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TDC FOR CRITICAL STEEL CASTINGS OF BOWL MILLS

1. GENERAL :

1.1 SCOPE AND FIELD OF APPLICATION

The purpose of this specification is to define the required quality and the general manufacturing and inspection conditions for critical steel castings of bowl mills.

2. CHEMICAL ANALYSIS AND MECH. PROPERTIES

The Chemical composition and Mechanical properties should be as per AA19511. (Latest Edition)

NOTE:

- The dimensions and number of test ingots shall be sufficient to allow specimens to be taken for test, retests and, if necessary, reworking.
- For each unsatisfactory test, 2 retests shall be performed. In the event that one of the retests is not satisfactory, reworking by new heat treatment is possible.

3. GENERAL MANUFACTURING CONDITIONS:

3.1 GENERAL

3.1.1 Execution of the items shall be in compliance with drawings and bills of material and with this specification.

3.1.2 To meet the dimensional accuracy, soundness and surface condition requirements for the items, pouring shall be done in a rigid mould.

3.1.3 The temperatures and durations of all the heat treatments shall be recorded and the recordings shall include the references of the items to ensure their traceability.

3.1.4 Material will be supplied in Normalized condition,

3.1.5 The manufacturing procedure is to be followed in the following sequence

- Casting , fettling
- Normalizing
- Keel Block Identification / stamping
- Keel Block Cutting
- Rough Machining
- NDT Checks
- Repair (If Necessary) and repeat NDT after repair.
- Stress Relieving with the Keel Block
- Mechanical test

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3.1.6 The castings shall be stress relieved to the cycle as per Annexure D

3.1.7 Any weld repair carried out after the final stress relief will be followed by additional stress relief at the specified temperature and time.

3.1.8 All the mechanical tests shall be done subsequent to the final stress relieving operation.

3.1.9 Mechanical test specimen will undergo all the stress relieving operation as the original material.

3.1.10 In case of thin shelled castings additional stress relief may be necessary before final machining to avoid distortion due to relieving of machining stresses.

3.1.11 In case the test specimen represents multiple pieces, the mechanical test specimen will undergo all the stress relieving operation corresponding to the piece subject to the additional relief as per clause 3.1.6.

3.2 REPAIRS

3.2.1 SURFACE DEFECTS

3.2.1.1. Surface defects detected on the items in the rough machined state during the non destructive inspections (visual examination, magnetic particle inspection) can be eliminated by grinding within the limit of the dimensional tolerances indicated on the drawings.

3.2.1.2. No surface excavation after final machining is accepted.

3.2.2 REPAIR WELDING:

3.2.1.1. Other defects outside the criteria including internal defects can be repaired by welding to bring the items into compliance with the inspection criteria.

3.2.1.2. A qualified repair welding procedure must previously have been drawn up in accordance with ASME IX.

3.2.1.3. A map of major defects shall be drawn up before repair.

3.2.1.4. Repaired and neighbouring zones shall be given the same inspection as before (see Annexure A), together with an ultrasonic inspection with separate angle probe and transceptor (or with a suitable close field) to detect any planar defect.

3.2.1.5. POST WELD STRESS – RELIEVING TREATMENT:

After welding, the items shall be given stress relieving heat treatment as per Annexure D.

3.3 MARKING:

3.3.1 The material attestation details shall be hard punched with 10 mm punch (min) at a place remaining as-cast unless otherwise specified in the drawing.

3.3.2 The following indications shall be included:

a) Pattern or drawing number.
b) BHEL vendor code.

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c) Heat number (to be quoted on all inspection documents)
d) Material specification BA75020+AA19511 REV.
e) Manufacturer monogram/initials shall not be cast on the casting.

3.3.3 The marking shall be surrounded by yellow paint to make it clearly visible.

4. GENERAL INSPECTION CONDITIONS:

4.1 GENERAL

4.1.1 The first time a type of item is made, the first casting shall be considered a prototype, but it will not be necessary to wait for the results of the inspections at the rough-machined stage before continuing with the manufacture of the other item.

4.1.2 The Quality Control Plan or manufacturing and associated inspection programme shall be drawn up. It shall indicate all the manufacturing operations in chronological order and all the inspections.

4.2 TESTS AND INSPECTIONS

The tests and inspections to be performed on the castings are as in Annexure A.

5. DOCUMENTS:

To be submitted to BHEL after manufacture and before shipment:

a. Chemical analysis certificates
b. Mechanical test certificates
c. Heat treatment Charts (Normalizing and Stress relieving)
d. Map of defects (defectogram) before repair.
e. Dimensional records
f. Non-destructive inspection certificates.

All of these documents shall be gathered together to form the constructor file, with a table of contents and cover pages.

6. ENCLOSED.

The following Annexure are enclosed to this specification:

Annexure A - Test & Inspection
Annexure B - Magnetic particle test criteria
Annexure C - Ultrasonic Test Criteria.
Annexure D - Stress Reliving Cycle.

7. PACKING AND TRANSPORT

The castings shall be packed suitably and transported to avoid transit damage

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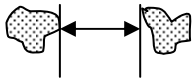
ANNEXURE B
MAGNETIC PARTICLE TEST CRITERIA- STEEL CATINGS

Equivalence ASTM E 125			- -	2	
LEVEL			01	02	
Size of the indication taken into account			0.3	2	
Non-linear indications (2)	Maximal whole area (sq. mm) (1)			35	
	Maximal individual size (mm)		1	4 (3)	
	Ordering of indications		Isolated or Cumulated	Isolated	Cumulated
Linear and aligned indications (2)	Maximal lengths of indications (mm) (1)	Thickness of Casting t ≤ 16 mm	1	4	6
		Thickness of Casting 16<t≤50 mm	1	6	10
		Thickness of casting t >50 mm	2	10	16

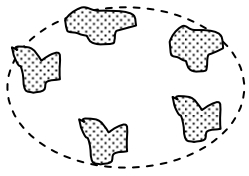
(1) In a frame of 105 x 148 mm (Corresponding to ISO/DIN A6 size).

(2)

The indication is **linear** if $L > 3\,I$ - Where L : length and I: width of the indication.
The indication is **Non linear** if $L \leq 3\,I$
If there are 3 or more indications (either linear or non linear) are arranged one behind other at a distance ≤ 2mm, they are called **aligned indication**.
The length taken into account for this purpose is the distance between the beginning of the first indication and the end of the last one.



If more than one defect is located inside a circle of diameter 3 times the pore diameter, the defects are to be considered as a **cluster**.
The length of the defect (The size of the defect in cluster) is taken corresponding to the outer edges of the farthest aligned (or clustered defects)



(3) 2 Indications Max. For this size in a single frame (ISO A6)

NOTE:

1. The frequency distribution and the size of the defects will roughly corresponding to the sketches as per Appendix-A of DIN 1690 Part 2
2. Hot Tears, Cracks and planer defects are not permitted.

REFERRED DOCUMENTS :-

BHEL SPEC NO: AA0850133, DIN 1690-2,

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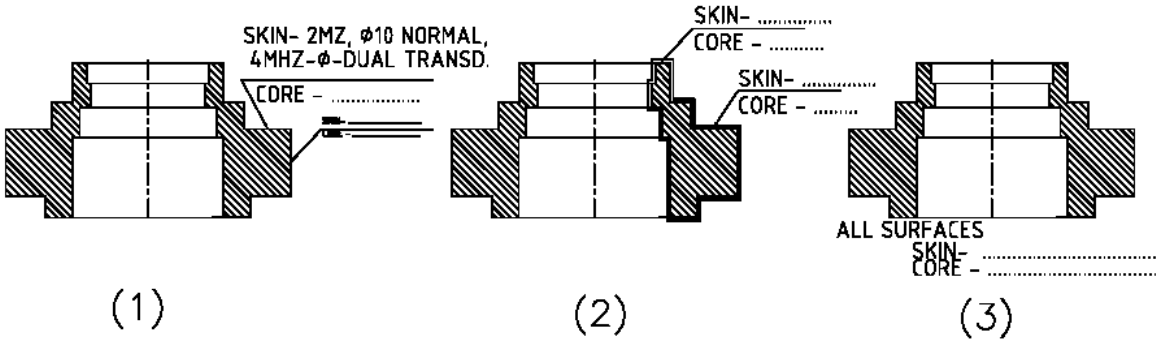
ANNEXURE C
ULTRASONIC TEST CRITERIA- STEEL CATINGS

1. The Ultrasonic test will be carried out as per EN12680-2:2003 and all the mandatory conditions of the above standard will be followed. This annexure is for explanation only.
2. The skin of the casting (or Rim) is defined as 20mm deep layer of the casting on all surfaces.
3. 100% of the castings will be tested after rough machining.
4. Acceptance Norms.
   - Skin of the casting - Severity Level 1 of EN 12680-2
   - Rest of the volume - Severity Level 2 of EN 12680-2
5. The component will be ultrasonic tested from both sides where ever the component geometry permits.
6. Wherever the component geometry does not permit examination from both sides, short range resolving probe shall be used additionally to detect the defects near to surface.
7. Twin crystal Normal and angle probes shall be used to examine the skin.
8. The core can be examined by scanning in two mutually perpendicular directions with normal probe or a normal probe and an angular probe.
9. The Ultrasonic test plan should be indicated in the test report on a sketch of the component. This is can be provided as (1), (2), (3) or any other suitable format.



10. For angle probes with angles > 60°, the beam path will be less than 150mm.
11. All the defect indications observed during the testing will be recorded.
12. The loss of back-wall echo and the zone will be recorded and investigated by suitable means regarding the size, shape, type, position etc. It may be necessary to carry out additional UT by different technique (angle, frequency etc alteration) or radiography.

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ANNEXURE - D

STRESS RELIF CYCLE FOR CASTINGS

1.0 **TYPE OF FURNACE** – Electrical, Oil or gas fired.

2.0 TEMPERATURE CONTROL - The temperature of the furnace should be maintained within ± 14 °C during the operation.

3.0 TEMPERATURE MEASUREMENT: Thermocouple should be placed at 1 meter intervals to ensure uniformity of temperature.

4.0 LOADING – care should be exercised to ensure

4.1 No direct impingement of flame on the components

4.2 Sufficient space is maintained between components to ensure uniform heating.

4.3 Components are supported to avoid distortions.

5.0 The stress reliving cycle to be followed for the casting is

Maximum Ruling section Thickness (Thk)	Heating rate Max (°C / Hr)	Holding Temperature (°C)	Min Holding time (Minutes)	Max Holding Time (Minutes)	Cooling rate Max (°C / Hr)
< 12 mm	80 - 100	600 – 650	30	60	80
13– 100 mm	50	600 – 650	2.5 x Thk	4 x Thk	50
> 100 mm	50	600 – 650	150 + Thk	4 x Thk	50

6.0 Initial temperature of the furnace before the heating cycle commences may be at 400°C maximum.

7.0 The temperature difference between zones during heating should be less that 100°C in any 4 meter length.

8.0 The specified cooling rate to be followed till the furnace is brought down to at least 400°C. Subsequently the components may be cooled preferably in furnace. In case air cooling is resorted to, necessary care should be exercised to avoid forced/ unforced air drafts.

9.0 The SR Chart must document the instrument calibration records, positioning, and the record of the charge.

10.0 The soaking temperature limits to be maintained for all components of a lot if components of various ruling sections are clubbed together in a single heat treatment charge.

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11.0 RECORD OF REVISIONS

REV.NO	DATE	REVISION DETAILS	REVISED	APPROVED
01	18.8.06	Common clauses with AA19511 deleted.	AMAN	SG
02	27.06.07	For MPI ref.- AA0850133 And Method of Inspection-AA0850134 were ASTM E-125 and Annexure-C of ASTM E-125 respectively in Annexure-A	AMAN	SG
03	20.8.08	LPI deleted. Defectogram added. Stress relieving cycle added.	Aman	SG