQR):

Sr. No.	Description of pre-qualification requirement	Vendor Response	
		Complied/ Not complied	Supporting Documents required to accept compliance
1)	Manufacturer of forging / their authorized representative.		Certificate of being manufacturer (for manufacturer) / authorization (for authorized representative).
2)	Experience of manufacturing steel shaft forging as per HG10035 or equivalent or higher grade (yield point) and supply of the same during last 10 years (see note-3) having following criteria: a) Minimum 3 supplies of individual forging weight of 15000.0 kgs. OR b) Minimum 2 supplies of individual forging weight of 18500 kgs. OR c) Minimum 1 supply of individual forging weight of 29500 kgs.		- Purchase order - Test certificate & invoice.
3)	Capability of manufacturing shaft forging as per BHEL drawing, specification and QA plan.		Self-certification of having the capability.
4)	Company shall be certified with ISO 9001. In case of authorized representative, valid ISO certificate of manufacturer is required.		Valid certificate to be submitted.

Note:

1. Compliance to above Technical Pre-Qualification Requirements are mandatory. In absence of compliance of above requirements vendor TPQ application is liable to be rejected.
2. BHEL has the right to verify information / confirmation furnished, by asking additional documents, proofs etc.
3. The reference date will be the date of enquiry.
4. For each P.O submitted for point no 2 above, Vendor to provide Contact details such as mail id, address and contact numbers of mentioned customer for verification purpose.

Sign & seal of Vendor