



TD 219
Rev 00

**PLANT PURCHASING
SPECIFICATION
HYDERABAD**

HY 195 93

Rev. No. 04

Page 1 of 12

STAINLESS STEEL CASTINGS (Gr. X4CrNi13-4)

1.0 GENERAL:

This specification governs the quality requirements of 12 Chromium-4 Nickel Stainless Steel Castings.

2.0 APPLICATION:

These castings are required for pumps components like Impellers, diffusers etc.

3.0 CONDITION OF DELIVERY:

These castings shall be supplied in hardened & tempered, rough machined and finally stress relieved condition, unless otherwise specified in the drawing or purchase order.

4.0 COMPLIANCE WITH NATIONAL STANDARD:

The castings shall comply with EN10213 Gr. X4CrNi13-4 (in general) and all the additional requirements of this specification.

5.0 MANUFACTURE:

5.1 The steel shall be made by electric arc or induction furnace process. Any other process of steel making shall be referred to BHEL for approval.

5.2 The steel castings shall be made from fully killed steel.

5.3 Depending on the surface finish requirements as per the ordering drawing, components like impellers and diffusers, etc. shall be made by investment casting process. Other castings can be manufactured by sand casting process.

5.4 The castings shall not be peened, plugged or impregnated to stop leaks etc.

5.5 Manufacturing Process Plan (MPP):

Unless waive off for submission of MPP is provided by BHEL (in writing), the manufacturer shall submit a MPP for review & approval for each drawing.

The MPP shall include stage wise details of the process controls during manufacturing with the details of the facilities used for steel melting and refining and heat treatment, inspection sequence and testing plan for destructive and non- destructive testing (including NDT scan plans for UT, MPI etc.) as per the specification and ordering drawing.

This approved MPP can be used till there are no changes in the manufacturing process and the facilities used for the manufacture of the castings.

Revision: Modified Cl. 6.0, 7.2 and QAP.			Issued : STANDARDS ENGINEERING & IPR COORDINATION DEPARTMENT		
Rev. No. 04	Amd. No.	Reaffirmed:	Prepared:	Approved:	Date of 1st issue:
Dt. 25-11-2020	Dt.	Year:	Sr.ENGINEER, (MATLS ENGG.)	AGM (R&D and EC)	DEC. 1983

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6.0 HEAT TREATMENT:

The castings shall be hardened & tempered as per EN10213 to achieve the mechanical properties as per Cl.10.0 of this specification. Subsequently after rough machining stress relieving shall be done at a temperature at least 20°C below tempering temperature. Actual heat treatment cycles followed shall be reported in test certificate.

All mechanical and NDT tests shall be carried out after rough machining in final dispatch condition.

7.0 Quality of Castings :

7.1 For Sand Casting:

Dimensions & Tolerances: The enclosed drawings are finish machined ones (unless otherwise specified). The castings shall be supplied in rough machined condition with an allowance of 4 to 6mm on the surfaces where machining symbols have been shown on the drawing. Small grooves, steps etc., up to 50 mm (width or size), need not be rough machined.

Finish: The castings shall be cleaned and fettled thoroughly ensuring complete removal of sand, slag, fins and scales from both internal and external surfaces.

Freedom from defects: Foundry defects like blow holes, shrinkage cavities porosity, non-metallic inclusions etc. appearing on the surfaces to be machined shall be opened out and smoothly ground provided the depth of any of these defects, when so ground, doesn't exceed 2/3 of the machining allowances. All as cast surfaces shall be free from harmful foundry defects like slag inclusions, sand spots, cold shuts, shrinkage, scabs etc.

7.2 For Investment casting:

Dimensions & tolerances: The dimensions and tolerances shall be as specified in the ordering drawing/ product standard. Additionally, shroud thickness at various locations for impeller castings at eye side and neck side shall be checked and reported in Dimensional Inspection Report.

Finish: The surface of the casting shall be free of adhering ceramic, scale, and hot tears. The surface finish of the casting shall be as per the ordering drawing.

Freedom from defects: Cracks are not permitted on any surface of the casting.

7.3 In case where pressure tightness is called for (though the test may be required to be conducted at BHEL) the requisite quality must be ensured to guarantee the same.

8.0 CHEMICAL COMPOSITION:

The chemical analysis of the steel supplied shall confirm to the following chemical composition:

Elements (% wt)		C	Si	Mn	Cr	Ni	Mo	S	P
X4CrNi13-4*	Min.	-	-	-	12.0	3.50	-	-	-
	Max.	0.06	1.00	1.00	13.5	5.00	0.70	0.025	0.035

*V- 0.08 max; Cu- 0.30 max



TD 219
Rev 00

**PLANT PURCHASING
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Rev. No. 04

Page 3 of 12

9.0 TEST SAMPLES:

Unless otherwise specified in the drawing, the mechanical properties shall be determined on one separately cast test coupon for each heat and heat treatment batch (if the casting weight is less than or equal to 500 kg) or on one integral test coupon (castings having weight more than 500 kg) for each casting.

The size of the test coupon shall be selected as appropriate to the thickness of the actual castings and the extent of testing and to carryout repeat tests if required. After casting, the test coupons shall receive a stamp indicating the heat number. It is mandatory to keep the separately cast test coupon along with the castings from same heat during each subsequent heat treatments of the casting. The integral test piece shall not be removed prior to complete heat treatment and shall be suitably stamped & identified by BHEL representative before detaching it from the casting.

10.0 MECHANICAL PROPERTIES:

The mechanical properties tested on test coupons shall be as follows:

Tensile Strength N/mm ² min.	0.2% Proof Stress, N/mm ² min.	Elongation % L = 5.65 √So min.	Charpy Impact Strength (ISO-V) J min.	Hardness (BHN) (on casting)
760-960	550	15	27	235-285

10.1 The tensile test shall be conducted as per IS: 1608 or any reputed National or International Standard.

10.2 The impact test specimen shall be 10mm x 10mm 55mm with a 2mm ISO V-notch. The test shall be conducted as per IS: 1757 or any other reputed National or International Standard.

The minimum impact strength specified above is the average of three samples at the same location. Only one value can be lower than the minimum specified average value, but in no case lower than 2/3rd of the same. All the three values shall be reported.

10.3 The Brinell hardness shall be tested on each casting after heat treatment. A minimum of 3 hardness values shall be taken at different locations as far as possible from each other (preferably of opposite faces of the casting) on each casting. The variation in the minimum and the maximum hardness values obtained on the casting shall not be more than 25BHN.

10.4 The hardness values shall also be tested on the repair welded areas and the hardness variation of weldment to the parent material shall not be more than 35 BHN.

11.0 HYDRAULIC TEST:

The hydraulic test shall be carried out at BHEL if mentioned in the drawing. In case the supplier needs to carry out the test the same will be indicated in the drawing/order. The test pressure shall be maintained for a minimum of 30 minutes (unless otherwise mentioned) without leakage.

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12.0 NON-DESTRUCTIVE TESTS :

The following non-destructive tests shall be performed in the final delivery condition of the casting:

12.1 **Visual Inspection:**

- a. **For Sand casting:** The visual inspection on all the un-machined surfaces shall be as per MSS SP-55.
- b. **For investment castings:** The visual examination shall be carried out as per the requirements of ordering drawing.

12.2 **Magnetic Particle Inspection:**

Unless otherwise specified in the drawing, all the areas of the castings (or as per the approved MPP) shall be tested by magnetic particle test as per AA 0850133 and the acceptance norms (if not specified in the drawing) shall be as per AA 0850134, level-2.

12.3 **Ultrasonic Test (For Sand Casting):**

Unless otherwise specified in the drawing, ultrasonic examination shall be conducted on 100% volume of the castings (or as per the approved MPP) as per AA 085 01 04 and acceptance norms (if not specified in the drawing) shall be level 2 as per the AA0850104.

13.0 ADDITIONAL TESTS:

- 13.1 **Ultrasonic Test (For investment casting):** If specified in the drawing / product Standard, Ultrasonic Examination shall be conducted on the casting as per the drawing requirement.
- 13.2 **Radiographic Test:** If specified in the drawing / product Standard, Radiographic Examination shall be conducted on the casting as per the drawing requirement.
- 13.3 **Liquid Penetrant Examination:** If specified in the drawing / product Standard, LPI shall be conducted on the casting as per the drawing requirement.

14.0 REPAIR WELDING:

Before weld repair, all the defects in the castings shall be reported to BHEL by sending defectograms & repair welding procedure for the written approval by BHEL.

15.0 FIRST PIECE QUALIFICATION TESTS:

Whenever the supplies are made for the first time to BHEL for each and every ordering drawing, additional requirements for the supplies will be applicable. Depending on the past experience and references available to BHEL, supplier will be asked to carry out additional tests which will be duly incorporated in the manufacturing process plan (MPP)/ Quality plan, before placement of order for the first time supplies.

Note: In case of first time supplies of pump impeller and diffuser casting, RT on cut piece castings will be applicable as a mandatory requirement, for the first lot. This requirement will be incorporated in the MPP.



TD 219
Rev 00

**PLANT PURCHASING
SPECIFICATION
HYDERABAD**

HY 195 93

Rev. No. 04

Page 5 of 12

16.0 QUALITY PLAN:

- 16.1** The supplier shall follow the quality plan Ref. BHEL/QP/HY 19593 Rev.04 as per annexure A, unless the conditions stipulated in Cl. 16.2 & 16.3 are applicable.
- 16.2** 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.
- 16.3** In case of new vendors or first time supplies according to drawings mentioned in BHEL enquiry, QP shall be submitted for approval by BHEL. The attached QAP will not be applicable.

17.0 INSPECTION AT SUPPLIER'S WORKS:

- 17.1** BHEL representative shall have free entry and access to all areas where the manufacture of castings ordered is carried out. All reasonable facilities shall be provided to him including labour where necessary.
- 17.2** BHEL representative shall be given sufficient advance intimation to witness the various processes, tests etc. Punching and identification shall be done in the presence of BHEL representative.

18.0 TEST CERTIFICATE:

- 18.1** The supplier shall furnish five copies of certificates (in English) to BHEL. Each copy shall contain the following details.

- 1) HY19593 / Rev.04
- 2) BHEL Order No.
- 3) Item description and Drawing No. of the Casting.
- 4) Supplier's Name
- 5) Melt No. & Heat treatment Cycle
- 6) Casting Serial No. per melt.
- 7) Details of manufacturing process like sand or investment casting
- 8) Heat treatment charts/ details
- 9) Defectogram & Welding repair procedure (in case of weld repair)
- 10) Results of all tests as per this specification (including FPQ requirement as per order)
- 11) Dimensional inspection report including shroud thickness value at various locations
- 12) Copy of BHEL approved MPP (if applicable)

- 18.2** The certificate shall be attested by the chief of Inspection / Chief Metallurgist of the supplier and attested by BHEL Representative.

19.0 MARKING & PACKING:

- 19.1** The following details shall be hard punched clearly on the castings:

1. HY 19593 Rev.04
2. Melt No.
3. Drawing No.
4. BHEL Inspector's stamp
5. Supplier's mark

- 19.2** The castings shall be suitably packed and protected from damage and corrosion during transit.



20.0 REJECTION AND REPLACEMENT:


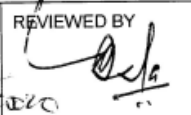

The final decision regarding acceptance or rejection rests with BHEL if the casting is not found as per this specification at any time during further operations on the castings. The supplier shall replace the rejected casting at his own cost and the rejected casting shall be returned after all commercial terms and conditions are satisfied.

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BHARAT HEAVY ELECTRICALS LIMITED R.C.PURAM, HYDERABAD		STANDARD QUALITY PLAN FOR VENDOR ITEMS						QP. NO: HYQA/PMP/SQP/079 REV. NO.: 01 DATE: 26-11-2020 VALID UPTO: 25-11-2022					
		ITEM: STAINLESS STEEL CASTINGS(GR. X4CrNi13-4) BHEL SPEC: HY19593 R04						PAGE 1 OF 6					
SI No	Component & Operations	Characteristics	Class	Type Of Check	Quantum Of Check	Ref Document	Acceptance Norms	Format Of Record	*	Agency			Remarks
										D	P	W	
1.0 RAW MATERIAL STAGE													
1.0	Incoming Material Inspection	Incoming Material Inspection	Major	As per Mfr practice	One Per GRIM	Mfr Internal Records	Mfr Internal Records	Inward Material Report	-	2			
2.0 IN-PROCESS INSPECTION													
2.1	Pattern / Die Inspection	Visual, Dimensional inspection	Major	Visual Measrt.	100%	Mfr Internal Records	Mfr Internal Records	Pattern Inspection Report		2		1	Verification of Pattern by TPIA to be reported in CQIR
2.2	Moulding	Visual, Dimensional inspection of Moulds & Cores	Major	Visual	100%	Mfr Internal Records	Mfr Internal Records	Moulding Records	√	2		1	
2.3	Melting & Pouring	Chemical composition.	Major	Chemical	Every Melt	HY19593 Rev04 & BHEL Drg.	HY19593 Rev04 & BHEL Drg.	Test Certificate	√	2		1	Verification of melting log sheets

<p>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.</p>	<p>PREPARED BY</p> 	<p>REVIEWED BY</p> 	<p>APPROVED BY</p> 
	<p>ISSUED BY QUALITY ASSURANCE DEPARTMENT</p>		



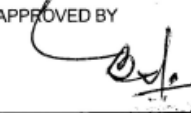
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Addl. General Manager / QA (Head)
 BHEL-HPER
 Hyderabad-500032

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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	
2.4	Heat Treatment	Time & Temperature	Major	Time & Temp.	100%	HY 19593 Rev.04	HY 19593 Rev.04	HT Chart, TC	√	2		1	TPIA shall verify HT charts, furnace calibration certificates, temperature recorders, measuring instruments
2.5	Keel Block/ Test Piece Identification	Physical	Major	Physical	Each Heat/HT batch (≤ 500 Kg) or Test Piece/ Each Casting (> 500 Kg)	HY19593 Rev04 & BHEL Drg.	HY19593 Rev04 & BHEL Drg.	Identification Report	√	2	1		
2.6a	WPS/PQR for repair welding, if any	Record review	Major	Review	100%	HY19593 Rev04 & BHEL Drg.	HY19593 Rev04 & BHEL Drg.	Defectogram, WPS/PQR, Welding records	√	2		1	Defectogram shall be submitted to BHEL for written permission for any weld repair.
2.6b	Welder qualification records	Record review	Major	Review	100%	HY19593 Rev04 & BHEL Drg.	HY19593 Rev04 & BHEL Drg.	Welding qualification records	√	2		1	

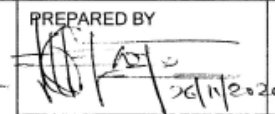
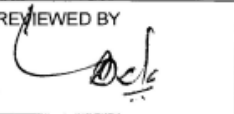
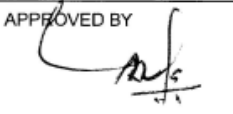
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SI No		Component & Operations	Characteristics	Class	Type Of Check	Quantum Of Check	Ref Document	Acceptance Norms	Format Of Record	* D	Agency			Remarks
											P	W	V	
2.7		Stress Relieving after Rough machining	Record review	Major	Review	100%	HY19593 Rev04 & BHEL Drg.	HY19593 Rev04 & BHEL Drg.	SR Chart, TC	√	2		1	
3.0 FINAL INSPECTION & TESTING														
3.1a		Test Sample	Mechanical Properties. (checked on test samples identified/stamped by TPIA)	Major	Mech. Properties	As per SI No 1.5 above	HY19593 Rev04 & BHEL Drg.	HY19593 Rev03 & BHEL Drg.	Test Certificate	√	2	1		
3.1b		Test sample & casting	Hardness	Major	Hardness	Weld Repaired areas, casting & test coupon	HY19593 Rev04 & BHEL Drg.	HY19593 Rev04 & BHEL Drg.	Test Report	√	2	1		Hardness values shall be reported for both on casting, test coupon & weld repaired areas
3.2		Casting	Final Dimension	Critical	Dimn. Measure	100%	HY19593 Rev04 & BHEL Drg.	HY19593 Rev04 & BHEL Drg.	Dimn. Report	√	2	1		Shroud Thickness at Various locations for impeller casting at eye side and neck side shall be checked and reported in DIR (Dim. Inspection Report)

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										P	W	V	
3.3	NDT on Final Delivery Condition of Casting	Surface finish, cleaning of internal surfaces, holes, opening etc.	Critical	Visual	Each Casting	HY19593 Rev04 & BHEL Drg.	HY19593 Rev04 & BHEL Drg.	Inspection report	√	2	1		
		Soundness of Casting	Critical	MPI	BHEL Drg./ Spec/ approved MPP	HY19593 Rev04 & BHEL Drg.	HY19593 Rev04 & BHEL Drg.	MPI Report	√	2	1	1	
			Critical	LPI	BHEL Drg./ Spec/ approved MPP	HY19593 Rev04 & BHEL Drg.	HY19593 Rev04 & BHEL Drg.	LPI Report	√	2	1	1	
			Critical	UT	BHEL Drg./ Spec/ approved MPP	HY19593 Rev04 & BHEL Drg.	HY19593 Rev04 & BHEL Drg.	UT Report	√	2	1	1	
4.0	Marking & Stamping	Visual Inspection	Major	Visual	Each Casting	HY19593 Rev04 & BHEL Drg.	HY19593 Rev04 & BHEL Drg.	Inspection Report	√	2	1	1	Marking by hard stamp method
5.0	Documentation & Certification	Verification	Major	Verify.	Each Casting	HY19593 Rev04 & BHEL Drg.	HY19593 Rev04 & BHEL Drg.	Inspection Report	√	2		1	

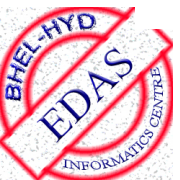
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 * D: RECORDS IDENTIFIED WITH TICK (✓) SHALL BE ESSENTIALLY INCLUDED IN QA DOCUMENTATION.


PREPARED BY: *[Signature]* 26/11/2020
 REVIEWED BY: *[Signature]*
 APPROVED BY: *[Signature]*
 ISSUED BY QUALITY ASSURANCE DEPARTMENT

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

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 General Manager / QA (Head)
 BHEL-HYD


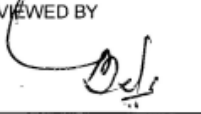
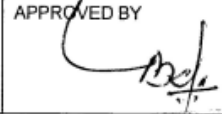
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SI No	Component & Operations	Characteristics	Class	Type Of Check	Quantum Of Check	Ref Document	Acceptance Norms	Format Of Record	* D	Agency			Remarks
										P	W	V	
6.0	Preservation & Despatch	Visual Inspection	Major	Visual	Each Casting	HY19593 Rev04 & BHEL Drg.	HY19593 Rev04 & BHEL Drg.	Test Report	√	2		1	

NOTES:

- 1) BHEL specification and drawing shall prevail over quality plan in case of any mismatch.
- 2) This QAP is not applicable for vendors supplying these castings for the first time to BHEL
- 3) This QAP is not applicable in case of NTPC projects
- 4) This QAP is also not applicable for projects where customer approval of QP is involved
- 5) Vendor/Purchase shall consult QA for clarity on involvement of customer during QP approval and prior providing despatch clearance to vendors
- 6) PO specified version of standards/drawings /tolerances etc. to be mentioned in Quality Plan/Drawing
- 7) BHEL reserves the right for conducting repeat test, if required
- 8) BHEL approved inspection engineers to be deployed for inspection
- 9) Inspection to be offered only after ensuring that all documents (Quality Plan, Drawings, Data Sheet, Purchase Specifications, etc.) are available as per Purchase Order
- 10) Vendor to offer Original Test Certificates issued by Third Party Laboratories or Suppliers
- 11) Vendor to ensure with TPIA that a note ' Compared with Original Test Certificate. Reviewed, Verified and found in order ' shall contain with every Inspection Report
- 12) Only valid and calibrated measuring instruments and equipment shall be used
- 13) Vendor to ensure that Material Test Certificate & Traceability Records are available for use of correct material
- 14) Vendor to ensure that all certificates are endorsed by TPIA with comments (Witnessed or Verified), as applicable per quality plan
- 15) Vendor shall ensure to offer log sheets containing actual measured values instead of saying OK/Not OK to TPIA
- 16) Vendor shall submit complete Inspection and test documentation whichever is identified with (√) under column D of approved quality plan shall be enclosed with the Inspection Report
- 17) Vendor shall submit Original copies of all inspection and test documents authenticated by TPIA


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 General Manager / QA (Head)
 HY19593, Rev. 04 (Pg. 11 of 12)


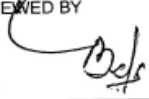
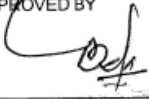
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SI No	Component & Operations	Characteristics	Class	Type Of Check	Quantum Of Check	Ref Document	Acceptance Norms	Format Of Record	* D	Agency			Remarks
										P	W	V	

HISTORY OF REVISIONS:

Sl. No	Revision details	Date of Revision	Prepared By	Reviewed By	Approved By
00	SQP prepared in line with procurement requirement	11.11.2014	ML RAJAM	KSN MURTHY	KSN MURTHY
01	'Measurement of Shroud thickness at various locations added for Impellers' added under CI 3.2	26.11.2020	ML RAJAM	G BALA	G BALA

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