

	BHEL – Tiruchirappalli - 620014, India. Quality Assurance Department TECHNICAL DELIVERY CONDITIONS	DOC No: TDC:0:202 Rev No: 08 Effective Date: 04/10/2017 Page: 1 of 3
Product: BOILER QUALITY STEEL PLATES AS PER SA 515, SA 516 & SA 387 SPECIFICATIONS		

Record of revisions:

Rev 04: 18/07/2008 Cl 1.0 to Cl 6.0 modified.
Rev 05: 02/02/2011: SA387 Gr 91 Class 2 added, Cl 2.0, 3.0, 5.0, 6.0, 9.0, and 10.0 modified.
Rev 06: 28/06/2014 Cl 1.0: Material spec SA516 included. CL 3.0 and 5.0 modified.
Rev 07: Dt: 27/04/2016 – Cl 1 modified; Cl 3- Heat treatment temperatures revised; Cl 4 to 8- modified; Cl 10- revised as per latest IBR requirements.
Rev 08: 04/10/2017: Cl 2 (b), 2 (d), 10 (iii), 10(v) modified and Cl 5.0 (e), 10 (c) & 10 (d-ix) added.

1.0 MATERIALS

Specification : ASME (Latest as on the date of Enquiry or PO, whichever is earlier)
Carbon steel (CS) : SA515 Gr.70, SA516 Gr.70
Alloy Steel (AS) : SA387 Gr.12 Class 2, Gr. 22 Class 2, Gr. 91 Class 2
Additional Requirements : As listed below (Supplementary to the above material specifications)
Size and Quantity : As per Purchase Order (PO)

2.0 CHEMICAL COMPOSITION & PROCESS

- All plates shall be of Fully Killed steel.
- Drum** plates shall be Vacuum Degassed. (S1 of SA20).
- Final rolling: Length-wise.
- Plates may be made from ingots or strand cast slabs.* Reduction ratio in thickness from slab/ingot to plate shall be at least 3:1.
Sufficient "Top of Ingot" to be discarded to ensure plate free of segregation. After top discard, the increase in Carbon content at the top-mid width, mid thickness of the plate shall not exceed 20% of the reported ladle analysis value. This value shall be reported in Test Certificate.
- Ladle analysis: 1 sample per cast; Product analysis: Min.1 sample per plate as rolled.
Max. Carbon: CS: 0.25%. Max. Carbon Equivalent for Carbon Steel: As per S20 of SA20.

3.0 HEAT TREATMENT (HT) (as delivered condition)

Materials	Heat Treatment Temperature (°C)	
	Normalising	Tempering
CS: SA 515 Gr 70, SA 516 Gr 70	880-920	-
AS: SA387 Gr 12 Class 2	920-960	650-700
AS: SA387 Gr 22 Class 2	920-960	680-750
AS: SA387 Gr 91 Class 2	1040-1080	750-780

4.0 SIMULATION HEAT TREATMENT for test coupons in addition to Cl.:3.0 (For CS Drum plates only as indicated in the Enquiry/PO):

Normalizing: 880-920°C, Stress Relieving (SR): 615±10°C, 3 hr/inch of thick (t), furnace cool to 400°C;
ROH/ROC for SR: <220°C/hr divided by t in inches, but need not be slower than 55°C/hr.

5.0 MECHANICAL TESTS (In simulation heat treated condition for CS Drum plates and in as delivered condition for other CS plates & all AS plates):

Extent of test: For each rolled/mother plate.

- Tensile Test
- Bend Test: Angle of bend: 180 deg. Diameter of the Mandrel = 2xThickness of the plate as rolled.
- High temperature tensile test for carbon steel drum plates shall be as per S7 of SA 20. Min yield strength at 350°C: 19.7 kg/mm².
- For Gr 91 - Hardness: 195 – 250 HBW, Tensile strength: Min: 630 MPa, Yield Strength: Min: 450 MPa.
- Creep testing and reporting shall be carried out as indicated below (only for IBR application).*

CREEP TESTING REQUIREMENTS

Creep testing is required as per IBR for all alloy steels of pressure parts used in boilers (Fossil & HRSG/CFBC/BFBC Boilers) being erected in India. Creep testing shall be done in line with the following:

If starting raw material (Ingot/Slabs) is sourced from indigenous steel makers, supplier shall produce the Creep test report for each material grade being supplied by them as per the Table 1 given below:

- Creep testing shall be done at National Metallurgical Laboratory, Jamshedpur or Corporate Research & Development Laboratory of Bharat Heavy Electricals Limited, Hyderabad for indigenous suppliers.*
- In case the plate supplier sources the slab/ ingots from more than one source, the creep tests shall be done for all the sources from whom they would source the slab/ ingots for BHEL supply.*

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- c) Creep testing shall be done as per ASTM E139 or BS EN ISO 204.
- d) Acceptance Criteria: The samples tested shall not rupture and shall meet the requirement of 1,000 hours of creep testing at indicated temperatures & stress values as per Table 1.
- e) Reporting: The following shall be made available in creep test report:
Product form, Material Specification, Raw Material source, heat/melt number, Heat treatment details, testing laboratory, Test start date & time, Test end/reporting date & time, Test duration, temperature, stress value, testing method/ Standard, Sample size, number of samples, test result and acceptance criteria.

Table 1. Creep Testing Requirements

Sl. No.	Steel Type and Grade	Testing hours – min. (hrs.)	Testing Temperature (0C)	Stress Value (MPa)	% Elongation	No. of tests & Specimen Size
1	Alloy Steels (AS) – Grade 12 and Grade 22	1000	550	100	shall be within 0.01%	Two no. of tests with preferably M10 round sample
2	Alloy Steels (AS) – Grade 91	1000	600	120	shall be within 0.01%	Two no. of tests with preferably M10 round sample

Suggested/Recommended Format for Reporting the Creep Testing Data:

Sl. No.	Description	Details
1	Name and Address of the Product Manufacturer	
2	Name and Address of the Steel Maker (slab/ ingot)	
3	Heat treatment details(Temperature, creep hours)	
4	Testing method/ Standard (ASTM E139 or BS EN ISO 204)	
5	Material Specification & Grade	
6	Heat No.	
7	Test Start Date & Time	
8	Test Sample Size	
9	No. of test samples	
10	Temperature at which Test is conducted (0C)	
11	Stress value observed (MPa)	
12	Elongation at the Reporting/completion of test	
13	Test End Date/Reporting & Time	
14	Name and Address of Testing Laboratory	
15	Test witnessed by	
16	Test Result (Accepted/Not Accepted)	

6.0 NON DESTRUCTIVE TEST (For all plates of thickness >10mm)

Ultrasonic test: As per SA578. Acceptance: Level B.

7.0 DIMENSIONAL CHECKS

All dimensions shall be as per PO. Tolerance on thickness of plates shall be positive only.

8.0 REPAIRS AND FINISH

Plates to be free of mill scales, edge crack & other injurious defects. Repairs by fusion welding are prohibited. Mechanical removal of defects are permitted subject to availability of min. thickness & smooth surface.

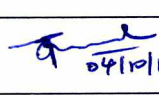
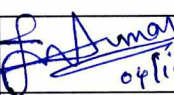
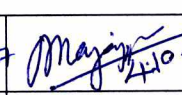
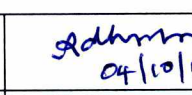
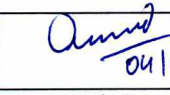
9.0 MARKING

- Specification, grade, Melt number, Size, Plate number, Maker's emblem/ code and Inspecting Authority's seal to be stamped on each plate.
- For plates of thickness > 6mm, marking shall be by stencilling & steel die stamping
- For plates of thickness ≤ 6mm, marking shall be by stencilling & steel die stamping using low stress on each plate & bordered by white paint.
- In addition, for SA387, each plate shall be legibly stamped with the letter N to indicate for normalised and tempered plate. Rolling direction shall be marked by paint. PO No., "BHEL - Tiruchirappalli" & weight to be painted on the product.

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10.0 INSPECTION AND CERTIFICATION:

- a. Products shall be inspected at works & the test certificates (in English only) countersigned by Inspecting Authority as below:
 - ☐ **Imported:** Inspecting Authority approved by IBR for the country of origin (to be concurred by BHEL).
 - ☐ **Indigenous Supply:** Director of Boilers/Chief Inspector of Boilers/Inspecting Authority approved by IBR, for the respective state.
- b. All the products shall be accompanied by IBR Form-IV (for IBR well-known steel makers & others) and manufacturer's mill test certificate (in English only) supplied against every purchase order.
- c. *For Non-IBR application, Form IV is not applicable and certification shall be as per EN 10204 3.1*
- d. Additionally, manufacturer's test certificate shall be submitted meeting all the requirements contained in the purchase order, this TDC, and the applicable ASME Specification with the following details:
 - i. Purchase Order No (BHEL), TDC No & Rev No, Test certificate number & Date, Quantity.
 - ii. Specification and Grade with applicable year of code, Heat Number, Plate number.
 - iii. Steel making process, Chemistry including incidental elements - Ladle and Product analysis *[as per Cl 2(d) & 2(e)]*.
 - iv. Heat Treatment details of material and test coupons like temperature, soaking time, cooling medium etc.
 - v. The *certification of reduction ratio in thickness $\geq 3:1$* from a strand-cast slab/*ingot* to plate shall be reported in the test certificate.
 - vi. Mechanical, NDE & other test results with reference & acceptance standards.
 - vii. Print of the stamp of Inspecting Officer, which is used on the plate.
 - viii. The manufacturer shall furnish a certificate of compliance stating that the plates have been manufactured, inspected, and tested in accordance with the requirements of the applicable product specification.
 - ix. *Creep test report as per the format suggested in Cl 5 of this TDC (applicable only for IBR application).*

 04.10.2017	 04/10/17	 04/10/2017	 04.10.17	 04/10/17	 04/10/17
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