

Record of Revision:

Rev 00: 06/10/14: Fresh Issue

Rev 01: 10/12/14: Cl 2, 4, 5 and 9 corrected

1. Material:

Specification	:	ASME SB167 (Latest on the date of Purchase Order)
Material	:	UNS N06617
Additional Requirement	:	As listed below (Supplementary to Specification)
Size and Qty.	:	As per Purchase order

2. Chemical Composition and Process:

Material shall be produced by using vacuum induction melting (VIM) followed by vacuum arc re-melting (VAR) or electro slag refining (ESR). Any other suitable melting and re-melting process shall be used only after approval from the purchaser.

Product Analysis: As per spec. Raw materials used in making of pipes including incoming scrap shall be checked by supplier to ensure freedom from radioactivity. Pipes shall be made by seamless process/ extruded process and shall be hot worked annealed or cold work annealed.

Heat Analysis in weight %: Test method as per ASTM E1473

Element	Cr	Fe	Mn	Mo	Co	Al	C	Cu	B	Si	S	N	Ti	Ni
Wt %	21-23	1.5 max	0.3 max	8-10	11-13	0.8-1.3	0.05-0.08	0.05 max	0.002-0.005	0.3 max	0.008 max	0.05 max	0.3-0.5	Bal

3. Dimensional Tolerances & Straightness:

- i) OD/ID and Wall thickness tolerances as per BHEL PO and relevant Drawing.
- ii) The Pipes shall not deviate from straightness by more than 1mm in any one shall not be more than 6mm over the entire length. A sharp bend at the end or kink and twist are not acceptable. These limitations are applicable for any given plane.

4. Heat Treatment:

UNS N06617 – solution annealed in the range 1150°C to 1175°C.

5. Mechanical Tests:

Extent of test: one sample/for each size/heat/HT batch; on final heat treated condition samples:

UNS N06617: Tensile Strength: Min 665 MPa, Yield Strength (0.2% off set): Min 240 MPa, Elongation ($L=5.65\sqrt{A}$), min 35%

Microstructure: Grain size ASTM No 2 to 5.

6. Non-destructive testing & Hydro testing: (Preferably on-line automated)

Each tube shall be examined for its integrity of full section over its entire length.

Eddy current testing: Eddy current testing shall be conducted as per ASTM E 571. 100 % area shall be inspected to ensure absence of surface and sub-surface defects.

Ultrasonic Testing: For thickness equal to and greater than 3.6 mm UT shall be conducted as per ASTM E213. Calibration: 2 axial notch (one ID & one OD) and 2 transverse notch (one ID & one OD) shall be used to standardise the system settings (to draw DAC) for circumferential scan and axial scan respectively. Notch shall be of length 50mm and depth 3% (maximum) of nominal thickness of job (Minimum depth shall be 0.3 mm). For OD less than 30mm one notch in outer surface (OD) is sufficient for calibration. The direction of scanning shall be clockwise & anti clockwise for circumferential scan to find longitudinal discontinuity and two axial direction for axial scanning to find transverse discontinuity. Scanning shall be done with scanning sensitivity of reference level plus 6 dB. Evaluation shall be carried out with reference sensitivity.

Acceptance criteria: Any discontinuity crossing the DAC shall not be acceptable irrespective of length. Any discontinuity with indication less than DAC shall be sized and if the length of discontinuity is greater than 10 mm it shall not be acceptable. All indications shall be sized and reported.

Hydro testing: Extent of test: On all pipes as per ASME SB 829 Cl 5.2 with $S = 163\text{MPa}$.

7. Workmanship and Finish:

The Inside & outside surfaces of the pipes shall be free from any imperfections. The material shall be plain, uniform in quality and condition, smooth, straight or flat and free of wrinkles, overlaps, tears, cracks & defects like laps, seams, folds, cracks, pitting etc. Localised imperfections, if any, may be removed by skin machining only to a surface finish of ≤ 6.3 microns ensuring the wall thickness, inside and outside diameter. Local depressions or ground spots are not acceptable. No repairs/weld repairs permitted. Pipes (inside & outside) to be clean & shot blasted to remove scales after HT.

8. Marking & Packing:

Details to be identified: On Each Pipe 1) Heat number 2) Specification & grade 3) Size 4) Maker's emblem/code, 5) No. of pipes 6) Inspector's seal.

- i) Upto OD 31.8 (Excl.) – Sl.No: 1 to 7 to be stamped on metal or plastic tag attached to bundle.
- ii) OD 31.8 to OD 76.1 (Incl.) – Sl.No:1 to 5, 7 to be paint stencilled on each pipe, 1 to 7 to be stamped on metal or plastic tag attached to bundle.
- iii) OD > 76.1- Sl.No: 2,3,4,5 & 7 to be hard stamped with round edged stamp at 100mm from an end of each pipe and 1 to 5 to be paint stencilled on each pipe.

9. Inspection & Certification:

- a) Products shall be inspected at works and the applicable IBR Form must be Countersigned by the Inspecting Authority as indicated below:
- b) Imported Items: Inspecting Authority approved by IBR for the Country of origin (To be concurred by BHEL before placing PO).
Indigenously Supplied items: Boiler Inspectorate/Directorate of respective State.
- c) Certification in IBR Form-IIID (Annexure – I) for IBR items from “IBR-Well Known Pipe Maker” and for Others IBR Form-IIIA (Annexure – II) as per enclosed format to be submitted.
- d) Manufacturer's Test certificate (MTC) (ORIGINAL in ENGLISH with following details):
 - i) Purchase Order No. (BHEL), TDC No. & Test certificate No., Size and Quantity-Melt wise.
 - ii) Specification and Grade with year of code, Code case number, Heat Number, Steel & Pipe making process, chemistry including incidental elements-Ladle and product Analysis.
 - iii) Supplier TC of the steel used in making the finished product – Well known steel maker IBR Form IV & others Form IVA.
 - iv) Details of steel ingot, Melting & forming process, Chemistry including incidental elements - Heat wise.
 - v) Heat treatment details of the material and test bars, Mechanical test results with reference & acceptance standard.
 - vi) NDE examination test results with reference & acceptance standard.
 - vii) Results of dimensional data sheet
- e) Survey meter shall be used to measure radioactive contamination at 5cm near the surface. Acceptance limits: Shall be less than 0.1 milli Rontgen (MR) per hr or 1 micro Sievert per hr. The Measured Radioactivity levels shall be reported in the Mill Test Certificate. (Not to be recorded in IBR Form).

All the tests specified here shall be carried out at works and the test results shall be furnished in the test certificates (4 copies). The bars shall be inspected and certified by the inspecting agency authorised by BHEL, wherever specified in the purchase order.

f) Quality Plan:

Before start of production the manufacturer shall submit a Manufacturing and Inspection plan (MIP) to **BHEL product QA** for approval. The MIP shall constitute of:

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| i) melting & refining, | vi) internal tests and inspection before final heat treatment, | xi) marking preservation and dispatch, |
| ii) ingot weight and type, | vii) quality heat treatment along with parameters, | xii) test instructions for NDE examinations along with sketches |
| iii) hot rolling/extrusion process | ix) test and inspections after heat treatment | xiii) type of machining and examinations. |
| iv) top bottom end discard percentages, | x), test certificate requirements, | |
| v) position of the part in ingot, | | |
| vi) preliminary heat treatment, | | |

g) Audit Checks at BHEL:

BHEL reserves the right to carry out audit checks for chemistry, HT condition, mechanical test and NDT on representative test bars or job. Supplies found defective during check or subsequent processing at BHEL are liable for rejection.

h) End Use

To be used in pipes of boilers and headers for Advanced Ultra-Super Critical (AUSC) boiler applications.

		 10/12/14		
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