	PRODUCT STANDARD <u>HYDRO TURBINE ENGINEERING</u>	HT 00261
		Rev. 02
COPYRIGHT & 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.		Page 1 of 23
<u>PURCHASE SPECIFICATION FOR 13% Cr 4% Ni STAINLESS STEEL IMPELLER</u> <u>FOR FRANCIS TYPE PUMP</u>		

1. MATERIAL :

Stainless Steel (13% Cr-4%Ni) to the material standard mentioned in the drawing (e.g., ASTM A743 CA6NM, EN 10283 Gr. GX4CrNi13-4, AA19542 etc.). Electric arc furnace shall be used and the steel shall be secondary refined using any of AOD (Argon Oxygen Decarburization) / VOD (Vacuum Oxygen Decarburization) process followed by VD (Vacuum degassing). However, if induction furnace is used, then also the steel after melting shall be secondary refined by AOD/ VOD process followed by VD. The casting manufacturer must have the relevant facilities in-house. Castings to be supplied in heat treated condition.

At 0° C the test pieces shall show an average Charpy impact value of 67.5 joules minimum over three test pieces. (However, the minimum value of one test piece shall not be less than 47 joules). The test will be conducted on a 2mm V-notch as per ASTM A370 & ASTM A781.

2. CONDITION OF DELIVERY:

2.1 FOR INTEGRALLY CAST IMPELLER

The integral casting shall be delivered in any one of the three following conditions specified in the drawing/purchase order.

1. Rough ground, Rough machined (See Annexure-II, Clause-1)
2. Semi-finish ground, Rough machined (See Annexure-II, Clause-2)
3. Finish ground, Finish machined (See Annexure-II, Clause-3)




2.2 FOR CAST FABRICATED IMPELLER


Cast fabricated impeller shall be delivered with following condition

- Finish machined water passage surface of crown and skirt and rough machined outer surface
- Finish machined blades (entire surface and edge preparation to be finish machined) with 3.2 micron surface finish.

3. SCOPE OF SUPPLY

1. Impeller Casting
2. One set of templates with last impeller
3. Test samples with each casting (if called in PO)
4. One set of impeller handling device with each impeller (if called in PO)

Rev. No.	Date of Rev.	Remarks	Approved		
01	27.03.2016	Clause1,Figure.3 and Table for figure.3 modified. Clause 10,11 and 12 added.	 J.S. Hanspal, AGM (HOD)-HTE		
02	27.04.16	Clause 8.1 & 16 modified.	Prepared  Shivendra Kr. Sr. MGR/HTE	Checked  A Mandal AGM-HTE	Date of issue (Rev 00) 02.12.15
			Saved in server as no. 42009900261		

	PRODUCT STANDARD HYDRO TURBINE ENGINEERING	HT 00261
		Rev. 02
COPYRIGHT & 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.		Page 2 of 23
<u>PURCHASE SPECIFICATION FOR 13% Cr 4% Ni STAINLESS STEEL IMPELLER</u> <u>FOR FRANCIS TYPE PUMP</u>		

4. HEAT TREATMENT:

The test samples shall be heat treated along with the castings. In case the casting is stress relieved after weld repair of defects, the test pieces shall also be subjected to same cycle of heat treatment. The runners and risers shall be machine cut. Any flame or arc cutting if done shall be carried out before heat treatment. The cycle of heat treatment shall be recorded in the certificates. Refer purchase order for any additional refining process.

5. FREEDOM FROM DEFECTS:

The casting shall be free from all casting defects. Surfaces shall not be peened, plugged or impregnated to cover the surface defects. Non-destructive testing and the accepting norms shall be as per Clause 8.0.

6. TEST SAMPLES:

The test pieces for mechanical tests will be prepared from integrally cast keel block, the size of which shall be as per sketch given in Figure-1.

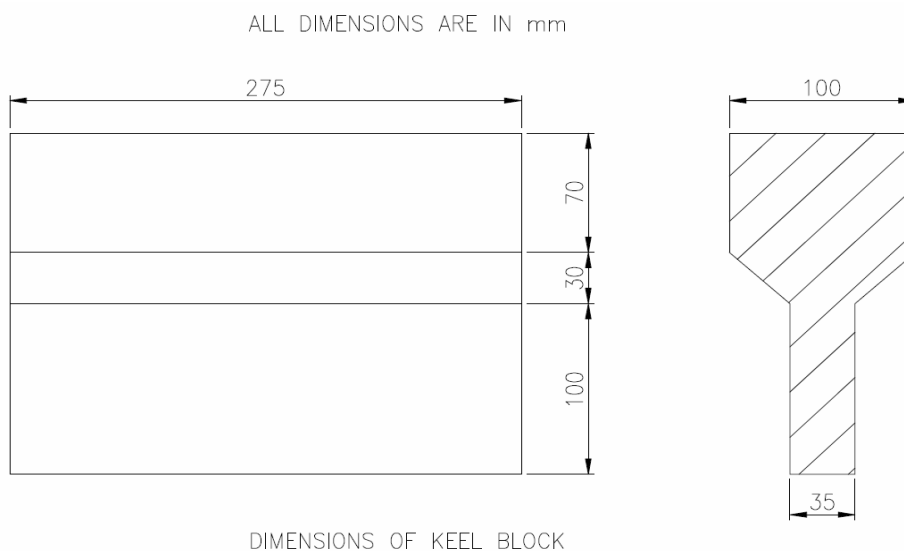






Figure-1

Rev. No.	Date of Rev.	Remarks	Approved		
01	27.03.2016	Clause 1, Figure 3 and Table for figure 3 modified. Clause 10, 11 and 12 added.	 J.S. Hanspal, AGM (HOD)-HTE		
02	27.04.16	Clause 8.1 & 16 modified.	Prepared  Shivendra Kr. Sr. MGR/HTE	Checked  A Mandal AGM-HTE	Date of issue (Rev 00) 02.12.15
			Saved in server as no. 42009900261		

	PRODUCT STANDARD HYDRO TURBINE ENGINEERING	HT 00261
		Rev. 02
COPYRIGHT & 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.		Page 3 of 23
<u>PURCHASE SPECIFICATION FOR 13% Cr 4% Ni STAINLESS STEEL IMPELLER</u> <u>FOR FRANCIS TYPE PUMP</u>		

The position of integrally cast keel block shall be as shown in figure 2(a) for integrally cast impeller:-

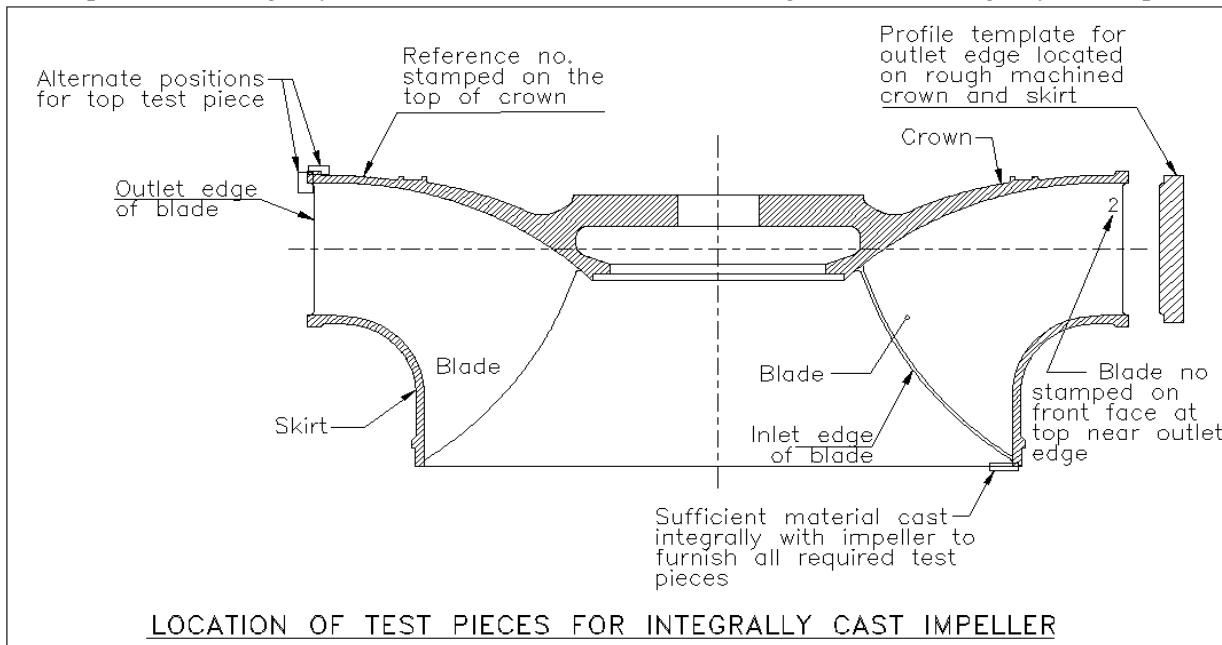


Figure-2(a)

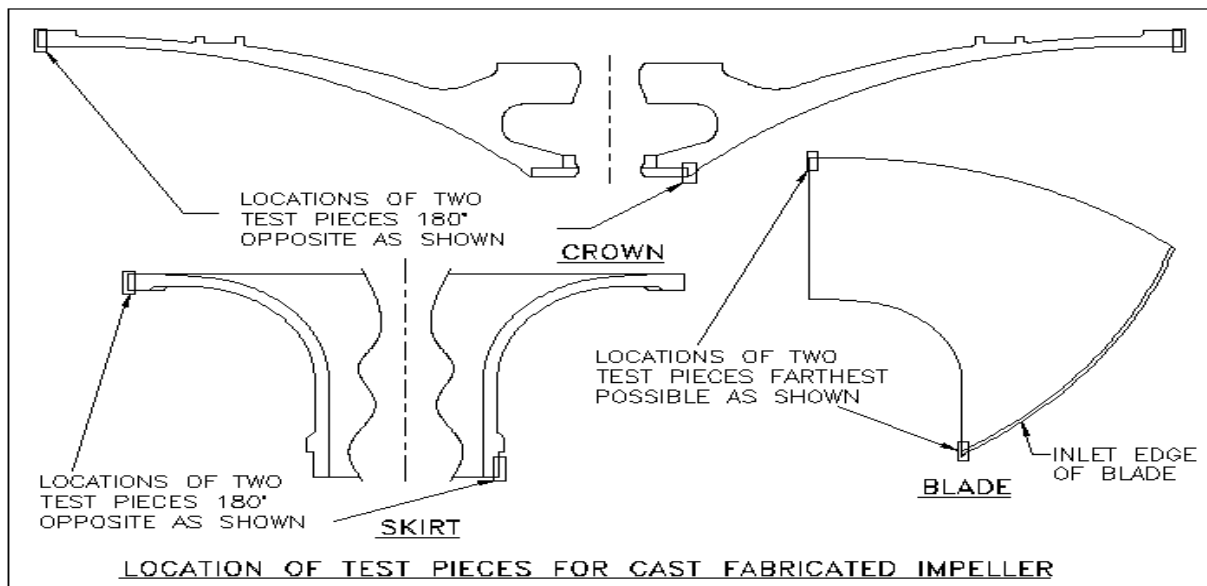






Figure-2(b)

Rev. No.	Date of Rev.	Remarks	Approved		
01	27.03.2016	Clause 1, Figure 3 and Table for figure 3 modified. Clause 10, 11 and 12 added.	 J.S. Hanspal, AGM (HOD)-HTE		
02	27.04.16	Clause 8.1 & 16 modified.			
			Prepared  Shivendra Kr. Sr. MGR/HTE	Checked  A Mandal AGM-HTE	Date of issue (Rev 00) 02.12.15
Saved in server as no. 42009900261					

	PRODUCT STANDARD <u>HYDRO TURBINE ENGINEERING</u>	HT 00261
		Rev. 02
<small>COPYRIGHT & 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.</small>		Page 4 of 23
<u>PURCHASE SPECIFICATION FOR 13% Cr 4% Ni STAINLESS STEEL IMPELLER</u> <u>FOR FRANCIS TYPE PUMP</u>		

The number of keel blocks to be attached with each casting shall be sufficient to supply the required number of test pieces as decided by the vendor, to carry out the tests to ascertain properties as per material spec.

One no. keel block duly stamped is to be dispatched to BHEL along with each impeller casting for integrally cast impeller (if called in PO).

One no. keel block from each crown, skirt and each heat of blades duly stamped is to be dispatched to BHEL along with each impeller if cast fabricated (if called in PO).

For each value of mechanical property at least an average of two test results shall be taken. The keel blocks shall be heat treated along with the casting and detached from the casting after heat treatment in the presence of **authorized inspection agency**.

7. TESTS & CHECKS AT VENDORS WORKS:




7.1 The following tests shall be conducted at the vendor's works:


- a. Test for chemical analysis as per material specification.
- b. Test for mechanical properties including charpy impact test as per clause 1 of this product standard
- c. Non-destructive tests as per **Figure-3**.
- d. Dimensional and profile checks as per casting drawing of the impeller, Annexure-I and impeller Inspection sheets. The impeller inspection sheets shall be supplied by BHEL along with the profile drawing at the time placement of order.
- e. Static balancing of impeller if specified in drawing.

7.2 INSPECTION AT VENDOR'S WORKS

All tests and inspection are to be conducted in the presence of the representative of BHEL/BHEL appointed TPA / BHEL's customer.

The inspector shall have entry at all time while the work on the impellers is being carried out. All reasonable facilities shall be provided to the representative, including labor, to satisfy himself that the casting is made to the specification. The vendor shall provide and prepare necessary test specimens and supply labor and appliances for such testing as may be carried out in his premises. Failing

Rev. No.	Date of Rev.	Remarks	Approved		
01	27.03.2016	Clause 1, Figure 3 and Table for figure 3 modified. Clause 10, 11 and 12 added.	 J.S. Hanspal, AGM (HOD)-HTE		
02	27.04.16	Clause 8.1 & 16 modified.	Prepared  Shivendra Kr. Sr. MGR/HTE	Checked  A Mandal AGM-HTE	Date of issue (Rev 00) 02.12.15
			Saved in server as no. 42009900261		

	PRODUCT STANDARD HYDRO TURBINE ENGINEERING	HT 00261
		Rev. 02
COPYRIGHT & 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.		Page 5 of 23
<u>PURCHASE SPECIFICATION FOR 13% Cr 4% Ni STAINLESS STEEL IMPELLER</u> <u>FOR FRANCIS TYPE PUMP</u>		

facilities at his own works for carrying out the prescribed tests, the vendor shall make necessary arrangements for carrying out the prescribed tests elsewhere.

The inspector should be present during cutting of the test pieces, marking the test pieces with punching and shall witness the testing in the laboratory. The test bars must be marked in such a manner that the inspection marks are visible. Wherever necessary, re-punching shall be done in the presence of the inspector. The impression of punch marking to be sent to BHEL Bhopal

In case any special discussions are to be held in connection with the various clauses of this specification, the information may be sent directly to BHEL, under intimation to the authorized testing agency, sufficiently in advance so that the arrangement are made to depute the technical representative to vendor's works for study and action.

8. NON DESTRUCTIVE TESTING:

Castings shall be examined by various methods of non-destructive testing as mentioned below to locate surface, sub-surface and internal flaws.

8.1 SCOPE OF NDT FOR INTEGRALLY CAST IMPELLER:

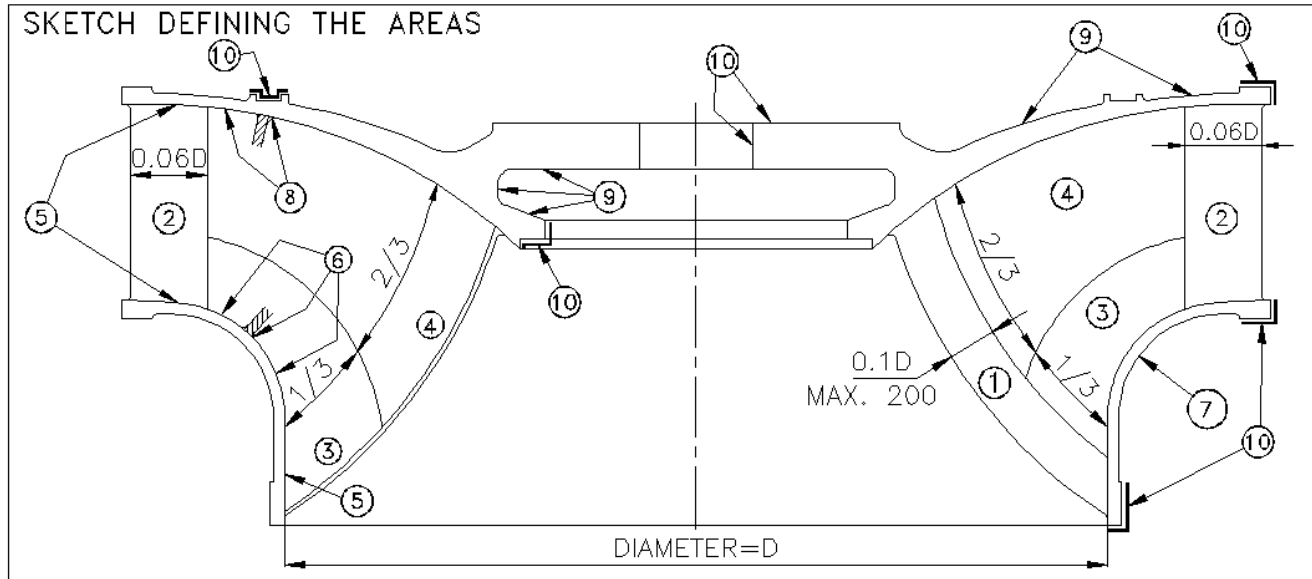






Figure-3

Rev. No.	Date of Rev.	Remarks	Approved		
01	27.03.2016	Clause 1, Figure 3 and Table for figure 3 modified. Clause 10, 11 and 12 added.	 J.S. Hanspal, AGM (HOD)-HTE		
02	27.04.16	Clause 8.1 & 16 modified.	Prepared  Shivendra Kr. Sr. MGR/HTE	Checked  A Mandal AGM-HTE	Date of issue (Rev 00) 02.12.15
Saved in server as no. 42009900261					

	PRODUCT STANDARD HYDRO TURBINE ENGINEERING	HT 00261
		Rev. 02
COPYRIGHT & 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.		Page 6 of 23
<u>PURCHASE SPECIFICATION FOR 13% Cr 4% Ni STAINLESS STEEL IMPELLER</u> <u>FOR FRANCIS TYPE PUMP</u>		

ZONE OF INSPECTION		1	2	3	4	5	6	7	8	9	10	Procedure	Acceptance standard
		DYE-PENETRANT Delivery Condition	1										
	2	X	X	X	X	X	X	X	X	X			
	3	X	X	X	X	X	X	X	X	X	X		
MAGNAFLUX		X	X	X	X	X	X	X	X	X	X	CCH70-3	CCH 70-3, MT 70-3, Class-2
ULTRASONIC		X	X	X	X	X		X		X	X	CCH70-3	CCH 70-3, UT 70-3, Class-2 (up to 50 mm thickness) & Class-3 (above 50 mm thickness).
RADIOGRAPHY		X	X	Wherever necessary in case of doubt arising from above tests and also to be carried out in critical sections.								ASTM E 1030	ASTM E186, E 280 & E 446. Level 2

DESIRED LOCATION FOR NDT

1. Rough ground, rough machined

2. Semi finish ground, rough machined

3. Finish ground, finish machined

NOTE: In case of "Finish ground and finish machined runner" the magna flux test shall be carried out prior to final finish machining and polishing to prevent any probe marks on the finished surfaces.

Table for Figure – 3




Areas to be subjected to dye penetrant, magna-flux, ultrasonic test and radiographic examination are given in Figure-3. NDT to be done after rough machining and stress relieving.


8.2 SCOPE OF NDT FOR CAST FABRICATED IMPELLER:
8.2.1 NON DESTRUCTIVE EXAMINATION BEFORE WELDING: -

- a) Finish machined Blades, Rough machined Skirt and Crown castings shall be 100% ND tested separately as per Table 3 above. Also see clause 8.3.

8.2.2 NON DESTRUCTIVE EXAMINATION AFTER STRUCTURAL WELDING FOR WELD SEAM LINES: -

- a) For full penetration weld joints, 100% PT (penetration test) shall be done after back chipping.
- b) Intermediate inspection by MT (magnetic test) shall be carried out after completing 50% of depths of welding for all weld seam lines.

Rev. No.	Date of Rev.	Remarks	Approved		
01	27.03.2016	Clause 1, Figure 3 and Table for figure 3 modified. Clause 10, 11 and 12 added.	 J.S. Hanspal, AGM (HOD)-HTE		
02	27.04.16	Clause 8.1 & 16 modified.	Prepared  Shivendra Kr. Sr. MGR/HTE	Checked  A Mandal AGM-HTE	Date of issue (Rev 00) 02.12.15
Saved in server as no. 42009900261					

	PRODUCT STANDARD <u>HYDRO TURBINE ENGINEERING</u>	HT 00261
		Rev. 02
COPYRIGHT & 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.		Page 7 of 23
<u>PURCHASE SPECIFICATION FOR 13% Cr 4% Ni STAINLESS STEEL IMPELLER</u> <u>FOR FRANCIS TYPE PUMP</u>		

- c) For the excavated areas, complete removal of defects shall be ensured by PT.
- d) 100% MT shall be carried for all weld seam lines after finish grinding.
- e) For full penetration welds, 100% UT (ultrasonic test) shall be carried out. Also see clause 8.3.

Acceptance criteria for above NDT shall be in accordance to ASME SEC. VIII.

8.3 Locations and types of probe for UT

<u>Sr. No.</u>	<u>LOCATIONS</u>	<u>TYPE OF PROBES TO BE USED</u>
01	Where allowance has been left for finish machining.	Twin crystal (Double probe normal)
02	At the positions of Runners & risers	Normal + twin crystal + angle beam.
03	At the change of sections.	Normal + angle beam.
04	Repair area.	Normal + angle beam.
05	Section thickness is 25 mm and below.	Twin crystal (Double Probe)




The areas which are not accessible or cannot be evaluated by above ultrasonic methods should be tested by radiography or else to be reported to BHEL with sketches for approval.


9. RETESTING:

If the results of the mechanical tests are found unsatisfactory, retesting shall be performed on double the number of specimens which gave unsatisfactory results. In case of unsatisfactory results show on even one specimen on retesting reheat-treatment is allowed after which the casting shall be treated as a new one.

10. SURFACE ROUGHNESS TEST

All surfaces shall be checked visually and confirmed to be without any mechanical damage, scratch, crack and injurious defect. The surface roughness of impeller crown, skirt/band and blade (if called finish machined) shall be checked after rough finishing and shall be complied to design requirements.

Rev. No.	Date of Rev.	Remarks	Approved		
01	27.03.2016	Clause 1, Figure 3 and Table for figure 3 modified. Clause 10, 11 and 12 added.	 J.S. Hanspal, AGM (HOD)-HTE		
02	27.04.16	Clause 8.1 & 16 modified.	Prepared  Shivendra Kr. Sr. MGR/HTE	Checked  A Mandal AGM-HTE	Date of issue (Rev 00) 02.12.15
			Saved in server as no. 42009900261		

	PRODUCT STANDARD <u>HYDRO TURBINE ENGINEERING</u>	HT 00261
		Rev. 02
COPYRIGHT & 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.		Page 8 of 23
<u>PURCHASE SPECIFICATION FOR 13% Cr 4% Ni STAINLESS STEEL IMPELLER</u> <u>FOR FRANCIS TYPE PUMP</u>		

11. HARDNESS TEST

The hardness test shall be conducted for all grades (Clause S-14 for ASTM 743 CA6NM). For standards AA 19542 and EN 10283 Gr. GX4CrNi13-4 the tests shall be conducted as per the provisions laid down in the respective standards.

Hardness of repair welded areas (as pointed out by the inspector) shall be recorded.

12. MICROSCOPIC TEST

The micro structure of crown/ skirt (band)/ blade shall be investigated for the following portions and photographs shall be taken with 100 times magnification to confirm the normal structure as required for the specified material. For blade the martensitic structure shall be free from the delta-ferrite

a) For repair welded portions:

The repair welded portion shall be selected from the hardest portion by the hardness test of the product and the photographs shall be taken from three zones, base metal, heat affected zone and weld deposit metal.

b) For base metal:

The top (external) side surface of crown, outside surface of skirt/band & both side surfaces of blade shall be checked.




13. REPAIR OF CASTING


13.1 No major defect shall be repaired or welded without the permission from BHEL or its representative. The vendor will submit the weld repair procedure for approval giving details of procedure for removal of defects, NDT before weld repair, specification of weld electrodes welding procedure specification (WPS), post weld heat treatment and NDT to be carried out after repair.

13.2 The defect shall be removed by mechanical means, i.e., chipping grinding etc. The air carbon arc gouging is not acceptable for removal of defects.

13.3 The dye penetrate and magna-flux test shall be employed to ensure that the defects have been removed to sound metal.

13.4 The vendor shall submit sketch (defectogram) showing the nature, location shape and size of each defect and obtain BHEL's prior permission for the major defect to repair.

Rev. No.	Date of Rev.	Remarks	Approved		
01	27.03.2016	Clause 1, Figure 3 and Table for figure 3 modified. Clause 10, 11 and 12 added.	 J.S. Hanspal, AGM (HOD)-HTE		
02	27.04.16	Clause 8.1 & 16 modified.	Prepared  Shivendra Kr. Sr. MGR/HTE	Checked  A Mandal AGM-HTE	Date of issue (Rev 00) 02.12.15
			Saved in server as no. 42009900261		

	PRODUCT STANDARD <u>HYDRO TURBINE ENGINEERING</u>	HT 00261
		Rev. 02
COPYRIGHT & 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.		Page 9 of 23
<u>PURCHASE SPECIFICATION FOR 13% Cr 4% Ni STAINLESS STEEL IMPELLER</u> <u>FOR FRANCIS TYPE PUMP</u>		

- 13.5 The electrodes to be used for weld repair shall be compatible with the parent material of the casting.
- 13.6 On completion of weld repair all the NDT shall be carried out, as to be done for the casting as per clause 8.0 of this specification.
- 13.7 It's preferable to carry out weld repair prior to carrying out normal heat treatment of the casting. In case the weld repair is carried out after normal heat treatment then the casting shall be stress relieved if necessary depending on the extent of repairs. Record of all weld repairs (major & minor) shall be furnished to BHEL along with details of post weld heat treatment and NDT.

14. INSPECTION AT BHEL

BHEL reserves the right of rechecking the castings in accordance with this specification. In case of unsatisfactory results of testing, the casting shall be rejected.




If any metallurgical defect is revealed during the subsequent machining operations of castings supplied in the rough machined rough ground or semi-finish ground, condition, the same shall be repaired by welding at vendor's cost if it does not affect the quality of performance. However, if the defects are such that their repair is likely to affect the performance during operation, the casting shall be rejected with due intimation to the vendor. The casting shall have to be replaced free of cost by the vendor.


15. INDEPENDENT TEST:

In case of dispute about the compliance of the material with regard to the composition or the test requirements of this specification BHEL and vendor shall have the right to have tests conducted by mutually acceptable testing authority. The results obtained by the individual testing authority shall be acceptable as final. If the material does not comply with this specification, the cost of independent testing shall be borne by the vendor, if material complies with this spec., the cost shall be borne by BHEL.

16. MARKING AND DOCUMENTATION :

Each impeller shall be marked on the top of the crown or stamped with **BHEL Order No., BHEL drawing no. heat no., weight and inspection stamp**. All test pieces are to be stamped with suitable identification marks to identify the casting which it represents and shall be supplied to BHEL as mentioned in Clause no. 6. The blades of the impeller shall be numbered and each blade shall be stamped with its appropriate number on the front face at the top, near the outlet edge (Fig.2a).

Rev. No.	Date of Rev.	Remarks	Approved		
01	27.03.2016	Clause 1, Figure 3 and Table for figure 3 modified. Clause 10, 11 and 12 added.	 J.S. Hanspal, AGM (HOD)-HTE		
02	27.04.16	Clause 8.1 & 16 modified.	Prepared  Shivendra Kr. Sr. MGR/HTE	Checked  A Mandal AGM-HTE	Date of issue (Rev 00) 02.12.15
			Saved in server as no. 42009900261		

	PRODUCT STANDARD <u>HYDRO TURBINE ENGINEERING</u>	HT 00261
		Rev. 02
COPYRIGHT & 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.		Page 10 of 23
<u>PURCHASE SPECIFICATION FOR 13% Cr 4% Ni STAINLESS STEEL IMPELLER</u> <u>FOR FRANCIS TYPE PUMP</u>		

Six copies of the certificates should accompany each, accepted impeller casting along with the following details:

- i) Drawing No. / Order No.
- ii) NDT of welds (if applicable)
- iii) Grade of steel
- iv) Batch No. Heat No.
- v) Results of Chemical Analysis.
- vi) Results of Mechanical Testing including charpy impact testing.
- vii) Results of Dye Penetration/Magna-flux tests.
- viii) Results of Ultrasonic Testing
- ix) Results of Radiographic Testing.
- x) Record of AOD/VOD and heat treatment (Time and temperature records /certificate).
- xi) Results of Dimensional checking.
- xii) Copies of impeller inspection sheets prepared as per Clause-1 of Annexure-I.
- xiii) Surface roughness test
- xiv) Hardness test
- xv) Microscopic test
- xvi) Gas analysis result *
 - * Gas analysis result shall contain oxygen, hydrogen and nitrogen content in the melt stage before pouring.

Note: The templates shall be dispatched along with last impeller (Clause 2, Annexure-I).
For total no. of templates refer clause no. 4.5 of Annexure-I.




17. DEVIATION


For any deviation from specified requirement prior approval must be obtained from BHEL. All deviations to be mentioned in check list submitted along with offer. If required vendor may attach a separate list of deviations.

18. REJECTION AND REPLACEMENT

In the event of casting proving defective from foundry causes in the course of preparation, machining, testing or erection such casting shall be rejected, not with-standing any previous certification of satisfactory testing and/or inspection.

The vendor shall under take to replace the rejected casting at his own cost and the rejected casting will be sent back to the manufacturer / vendor after fulfilling the commercial terms and conditions

Rev. No.	Date of Rev.	Remarks	Approved		
01	27.03.2016	Clause1,Figure.3 and Table for figure.3 modified. Clause 10,11 and 12 added.	 J.S. Hanspal, AGM (HOD)-HTE		
02	27.04.16	Clause 8.1 & 16 modified.	Prepared  Shivendra Kr. Sr. MGR/HTE	Checked  A Mandal AGM-HTE	Date of issue (Rev 00) 02.12.15
			Saved in server as no. 42009900261		

	PRODUCT STANDARD <u>HYDRO TURBINE ENGINEERING</u>	HT 00261
		Rev. 02
COPYRIGHT & 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.		Page 11 of 23
<u>PURCHASE SPECIFICATION FOR 13% Cr 4% Ni STAINLESS STEEL IMPELLER</u> <u>FOR FRANCIS TYPE PUMP</u>		

19. PATTERNS

Patterns shall be made by the vendor to suit the castings. BHEL will provide all necessary blading and impeller drawings. Pattern charges will be charged by the vendor as a lump-sum only on the first order on them. For subsequent future repeat orders, the vendor shall not charge any pattern charges. Pattern once made shall remain property of BHEL and the vendor will make arrangement to store free of charge with enough care for a minimum period of five years, at their works. The vendor shall seek written permission from BHEL prior to destroying the patterns after the lapse of the above mentioned period.

20. QA PLAN AND DRAWING ETC TO BE SUBMITTED AFTER PLACEMENT OF ORDER

Vendor must submit a QA Plan for Impeller casting and submit for BHEL's/Customer's approval. This approved QA Plan will be followed at all stages of manufacturing by the vendor. This QA plan must incorporate all specification requirements. Approval of QA Plan will not absolve the vendor from meeting all our requirements of drawing and specification.




Vendor to also submit manufacturing drg, WPS (Welding Procedure Specification) and PQR (Procedure Qualification Record) for BHEL's approval.


21. GENERAL

21.1 In case of any contradiction between the clauses of PO, this document & material specification, QA plan or drawing, the following hierarchical order of overriding will be applicable.

1. Drawing and impeller inspection sheets (*most important*)
2. Purchase Order
3. HT 00261
4. Approved QA plan
5. Material specification.

21.2 Before start of manufacturing, vendor has to get confirmation of latest revision no. of the drawing from Hydro Turbine Engineering / BHEL, Bhopal. Vendor must also have the QA Plan approved before manufacturing starts.

Rev. No.	Date of Rev.	Remarks	Approved		
01	27.03.2016	Clause 1, Figure 3 and Table for figure 3 modified. Clause 10, 11 and 12 added.	 J.S. Hanspal, AGM (HOD)-HTE		
02	27.04.16	Clause 8.1 & 16 modified.	 Shivendra Kr. Sr. MGR/HTE	Checked  A Mandal AGM-HTE	Date of issue (Rev 00) 02.12.15
			Saved in server as no. 42009900261		

	PRODUCT STANDARD <u>HYDRO TURBINE ENGINEERING</u>	HT 00261
		Rev. 02
COPYRIGHT & 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.		Page 12 of 23
<u>PURCHASE SPECIFICATION FOR 13% Cr 4% Ni STAINLESS STEEL IMPELLER</u> <u>FOR FRANCIS TYPE PUMP</u>		

ANNEXURE - I**WORKMANSHIP AND INSPECTION PROCEDURE**1. **IMPELLER INSPECTION SHEET :**

The vendor shall record on impeller inspection sheets, all relevant data for each impeller as required by this specification. The impeller inspection sheets shall be supplied by BHEL after placement of order.

2. **TEMPLATES:**




BHEL shall supply with the purchase order all the blade profile drawings for making the templates for the inspection of the impeller to the specification and drawing dimensions. The templates shall be supplied to BHEL by the vendor along with the last consignment of the impeller.


3. **CORRECTION OF BLADE INLET PASSAGE & INLET EDGE THICKNESS:**

3.1 The correction of blade inlet passages and inlet edge thickness shall be carried out by the grinding. With reference to the dimensions given on the impeller inspection sheet, and using the procedure outlined below in conjunction with Fig. 4.3 of Annexure-I.

	Case A	Case B
	Passage "P" is less	Passage "P" is correct or more
1	If blade's inlet edge "t" is thick	If blade's inlet edge "t" is thick
	Grind front side of thick blade's inlet edge (2) until either the passage is correct or blade inlet edge's thickness is correct.	Grind the back of blade's inlet edge (3) until blade inlet edge's thickness is correct.
2	If blade's inlet edge "t" is correct or thin.	If blade's inlet edge "t" is correct or thin.
	Grind backside of it's adjacent blade (1) until the passage is correct.	No action is required

3.2 After correction of passage and thickness, the blade inlet edges shall be shaped by grinding to the blade profile. Any corrective grinding is to be blended into adjacent portions of the blade over a distance of 15t to 20t, where "t" is the designed inlet edge thickness of the blade.




Rev. No.	Date of Rev.	Remarks	Approved		
01	27.03.2016	Clause 1, Figure 3 and Table for figure 3 modified. Clause 10, 11 and 12 added.	 J.S. Hanspal, AGM (HOD)-HTE		
02	27.04.16	Clause 8.1 & 16 modified.	Prepared  Shivendra Kr. Sr. MGR/HTE	Checked  A Mandal AGM-HTE	Date of issue (Rev 00) 02.12.15
Saved in server as no. 42009900261					


	PRODUCT STANDARD <u>HYDRO TURBINE ENGINEERING</u>	HT 00261
		Rev. 02
<small>COPYRIGHT & CONFIDENTIAL</small> <small>The information on this document is the property of BHARAT HEAVY ELECTRICALS LIMITED.</small> <small>It must not be used directly or indirectly in any way detrimental to the interest of the company.</small>		Page 13 of 23
<u>PURCHASE SPECIFICATION FOR 13% Cr 4% Ni STAINLESS STEEL IMPELLER</u> <u>FOR FRANCIS TYPE PUMP</u>		

ANNEXURE – I**4. INSPECTION:**

- 4.1 The inlet diameter of the skirt shall be inspected for squareness or such other angle as the drawing may specify, correction being made by grinding.
- 4.2 When grinding/machining has been completed and water passages have been corrected in accordance with clause-3 of Annexure-I, dimensions shall be recorded on the impeller inspection sheets provided along with the purchase order.
- 4.3 Blade profile, crown and skirt profile, surface waviness shall also be checked as per inspection sheets.
- 4.4 Tolerance and measuring methods for impeller shall be as per inspection sheets.
- 4.5 List of templates shall be as per table below. Each template shall have template no. , PO No. and name of project punched on it.




S. No.	Template no. (See sample inspection sheets)	Description
1	1	Blade outlet diameter (sample inspection sheet 1)
2	2	Blade outlet pitch at section E(sample inspection sheet 2)
3	3	Blade outlet pitch at section F (sample inspection sheet 2)
4	4	Blade outlet pitch at section G (sample inspection sheet 2)
5	5	Impeller inlet opening at section B-B (sample inspection sheet 4)
6	6	Impeller inlet opening at section C-C (sample inspection sheet 4)
7	7	Impeller inlet opening at section D-D (sample inspection sheet 4)
8	8	Impeller inlet opening at section E-E (sample inspection sheet 4)
9	9(s)	Impeller outlet angle-suction side at section E-E (sample inspection sheet 5)
10	10(s)	Impeller outlet angle-suction side at section F -F (sample inspection sheet 5)


Rev. No.	Date of Rev.	Remarks	Approved		
01	27.03.2016	Clause 1, Figure 3 and Table for figure 3 modified. Clause 10, 11 and 12 added.	 J.S. Hanspal, AGM (HOD)-HTE		
02	27.04.16	Clause 8.1 & 16 modified.	Prepared  Shivendra Kr. Sr. MGR/HTE	Checked  A Mandal AGM-HTE	Date of issue (Rev 00) 02.12.15
			Saved in server as no. 42009900261		

	PRODUCT STANDARD <u>HYDRO TURBINE ENGINEERING</u>	HT 00261
		Rev. 02
COPYRIGHT & 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.		Page 14 of 23
<u>PURCHASE SPECIFICATION FOR 13% Cr 4% Ni STAINLESS STEEL IMPELLER</u> <u>FOR FRANCIS TYPE PUMP</u>		

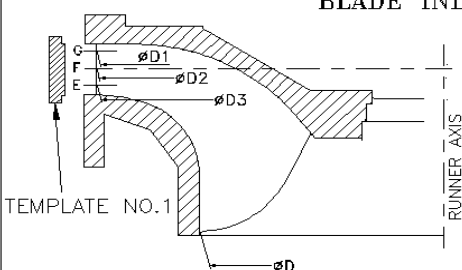
ANNEXURE – I

11	11(s)	Impeller outlet angle-suction side at section G–G (sample inspection sheet 5)
12	9(p)	Impeller outlet angle-pressure side at section E-E (sample inspection sheet 5)
13	10(p)	Impeller outlet angle-pressure side at section F-F (sample inspection sheet 5)
14	11(p)	Impeller outlet angle-pressure side at section G-G (sample inspection sheet 5)
15	12(s)	Impeller blade outlet profile -suction side at section E (sample inspection sheet 6)
16	13(s)	Impeller blade outlet profile -suction side at section F (sample inspection sheet 6)
17	14(s)	Impeller blade outlet profile -suction side at section G (sample inspection sheet 6)
18	12(p)	Impeller blade outlet profile -pressure side at section E (sample inspection sheet 6)
19	13(p)	Impeller blade outlet profile -pressure side at section F (sample inspection sheet 6)
20	14(p)	Impeller blade outlet profile -pressure side at section G(sample inspection sheet 6)
21	15(s)	Impeller blade inlet profile -suction side at section B (sample inspection sheet 6)
22	16(s)	Impeller blade inlet profile -suction side at section C (sample inspection sheet 6)
23	17(s)	Impeller blade inlet profile -suction side at section D (sample inspection sheet 6)
24	15(p)	Impeller blade inlet profile -pressure side at section B (sample inspection sheet 6)
25	16(p)	Impeller blade inlet profile -pressure side at section C (sample inspection sheet 6)
26	17(p)	Impeller blade inlet profile -pressure side at section D (sample inspection sheet 6)
27	18	Impeller inlet angle at section B-B (sample inspection sheet 7)
28	19	Impeller inlet angle at section C-C (sample inspection sheet 7)
29	20	Impeller inlet angle at section D-D (sample inspection sheet 7)

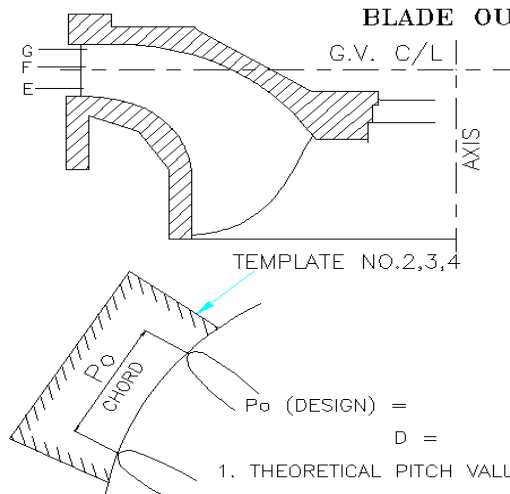
Rev. No.	Date of Rev.	Remarks	Approved		
01	27.03.2016	Clause 1, Figure 3 and Table for figure 3 modified. Clause 10, 11 and 12 added.	 J.S. Hanspal, AGM (HOD)-HTE		
02	27.04.16	Clause 8.1 & 16 modified.	Prepared  Shivendra Kr. Sr. MGR/HTE	Checked  A Mandal AGM-HTE	Date of issue (Rev 00) 02.12.15
			Saved in server as no. 42009900261		

	PRODUCT STANDARD HYDRO TURBINE ENGINEERING	HT 00261
		Rev. 02
COPYRIGHT & 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.		Page 15 of 23
<u>PURCHASE SPECIFICATION FOR 13% Cr 4% Ni STAINLESS STEEL IMPELLER</u> <u>FOR FRANCIS TYPE PUMP</u>		




ANNEXURE – I


RECORD OF INSPECTION BLADE INLET & OUTLET DIAMETER				
 <p>TEMPLATE NO.1</p> <p>NOTE: — DIAMETERS D1, D2 & D3 TO BE FOUND BY MEASURING GAP BETWEEN OUTLET EDGE TEMPLATE (LOCATED RADIALLY ON MACHINED OUTER DIAMETERS OF CROWN & SKIRT AS SHOWN ABOVE) AND BLADE OUTLET EDGE.</p>	ALLOWABLE DEVIATION INDIVIDUAL TO AVERAGE = $\pm 0.5\% D$ AVERAGE TO DESIGN = $\pm 0.125\% D$			
	OUTLET EDGE DIAMETER AT			
	SECTION – G (D1)	SECTION – E (D2)	SECTION – F (D3)	
DESIGN				
BLADE No.				
1				
2				
3				
4				
5				
6				
AVERAGE DIA				
INDIVIDUAL AVERAGE				
ALLOWABLE (MAX.)				
ALLOWABLE (MIN.)				
ALLOWABLE (MAX.)				
ALLOWABLE (MIN.)				

SAMPLE INSPECTION SHEET-1

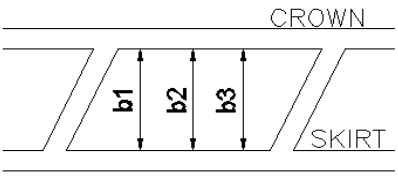
RECORD OF INSPECTION BLADE OUTLET PITCH				
 <p>TEMPLATE NO.2,3,4</p> <p>1. THEORETICAL PITCH VALUE MUST BE SCRIBED & MARKED ON THE TEMPLATE. 2. DEVIATION IN PITCH MAY BE MEASURED AGAINST MARKINGS PROVIDED ON THE TEMPLATE.</p>	ALLOWABLE DEVIATION IN PITCH P_o INDIVIDUAL TO AVERAGE = $\pm 0.5\% D$			
	OUTLET PITCH (P_o) mm			
	SECTION – E	SECTION – F	SECTION – G	
BLADE No. (from – to)				
1 – 2				
2 – 3				
3 – 4				
4 – 5				
5 – 6				
6 – 1				
AVERAGE				

SAMPLE INSPECTION SHEET-2

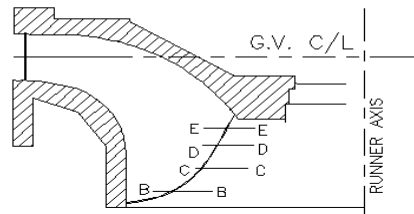
Rev. No.	Date of Rev.	Remarks	Approved		
01	27.03.2016	Clause 1, Figure 3 and Table for figure 3 modified. Clause 10, 11 and 12 added.	 J.S. Hanspal, AGM (HOD)-HTE		
02	27.04.16	Clause 8.1 & 16 modified.	Prepared  Shivendra Kr. Sr. MGR/HTE	Checked  A Mandal AGM-HTE	Date of issue (Rev 00) 02.12.15
Saved in server as no. 42009900261					

	PRODUCT STANDARD HYDRO TURBINE ENGINEERING	HT 00261
		Rev. 02
COPYRIGHT & 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.		Page 16 of 23
PURCHASE SPECIFICATION FOR 13% Cr 4% Ni STAINLESS STEEL IMPELLER FOR FRANCIS TYPE PUMP		




ANNEXURE – I


RECORD OF INSPECTION IMPELLER OUTLET HEIGHT																																															
		ALLOWABLE DEVIATION INDIVIDUAL TO AVERAGE = $\pm 0.3\%$ AVERAGE TO DESIGN = $\pm 0.1\%$																																													
b DESIGN =	<table border="1" style="width:100%; border-collapse: collapse;"> <thead> <tr> <th rowspan="2">BLADE NO</th> <th colspan="3">PASSAGE HEIGHT</th> <th>MEAN HEIGHT</th> </tr> <tr> <th>b1</th> <th>b2</th> <th>b3</th> <th>b b1+b2+b3/3</th> </tr> </thead> <tbody> <tr><td>1 - 2</td><td></td><td></td><td></td><td></td></tr> <tr><td>2 - 3</td><td></td><td></td><td></td><td></td></tr> <tr><td>3 - 4</td><td></td><td></td><td></td><td></td></tr> <tr><td>4 - 5</td><td></td><td></td><td></td><td></td></tr> <tr><td>5 - 6</td><td></td><td></td><td></td><td></td></tr> <tr><td>6 - 1</td><td></td><td></td><td></td><td></td></tr> <tr><td>Average</td><td></td><td></td><td></td><td></td></tr> </tbody> </table>	BLADE NO	PASSAGE HEIGHT			MEAN HEIGHT	b1	b2	b3	b b1+b2+b3/3	1 - 2					2 - 3					3 - 4					4 - 5					5 - 6					6 - 1					Average						
BLADE NO	PASSAGE HEIGHT			MEAN HEIGHT																																											
	b1	b2	b3	b b1+b2+b3/3																																											
1 - 2																																															
2 - 3																																															
3 - 4																																															
4 - 5																																															
5 - 6																																															
6 - 1																																															
Average																																															

SAMPLE INSPECTION SHEET-3

RECORD OF INSPECTION IMPELLER INLET OPENING (a0)																																																																				
		ALLOWABLE DEVIATION : INDIVIDUAL TO AVERAGE = $\pm 5\%$ AVERAGE TO DESIGN = $\pm 1.5\%$																																																																		
TEMPLATE NO.5,6,7,8 NOTE : a0 = MIN. INLET OPENING AT LEADING EDGE FROM PRESSURE SIDE OF ONE BLADE TO SUCTION SIDE OF PREVIOUS BLADE.	<table border="1" style="width:100%; border-collapse: collapse;"> <thead> <tr> <th rowspan="2">BETWEEN BLADE NOS.</th> <th colspan="4">MINIMUM OUTLET OPENING(a0)</th> </tr> <tr> <th>SECTION</th> <th>B-B</th> <th>C-C</th> <th>D-D</th> <th>E-E</th> </tr> </thead> <tbody> <tr><td>1 - 2</td><td></td><td></td><td></td><td></td></tr> <tr><td>2 - 3</td><td></td><td></td><td></td><td></td></tr> <tr><td>3 - 4</td><td></td><td></td><td></td><td></td></tr> <tr><td>4 - 5</td><td></td><td></td><td></td><td></td></tr> <tr><td>5 - 6</td><td></td><td></td><td></td><td></td></tr> <tr><td>6 - 1</td><td></td><td></td><td></td><td></td></tr> <tr><td>AVERAGE -</td><td></td><td></td><td></td><td></td></tr> <tr><td>ALLOWA. AVERAGE MAX.</td><td></td><td></td><td></td><td></td></tr> <tr><td>ALLOWA. AVERAGE MIN.</td><td></td><td></td><td></td><td></td></tr> <tr><td>ALLOWA. INDIVIDUAL MAX.</td><td></td><td></td><td></td><td></td></tr> <tr><td>ALLOWA. INDIVIDUAL MIN.</td><td></td><td></td><td></td><td></td></tr> </tbody> </table>	BETWEEN BLADE NOS.	MINIMUM OUTLET OPENING(a0)				SECTION	B-B	C-C	D-D	E-E	1 - 2					2 - 3					3 - 4					4 - 5					5 - 6					6 - 1					AVERAGE -					ALLOWA. AVERAGE MAX.					ALLOWA. AVERAGE MIN.					ALLOWA. INDIVIDUAL MAX.					ALLOWA. INDIVIDUAL MIN.						
BETWEEN BLADE NOS.	MINIMUM OUTLET OPENING(a0)																																																																			
	SECTION	B-B	C-C	D-D	E-E																																																															
1 - 2																																																																				
2 - 3																																																																				
3 - 4																																																																				
4 - 5																																																																				
5 - 6																																																																				
6 - 1																																																																				
AVERAGE -																																																																				
ALLOWA. AVERAGE MAX.																																																																				
ALLOWA. AVERAGE MIN.																																																																				
ALLOWA. INDIVIDUAL MAX.																																																																				
ALLOWA. INDIVIDUAL MIN.																																																																				

SAMPLE INSPECTION SHEET-4

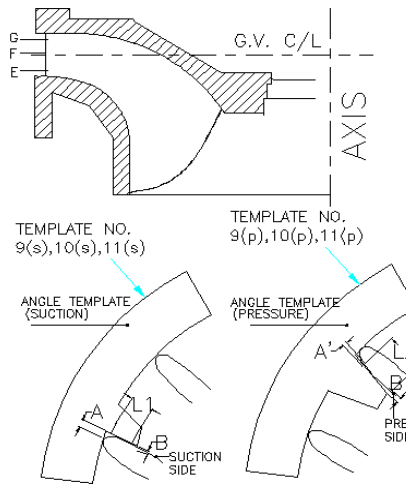
Rev. No.	Date of Rev.	Remarks	Approved  J.S. Hanspal, AGM (HOD)-HTE		
01	27.03.2016	Clause 1, Figure 3 and Table for figure 3 modified. Clause 10, 11 and 12 added.	Prepared  Shivendra Kr. Sr. MGR/HTE		Checked  A Mandal AGM-HTE
02	27.04.16	Clause 8.1 & 16 modified.	Date of issue (Rev 00) 02.12.15		
Saved in server as no. 42009900261					

	PRODUCT STANDARD HYDRO TURBINE ENGINEERING	HT 00261
		Rev. 02
COPYRIGHT & 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.		Page 17 of 23
<u>PURCHASE SPECIFICATION FOR 13% Cr 4% Ni STAINLESS STEEL IMPELLER</u> <u>FOR FRANCIS TYPE PUMP</u>		

ANNEXURE – I

**RECORD OF INSPECTION
IMPELLER OUTLET ANGLE**

ALLOWABLE DEVIATION : INDIVIDUAL TO AVERAGE = $\pm 1.5^\circ$
AVERAGE TO DESIGN = $\pm 0.5^\circ$



BLADE No.	SECTION E-E							SECTION F-F							SECTION G-G						
	A	B	L1	A'	B'	L2	$\frac{m}{4} \pm 1$	A	B	L1	A'	B'	L2	$\frac{m}{4} \pm 1$	A	B	L1	A'	B'	L2	$\frac{m}{4} \pm 1$
1																					
2																					
3																					
4																					
5																					
6																					
	AVERAGE $\pm \Delta\beta^t$							AVERAGE $\pm \Delta\beta^t$							AVERAGE $\pm \Delta\beta^t$						

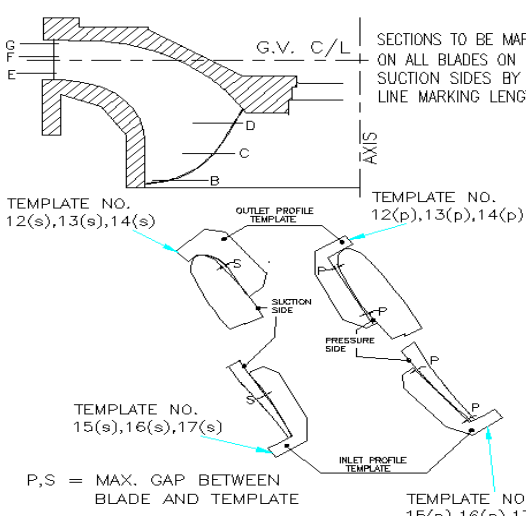
NOTE: 1. LENGTH OF PROFILE (TEMPLATE) = 600 mm
2. TEMPLATES ARE TO TAKE REFERENCE FROM AXIS OR MACHINED DIAMETER

TYPICAL SECTION
A,B & A',B' SHOULD LIE EITHER AT ZERO OR AT MAX. GAP.
P = A - B & P' = A' - B'
ANGLE DEVIATION = $0.5 * [(P/L1) - (P'/L2)] * 57.3$ Degrees

SAMPLE INSPECTION SHEET-5

**RECORD OF INSPECTION
IMPELLER BLADE PROFILE**

ALLOWABLE DEVIATION ON PROFILE :
INDIVIDUAL TO AVERAGE = $\pm 0.2\% D$
AVERAGE TO DESIGN = $\pm 0.1\% D$
INLET DIAMETER D =







SECTIONS TO BE MARKED ON ALL BLADES ON PRESSURE & SUCTION SIDES BY SCRIBING A LINE MARKING LENGTH 550 mm

BLADE No.	OUTLET PROFILE						INLET PROFILE					
	SECTION -E Pressure	SECTION -E Suction	SECTION -F Pressure	SECTION -F Suction	SECTION -G Pressure	SECTION -G Suction	SECTION -B Pressure	SECTION -B Suction	SECTION -C Pressure	SECTION -C Suction	SECTION -D Pressure	SECTION -D Suction
1												
2												
3												
4												
5												
6												
AVERAGE												

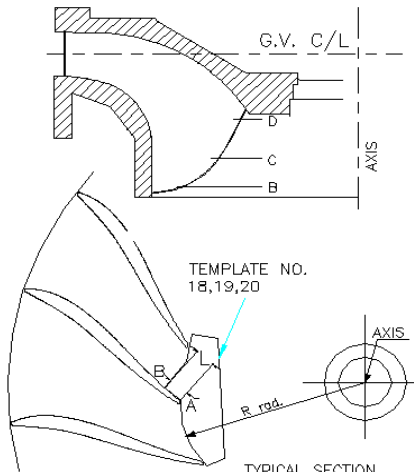
1 LENGTH OF PROFILE (TEMPLATE) = 600 mm
2 BLADE SURFACE SHOULD BE FREE FROM WAVINESS, PROTRUSIONS, HOLLOWES AND DISCONTINUITIES OF PROFILE
3 SURFACE FINISH OF BLADES TO BE ENSURED WITHIN SPECIFIED VALUE IN SPECN./CASTING DRG.

SAMPLE INSPECTION SHEET-6

Rev. No.	Date of Rev.	Remarks	Approved		
01	27.03.2016	Clause 1, Figure 3 and Table for figure 3 modified. Clause 10, 11 and 12 added.	 J.S. Hanspal, AGM (HOD)-HTE		
02	27.04.16	Clause 8.1 & 16 modified.			
			Prepared  Shivendra Kr. Sr. MGR/HTE	Checked  A Mandal AGM-HTE	Date of issue (Rev 00) 02.12.15
Saved in server as no. 42009900261					

	PRODUCT STANDARD HYDRO TURBINE ENGINEERING	HT 00261
		Rev. 02
COPYRIGHT & 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.		Page 18 of 23
PURCHASE SPECIFICATION FOR 13% Cr 4% Ni STAINLESS STEEL IMPELLER FOR FRANCIS TYPE PUMP		

ANNEXURE – I



ANGLE DEVIATION = $\{(A - B)/L\} * 57.3$ Degrees

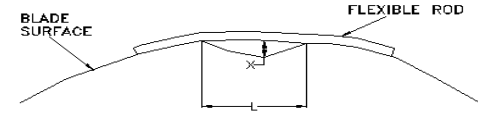
**RECORD OF INSPECTION
IMPELLER INLET ANGLE**

ALLOWABLE DEVIATION : INDIVIDUAL TO AVERAGE = $\pm 1.5^\circ$
 AVERAGE TO DESIGN = $\pm 0.5^\circ$

BLADE No.	SECTION B-B		SECTION C-C		SECTION D-D	
	$\frac{A - B}{L}$	ANGLE DEVIATION	$\frac{A - B}{L}$	ANGLE DEVIATION	$\frac{A - B}{L}$	ANGLE DEVIATION
1						
2						
3						
4						
5						
6						
AVERAGE						

NOTE: 1. LENGTH OF PROFILE (TEMPLATE) = 600 mm = L
 2. TEMPLATES ARE TO TAKE REFERENCE FROM AXIS OR MACHINED DIA.
 3. A & B ARE MEASURED GAPS BETWEEN THE TEMPLATE AND BLADE PROFILE AT EITHER ENDS OF THE TEMPLATE

SAMPLE INSPECTION SHEET-7



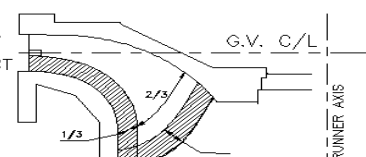
NOTE :

- THE FLEXIBLE ROD CAN BE APPLIED OVER ANY SURFACE OF THE RUNNER BLADE
- THE POINT OF MAX. DEPARTURE X SHALL LIE IN THE MIDDLE THIRD OF L L SHOULD NOT BE LESS THAN 50mm.
- MEASUREMENT FOR CHECKING WAVINESS TO BE CARRIED OUT SUITABLY AT LOCATIONS WHERE VISUAL INSPECTION WARRANTS SUCH A REQUIREMENT
- WAVINESS IS ALLOWED ONLY AS AN ISOLATED DEFECT OCCURRING OCCASSIONALLY ON SURFACE.

**RECORD OF INSPECTION
IMPELLER BLADE WAVINESS**



WAVINESS = X/L


BLADE No.	1		2		3		4		5		6	
	Pres	Suct	Pres	Suct	Pres	Suct	Pres	Suct	Pres	Suct	Pres	Suct
WAVINESS ZONE												
WAVINESS ZONE												
WAVINESS ZONE												
WAVINESS ZONE												
WAVINESS ZONE												
WAVINESS ZONE												
WAVINESS ZONE												



ALLOWABLE DEVIATION (MAX):
 AT INLET EDGES = ± 0.01
 & MARKED ZONES ON BOTH SIDES
 ELSEWHERE = ± 0.02

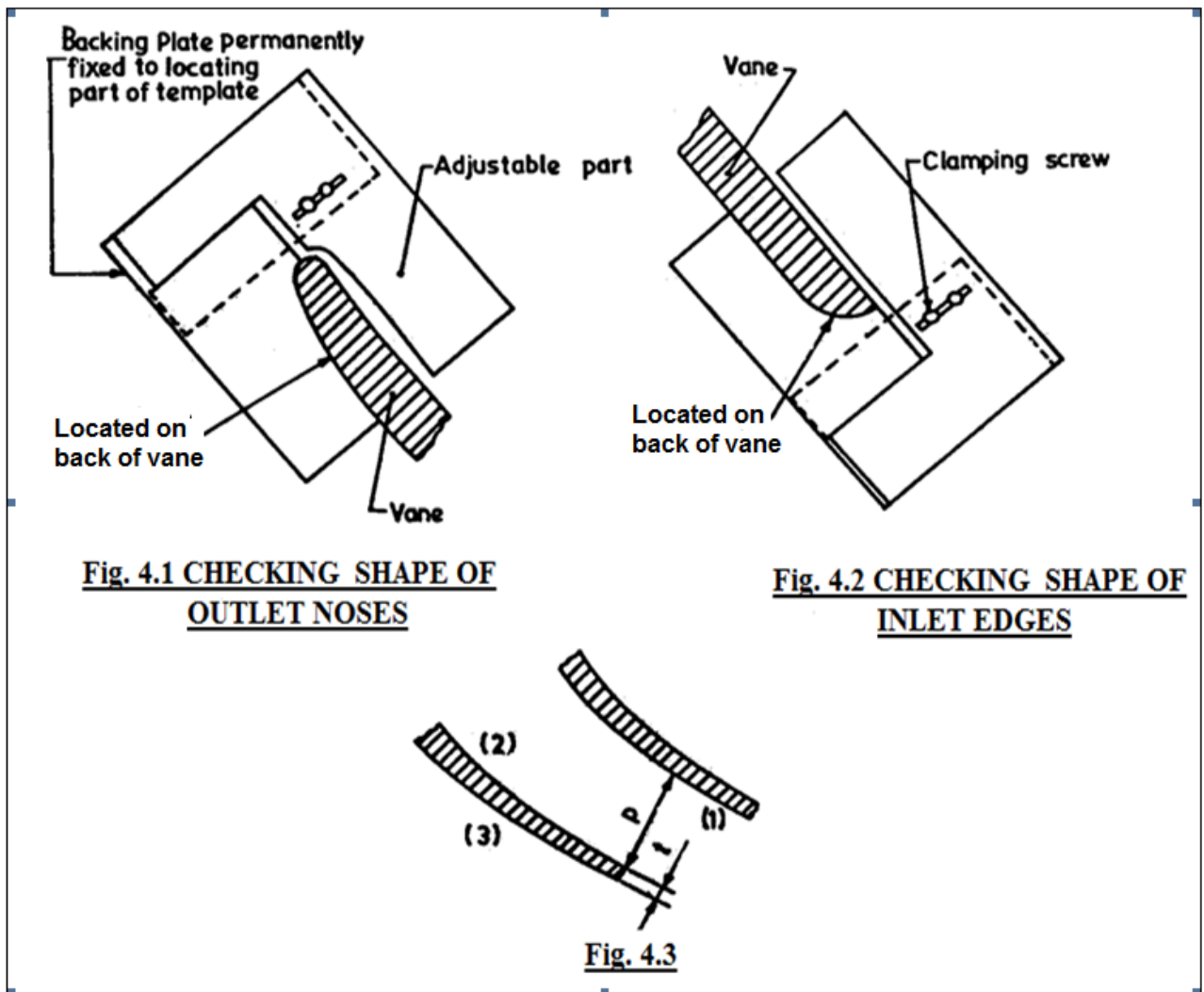
SAMPLE INSPECTION SHEET-8

Rev. No.	Date of Rev.	Remarks	Approved			
01	27.03.2016	Clause 1, Figure 3 and Table for figure 3 modified. Clause 10, 11 and 12 added.		J.S. Hanspal, AGM (HOD)-HTE		
02	27.04.16	Clause 8.1 & 16 modified.		Prepared	Checked	
			Shivendra Kr. Sr. MGR/HTE	A Mandal AGM-HTE	Date of issue (Rev 00) 02.12.15	
Saved in server as no. 42009900261						




	PRODUCT STANDARD HYDRO TURBINE ENGINEERING	HT 00261
		Rev. 02
COPYRIGHT & 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.		Page 19 of 23
<u>PURCHASE SPECIFICATION FOR 13% Cr 4% Ni STAINLESS STEEL IMPELLER FOR FRANCIS TYPE PUMP</u>		


ANNEXURE – I

CROSS SECTIONAL SHAPE OF OUTLET NOSES AND INLET EDGES CHECKED BY MEANS OF TEMPLATES WHICH ARE ADJUSTABLE WITHIN THE BLADE THICKNESS TOLERANCE AND LOCATED ON THE BACK OF THE BLADE



CORRECTION OF INLET PASSAGE AND INLET EDGE THICKNESSES
FIG.4




Rev. No.	Date of Rev.	Remarks	Approved  J.S. Hanspal, AGM (HOD)-HTE		
01	27.03.2016	Clause 1, Figure 3 and Table for figure 3 modified. Clause 10, 11 and 12 added.	Prepared  Shivendra Kr. Sr. MGR/HTE	Checked  A Mandal AGM-HTE	Date of issue (Rev 00) 02.12.15
02	27.04.16	Clause 8.1 & 16 modified.			
Saved in server as no. 42009900261					


	PRODUCT STANDARD <u>HYDRO TURBINE ENGINEERING</u>	HT 00261
		Rev. 02
COPYRIGHT & 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.		Page 20 of 23
<u>PURCHASE SPECIFICATION FOR 13% Cr 4% Ni STAINLESS STEEL IMPELLER</u> <u>FOR FRANCIS TYPE PUMP</u>		

ANNEXURE - II**CONDITION OF DELIVERY****1. ROUGH GROUND ROUGH MACHINED INTEGRAL IMPELLER****1.1 Impeller properly cast and fettled.**

All surfaces of water passages, including blades rough ground to a finish of 12.5 micron or better. All surfaces, in water passage to have continuous, smooth shape avoiding excessive undulations.




1.3 1.0 ± 0.25 mm grinding allowance to be left on each side of blade, lower portion of crown and inner face of skirt for final finish grinding.**1.4 Inlet and outlet edges of blades to be provided with additional allowances and to be left square. The outlet edges of blades to be provided with a tapered allowance on the suction and pressure side to ensure correct outlet angle to be achieved on final finish grinding.****1.5 The inlet diameter and blade outlet diameter shall be concentric to impeller center line and shall be taken as datum for all marking off.****1.6 Casting is to be rough machined on crown and skirt as per enclosed drawing.****1.7 Junction between blade and crown and also between blade and skirt ground to profile.****1.8 Impeller shall be marked off and dimensionally checked as per drawing and Annexure-I. These are to be recorded in Impeller Inspection sheets.****1.9 Complete impeller to be painted with suitable anti-corrosive compound.****2.0 SEMI FINISH GROUND ROUGH MACHINED INTEGRAL IMPELLER****2.1 All surfaces of water passage including blades shall be ground to a finish of 6.3 micron or better. All surfaces in water passage to have continuous smooth shape avoiding undulations.****2.2 Outlet edges shall be machined /ground to profile template located on rough machined crown and skirt (See Fig.2a).****2.3 The cross sectional shape of outlet noses of blades shall be obtained by grinding to profile templates which shall be adjustable within the permitted black thickness tolerance and be located on the back of the blade (see Fig. 4.1 of Annexure-I).**


Rev. No.	Date of Rev.	Remarks	Approved		
01	27.03.2016	Clause 1, Figure 3 and Table for figure 3 modified. Clause 10, 11 and 12 added.	 J.S. Hanspal, AGM (HOD)-HTE		
02	27.04.16	Clause 8.1 & 16 modified.	Prepared  Shivendra Kr. Sr. MGR/HTE	Checked  A Mandal AGM-HTE	Date of issue (Rev 00) 02.12.15
			Saved in server as no. 42009900261		

	PRODUCT STANDARD <u>HYDRO TURBINE ENGINEERING</u>	HT 00261
		Rev. 02
COPYRIGHT & 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.		Page 21 of 23
<u>PURCHASE SPECIFICATION FOR 13% Cr 4% Ni STAINLESS STEEL IMPELLER</u> <u>FOR FRANCIS TYPE PUMP</u>		

ANNEXURE - II

- 2.4 Inlet edge shall conform to general blades thickness tolerance and shall be ground and formed to template (see Fig. 4.2 of Annexure-I). Inlet passage shall be ground in accordance with instructions given in Annexure-I, clause 3. Inlet shall have a smooth and even contour from all irregularities.
- 2.5 The inlet diameter and blade outlet diameter shall be concentric to impeller center line and shall be taken as datum for all marking off.
- 2.6 Casting is to be rough machined on crown and skirt as per enclosed drawing. No allowance is to be left on water passages of crown and skirt and blade thickness. These surfaces shall be only polished at BHEL works.
- 2.7 Junction between blade and crown and also between blade and skirt ground to profile.
- 2.8 Impeller to be balanced within the limits of out of balance as specified in the drawing.
- 2.9 Impeller shall be marked off and dimensionally checked as per drawing and Annexure-I. The records to be maintained in impeller inspection sheets.
- 2.10 Complete impeller to be painted with anti-corrosive compound.
- 3.0 FINISH GROUND FINISH MACHINED INTEGRAL IMPELLER**
- 3.1 All surfaces of water passages including blades shall be finish ground and polished to give the finish specified in the drawing for various sections of water passages
- 3.2 Outlet edges shall be machined / ground to profile templates located on finish machined crown and skirt (See Fig.2a).
- 3.3 The cross sectional shape of outlet noses of blades shall be obtained by grinding to profile templates which shall be adjustable within the permitted blade thickness tolerance and be located on the back of the blade (See Fig. 4.1 of Annexure-I).
- 3.4 Inlet edge shall conform to general blade thickness tolerances and shall be ground and formed to template.(See Fig. 4.2 of Annexure-I) Inlet passages shall be ground in accordance with instructions given Annexure-I, clause 3. Inlet edge shall have a smooth and even contour free from all irregularities.
- 3.5 The inlet diameter and blade outlet diameter shall be concentric to impeller centre line and shall be taken as datum for all marking off.

Rev. No.	Date of Rev.	Remarks	Approved		
01	27.03.2016	Clause1,Figure.3 and Table for figure.3 modified. Clause 10,11 and 12 added.	 J.S. Hanspal, AGM (HOD)-HTE		
02	27.04.16	Clause 8.1 & 16 modified.	Prepared  Shivendra Kr. Sr. MGR/HTE	Checked  A Mandal AGM-HTE	Date of issue (Rev 00) 02.12.15
			Saved in server as no. 42009900261		

	PRODUCT STANDARD <u>HYDRO TURBINE ENGINEERING</u>	HT 00261
		Rev. 02
COPYRIGHT & 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.		Page 22 of 23
<u>PURCHASE SPECIFICATION FOR 13% Cr 4% Ni STAINLESS STEEL IMPELLER</u> <u>FOR FRANCIS TYPE PUMP</u>		

ANNEXURE - II

3.6 Impeller shall be completely finish machined to the drawing. Where fitted bolts are used for coupling with the shaft, the coupling holes shall be finished leaving an allowance of 3mm at tool point for final machining of impeller in our shop.




When keys are used in the coupling an allowance of 0.1mm be left on the width for final fitting of the keys with the shaft.


3.7 Junction between blades and crown also between blade and skirt ground to profile .

3.8 Impeller to be balanced within the limits of out of balance as specified in the drawing.

3.9 Impeller shall be marked off and dimensionally checked as per drawing and Annexure-I. The records shall be maintained in runner inspection sheets.

3.10 Impeller to be painted with one coat of primer and two coats of Black coal tar pitch epoxide paint. Machined surfaces to be given two coats of temporary rust preventive paints. The coupling holes and key-ways to be suitable protected against damage.

Rev. No.	Date of Rev.	Remarks	Approved		
01	27.03.2016	Clause1,Figure.3 and Table for figure.3 modified. Clause 10,11 and 12 added.	 J.S. Hanspal, AGM (HOD)-HTE		
02	27.04.16	Clause 8.1 & 16 modified.	Prepared  Shivendra Kr. Sr. MGR/HTE	Checked  A Mandal AGM-HTE	Date of issue (Rev 00) 02.12.15
			Saved in server as no. 42009900261		

	PRODUCT STANDARD <u>HYDRO TURBINE ENGINEERING</u>	HT 00261
		Rev. 02
COPYRIGHT & 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.		Page 23 of 23
<u>PURCHASE SPECIFICATION FOR 13% Cr 4% Ni STAINLESS STEEL IMPELLER</u> <u>FOR FRANCIS TYPE PUMP</u>		

CHECK LIST




(Check list to be filled in and submitted along with the offer)

1.	Name of project	
2.	Type of construction of impeller	Integral Casting/Cast Fabricated
3.	Condition of delivery (as per annexure-II)	
4.	Material of impeller will be as per drawing	YES / NO
5.	If cast fabricated, 100% surfaces of blades to be m/ced on 5-axes m/c	YES / NO
6.	Dimensions will be as per drawing	YES / NO
7.	Heat treatment will be done as per spec. of material	YES / NO
8.	Surface roughness test shall be done	YES / NO
9.	Hardness test shall be done	YES / NO
10.	Microscopic test shall be done	YES / NO
11.	Gas analysis results will be furnished	YES / NO
12.	Impeller will be supplied statically balanced (see drg.)	YES / NO
13.	Blade profile will be checked with templates	YES / NO
14.	Blade will not be provided with extra material	YES / NO
15.	Surface finish of blade will be as per drg.	YES / NO
16.	Templates will be supplied along with the last runner	YES / NO
17.	DP test will be done as per spec	YES / NO
18.	MPI will be done as per spec.	YES / NO
19.	UT will be done as per spec.	YES / NO
20.	Radiography will be done as per spec.	YES / NO
21.	Impact testing will be done	YES / NO
22.	Mechanical testing will be done as per material specification	YES / NO
23.	Chemical testing will be done as per material specification	YES / NO
24.	Type of furnace used	EAF / IF
25.	Secondary refining will be done by	AOD + VD / VOD + VD
26.	Whether secondary refining facility is available in-house	YES / NO
27.	TCs will be submitted as per clause 12	YES / NO
28.	Keel blocks will be cast integral with each casting	YES / NO
29.	Keel blocks will be removed in the presence of BHEL's inspector	YES / NO
30.	Keel blocks will be supplied along with impeller	YES / NO
31.	Before dispatch each impeller casting will be properly marked	YES / NO
32.	Nature of packing in which impeller will be shipped	_____
33.	Deviations, if any (Attach separate sheet if required)	_____
34.	BHEL's enquiry no./date	_____

Name/stamp of vendor

Date: _____

Name and authorized signature

Rev. No.	Date of Rev.	Remarks	Approved		
01	27.03.2016	Clause 1, Figure 3 and Table for figure 3 modified. Clause 10, 11 and 12 added.	 J.S. Hanspal, AGM (HOD)-HTE		
02	27.04.16	Clause 8.1 & 16 modified.	Prepared  Shivendra Kr. Sr. MGR/HTE	Checked  A Mandal AGM-HTE	Date of issue (Rev 00) 02.12.15
			Saved in server as no. 42009900261		