



**PLANT PURCHASING
SPECIFICATION
HYDERABAD**

HY19571

Rev. No. 08

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**ALLOY STEEL CASTINGS FOR STEAM TURBINES
FOR HIGH TEMPERATURE SERVICE**

GRADE: G 20 Mo 5

1.0 GENERAL :

This specification governs the quality requirements of steel castings in material grade G20Mo5 (Material No. 1.5419) for steam turbine parts exposed to high pressure and high temperatures.

2.0 APPLICATION :

These castings are required for steam turbine casings, valve bodies, guide blade carriers, inserts etc

3.0 CONDITION OF DELIVERY :

The castings shall be supplied in hardened & tempered, rough machined; stress relieved and shot blasted condition. Cleaning of internal surface shall be ensured. The surface condition of the casting shall be suitable for the applicable NDT. The castings shall not be painted.

4.0 COMPLIANCE WITH NATIONAL STANDARDS :

This specification complies, in general, with EN 10213, Gr. G 20 Mo 5.

5.0 DIMENSIONS AND TOLERANCES :

5.1 Dimensions:

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.

5.2 Tolerances:

If not specified in the purchasing documents, the general tolerances according to DIN 1683-1, Grade GTB 18 are applicable.

Revisions: 1) Modified Annexure A (QAP)

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6.0 MANUFACTURE:

6.1 General requirements :

The steel shall be manufactured by an electric melting process or by any other process involving secondary refining. Surface finish of the machined surface shall be as per ordering drawing.

6.2 Welding: Welding shall be performed on heat treated castings only according to the successful welding procedure approval record (WPAR). Area to be welded shall be ground down to the flawless base metal & design welds shall be prepared accordingly. This shall be checked by surface crack inspection. In this case quality level S1 according to AA0850108 shall be achieved. In case of design welding, the weld ends have to fulfill severity level 1 as per AA0850107 over a length of 50 mm.

Before welding of all major defects, the supplier shall hand over to BHEL a documentation of the areas to be prepared for welding & the welding procedure specification (WPS).

Major defects are classified as:-

1. Excavations ready for welding with a length ≥ 150 mm.
2. Excavations with a depth $\geq 40\%$ of the wall thickness or ≥ 25 mm.
3. Any build-up welding greater than 100 cm^2 .
4. Unusual large production welding (e.g. weight of filler metal $\geq 3\%$ of the total casting weight) and/or welding situated in high stress of the casting.

These shall be documented by a sketch or photograph noting the appropriate positions and dimensions so that their traceability is assured.

- Note:**
1. A written permission from BHEL shall be obtained before starting weld repair of any defects
 2. Production welds without post weld heat treatment are not acceptable.

6.3 On each casting, weld hardness shall be checked at random and documented accordingly. Values of maximum 320 HV or 304 BHN max. are permitted.

6.4 The welding filler materials shall be covered electrodes EMOB42H5 according to EN1599 or E7018-A1 according to AWS A5.5-96. The use of other welding filler material is only allowed after prior agreement with the purchaser.

7.0 HEAT TREATMENT :

According to EN 10213.

Hardening: At temperature $920-980^\circ\text{C}$, holding time corresponding to the wall thickness.

Tempering: At $650-730^\circ\text{C}$, holding time corresponding to the wall thickness, cooling at calm air or cooling in furnace down to 300°C , than calm air.



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Stress relieving: After rough machining in the foundry, stress relieving treatment is necessary before delivery of the casting. The stress relieving temperature should not be more than the actually applied tempering temperature. The cooling rate for the stress relieving should be $\leq 30^\circ\text{C/hr.}$ down to $\leq 300^\circ\text{C}$.

The stress relieving after rough machining can be dropped, if production welding followed by stress relieving is carried out after rough machining.

The actual heat treatment cycles followed shall be reported in the test certificate.

8.0 FREEDOM FROM DEFECTS:

8.1 Supplier shall ensure that the casting is free of defects like porosity, shrinkage, cracks etc., in the areas which will be subsequently machined at BHEL.

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

8.3 As cast surfaces shall be free from harmful foundry defects like slag inclusions, sand spots, cold shuts, shrinkage, scabs etc.

8.4 Cracks are not permitted on any surface of the castings.

9.0 CHEMICAL COMPOSITION :

Heat analysis according to EN10213 in weight % shall be as follows.

Element	Melt analysis	
	Minimum	Maximum
C	0.15	0.23
Si	-	0.60
Mn	0.50	1.00
S	-	0.020
P	-	0.025
Mo	0.40	0.60
Cr	-	0.30
Ni	-	0.40
V	-	0.05
Cu	-	0.30
Al	-	0.040
Ti	-	0.025
Sn	-	0.025

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10.0 MECHANICAL PROPERTIES :

10.1 Test samples – 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. After casting, the test coupons shall receive a stamp indicating the heat number. It is mandatory to keep the test coupon along with the castings from same heat during each subsequent heat treatment.

10.2 Supply of keel blocks to BHEL (only applicable for Outer casing, Inner casing and Steam chambers) – Another integral keel block similar to the size of the keel block already used for testing at suppliers works shall also be casted along with the casting. It shall be stamped with Heat No./P.O. No./HY19571 and also third party stamp and supplied to BHEL after detaching from the casting but tack welded at a suitable location where its removal is easy at BHEL. This test block will be utilized for any retests required at BHEL.

10.3 Mechanical properties – the following mechanical properties shall be achieved at room temperature in the delivery condition of the casting.

Tensile Strength N/mm ²	0.2% Proof stress, N/mm ² min.	Elongation % L=5.65 √So min.	Charpy Impact strength J Min.
440-590	245	22	27 *

* Average of 3 charpy (2mm V-notch) specimens, where the smallest value shall be at least 21 J.

10.4 Hardness check –

- All welded zones shall be checked for hardness at random and the hardness shall be 320 HV or 304 BHN maximum.
- All castings (weighing less than or equal to 500 kg, for which separate keel block is casted for mechanical testing) shall be subjected to hardness check on three far off locations on the casting. The hardness values of the castings shall be within ± 20 BHN of the average of three hardness values tested on the keel block after heat treatment.

11.0 OUTER AND INNER QUALITY / NDE :

The following non-destructive examinations shall be conducted:



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11.1 Ultrasonic Examination:- Unless otherwise specified in the drawing/order, 100% area of the casting shall be tested by ultrasonic examination . Acceptance norms shall be severity level 1 weld ends and 2 for all other areas, as per AA0850107. Wherever ultrasonic examination is not technically feasible, radiography examination shall be made. In case both are not possible, the same shall be referred to BHEL for clarification and approval.

11.2 Magnetic Particle Examination:- Unless otherwise specified in the drawing/order, 100% area of the castings (technically feasible) shall be tested by magnetic particle examination. Acceptance norms shall be severity level 1 for weld ends and 2 for all other surfaces as per AA0850108.

11.3 Radiographic examination: Unless otherwise specified in the order, all areas marked on the drawings, high defect level areas as indicated in ultrasonic examination and also the areas which are not feasible to be examined by UT shall be examined by radiographic examination. Acceptance norms shall be severity level 1 for weld ends and 2 for all other areas, as per EN 12681.

12.0 QUALITY PLAN :

12.1 The supplier shall follow the quality plan Ref. BHEL/QP/HY 19571 Rev.08 as per annexure A, unless the conditions stipulated in cl. 12.2 & 12.3 are applicable.

12.2 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.

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

13.0 TEST CERTIFICATE:

Three sets of the original test certificates (in English) shall be furnished to BHEL with the following details.

- Heat no. and order no. on every page.
- Material specification HY 19571 Rev.08 and material grade G 20 Mo 5.
- Heat analysis and melting method.
- Information about the size of the separately cast sample or the attached sample.
- Mechanical test results for each casting or heat treatment load, as applicable.
- Hardness test results.

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- (g) Heat treatment charts / cycles actually followed.
- (h) Photos or sketches with all recordable areas prepared for welding.
- (i) Weld report with the information of PQR, the welders and the used electrodes and copy of written approval for welding by BHEL
- (j) Confirmation of the quality ordered.
- (k) Records / Reports for NDE.
- (l) Dimensional inspection report.

Deviation: Any deviation from this delivery specification has to be reported to BHEL immediately. Any deviation is generally accepted only if this has been approved by BHEL in a written form.

14.0 MARKING:

For castings' the pattern and heat numbers shall be used as identification markings. The pattern number may be applied by casting or with numeral punches depending on the item size. The heat number shall be applied with numeral punches.

In addition to above following information shall also be provided on the castings.

- (a) HY 19571 Rev. 08.
- (b) Drawing Number and Purchase Order Number.
- (c) BHEL appointed inspectors' stamp.

15.0 PACKING, PRESERVATION AND TRANSPORTATION :

The casting shall be suitably packed in a condition to withstand for indefinite time exposure to all climatic conditions without developing any external and internal defects.

The castings shall be properly protected from damage and corrosion during transport. The entire surface of the castings shall be applied with suitable non-greasy anticorrosive coating. Painting is not permitted on any surface. Supplier may use anticorrosive paint HE 1707 (produced by central insulation technology, BHEL, Bhopal) or petrolatum (produced by Bharat petroleum). The overseas supplier may use Tectyle 506 produced by Volvoline, Germany.

16.0 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 operation on the casting.

The supplier shall replace the rejected casting at this own cost and the rejected castings shall be returned after all commercial terms and conditions are satisfied.

ANNEXURE A (as per clause 12.0)								HY19571REV.08 PAGE 7 OF 8			
Vendor's Name & Address		Customer:			BHEL ENQ. NO.			QP No. BHEL/HY19571REV.08			
		Project:			Date:			Page: 1 of 2			
		Product:			BHEL Spec. HY19571REV.08						
Sl. No.	Characteristics	Type of Check	Quantum	Reference Document	Acceptance Norms	Format of records	Documents to be submitted to	AGENCY			Remarks
								M	C	I	
1.	Pattern	Dimensions	Each pattern	Internal	BHEL Drg.	Internal records	-	P		V	
2.	Chemical composition	Chemical	Every Melt	HY19571 Rev.08	HY19571 Rev.08	TC	TC	P		V	
3.	Heat treatment	HT cycles review	100%	-do-	-do-	H.T Records	HT Charts, TC	P		V	Final verification of documents.
4.	Keel block identification	Physical	Each casting	Each casting	HY19571 Rev.08	HY19571 Rev.08	Identification report	P		W	If casting weight is more than 500 kg. Refer Cl.10.1
5.	Mech. properties (in final dispatch condition)	Mechanical tests	-do-	-do-	-do-	-do-	TC	P		W	Tests shall be conducted on samples selected / identified by BHEL nominated inspection agency.
		Hardness	Weld repaired areas & casting/test coupon	HY19571 Rev.08	HY19571 Rev.08	TC	TC	P		W	Refer clause 10.4
6.(a)	WPS/PQR for repair welding, if any (Based on internal NDT)	Record review	100%	-do- Cl. 6.2	-do-	Welding records, Defectogram	Inspection Report, Welder qualification Records	P		V	Defectogram shall be submitted to BHEL for written permission for weld repair.
6.(b)	Welder qualification	Record view	100%	100%	HY19571 Rev.08	HY19571 Rev.08	Welding records	P		V	Review of welder qualification
7.	Stress relieving followed by shot blasting	Record view	100%	HY19571 Rev.08	HY19571 Rev.08	H.T Records	HT Charts, TC	P		V	Refer clause 7.0
8.	Dimensional Inspection (after rough machining)	Visual	Each Casting	Spec. & Drg.	Spec. & Drg.		TC	P		W	See Note 1 (applicable only to Outer casing, Inner casing and steam chamber)
9.	Surface quality	MPI	100% technically feasible areas	-do-	-do-	-do-	TC	P		W	

Signature of the Manufacturer with Company Stamp
(To be submitted along with the technical offer)

RESTRICTED USE



ANNEXURE A (as per clause 12.0)								HY19571REV.08PAGE 8 OF 8			
Vendor's Name & Address		Customer:			BHEL ENQ. NO.			QP No. BHEL/HY19571REV.08			
		Project:			Date:			Page: 2 of 2			
		Product:			BHEL Spec. HY19571REV.08						
Sl. No.	Characteristics	Type of Check	Quantum	Reference Document	Acceptance Norms	Format of records	Documents to be submitted to BHEI	AGENCY			Remarks
								M	C	I	
10.	Soundness of material	UT	-do-	-do-	-do-	-do-	TC	P		W	RT films to be reviewed.
		RT	At areas marked in Drg and any other area where UT & MPI are not possible	-do-	-do-	-do-	TC	P		V	
11.	Matching of upper & lower half of casting	Visual	100%	Drg	Drg	TC	Dimensional Inspection Report, TC	P		W	Casting shall be allowed to dispatch as a set only (if ordered as a set).
12.	Marking and punching	Markings	Each casting	Spec. & Drg.	Spec. & Drg.			P		W	
13.	Visual Inspection	Visual check 1) surface finish 2)cleaning of internal surfaces 3)Cleaning of holes, opening etc	Each Casting	Spec. & Drg.	Spec. & Drg.		TC	P		W	
14.	Preservation & Dispatch	Visual	Each casting	Spec. & Drg.	Spec. & Drg.	Records	Records	P		V	Both U/P & L/P castings shall be dispatched as a set only after machining (if ordered as a set).
15.	Documentation & certification		Each casting	Spec. & Drg.	Spec. & Drg.	TC	TC	P		V	TPIA shall certify all documents required as per specification & drawing.

LEGENDS: P PERFORM ;W WITNESS ;V VERIFICATION ; M:MANUFACTURE/SUB-SUPPLIER; C: CUSTOMER (BHEL); I: NOMINATED INSPECTION AGENCY

Note 1: All the reference planes, axes and dimensions of major features (like length, diameters, groves, steps etc.) shall be hard punched on the casting itself. Same shall be highlighted by painting two parallel lines on either side of the punches.

Signature of the Manufacturer with Company Stamp
(To be submitted along with the technical offer)

RESTRICTED USE

