CARBON STEEL PRESSURE VESSEL PLATES FOR LOW AND MODERATE TEMPERATURE SERVICE
(IS 2041 Grade R260 & ASME SA 516 Gr. 70)

1.0 GENERAL:

The specification covers the technical requirements of Boiler Quality carbon steel plates used for the fabrication of pressure vessels and heat exchangers as per ASME Boiler and Pressure Vessel code or Indian Boiler Regulations (IBR).

2.0 APPLICATION:

For fabrication of pressure vessels and heat exchangers as per ASME Boiler and Pressure Vessel code or Indian Boiler Regulations (IBR) having additional requirements of vacuum degassing, low temperature impact test and ultrasonic test on the plates used.

3.0 CONDITION OF DELIVERY:

3.1 The plates shall meet the requirements of IS 2041 Grade R260 & ASME SA 516 Gr.70 as per latest edition pertinent at the time of PO and all other requirements stipulated in this specification.

3.2.1 All the plates shall be free from mill scales, segregation or impurities, cracks, surface flaws, and laminations, rough, jagged and imperfect edges.

3.2.2 As rolled milled edges (round corners) are not acceptable. However, as rolled edges as obtained through Universal Mill (UM) process (where, edges are rolled with special set of side rolls) are acceptable. The tolerances on width and length shall be as per applicable tables given in SA20.

3.2.3 For rolled plates, the edges shall be cut either through shearing or gas/ flame/ plasma cutting by using automated process only. Manual gas/ flame/ plasma cutting is not permitted. Cut edges shall meet the tolerances as per SA20.

3.3 All the plates below 10mm thickness shall be suitably protected with rust preventive coatings at the time of supplies.

3.4 All the plates shall be supplied in normalized condition.

4.0 DIMENSIONS & TOLERANCES:

Size of the plates shall be as per BHEL enquiry/ purchase order.

Tolerances on thickness, width and length of plates shall be as per SA 20. However, no negative tolerances are permitted on thickness of the plates.

5.0 MANUFACTURE:

5.1 The steel shall be manufactured by open hearth furnace / basic oxygen / electric arc furnace. The steel may be refined by secondary refining process (LRF etc.). The steel shall also be Vacuum degassed as per Cl. 11.1 of this specification.

5.2 Steel making practice -- The steel shall be killed and shall conform to the fine austenitic grain size (5 or higher as per ASTM E 112, Plate IV). Aluminum shall be used as grain refining element. The aluminum content shall not be less than 0.020% total aluminum or alternatively, 0.015% acid soluble aluminum in the heat.

5.3 The steel may be strand cast or cast in stationary molds. When the plates are rolled from continuously cast slabs, the ratio of slab to plate thickness shall be atleast 3.0 to 1.0

6.0 HEAT TREATMENT:

The plates shall be subjected to normalizing heat treatment.

7.0 FREEDOM FROM DEFECTS:

7.1 The finished plates shall be reasonably free from harmful defects, such as cracks, seams, laminations, rough and jagged edges, etc.

7.2 Superficial defects may be removed by grinding or by other suitable means, provided the material is not reduced below the permissible limits of tolerance at the dressed spot. Hammer dressing, patching by welding, etc., are not be permitted.

8.0 TEST SAMPLES SELECTION:

8.1 Chemical composition – One sample per heat shall be taken up for chemical analysis and all elements required as per Cl.9.0 shall be reported in the test certificates.

8.2 Tensile tests – One tensile test sample (transverse to the rolling direction of the plate) shall be selected for tensile test from each plate as rolled, in supply condition. Up to 20mm (incl.) thick plates, the tensile test specimen shall be of full thickness of the plate. For over 20mm thick plates, axis of the test specimen shall be located midway between the center of thickness and the top or bottom surface of the plate.

8.3 Impact test – One impact test (3 specimens) shall be conducted from each plate as rolled, in supply condition. The location of the impact test specimens shall be adjacent to the tensile test specimens. The longitudinal axis of the specimen shall be in the transverse or longitudinal direction of rolling. The axis of the notch shall be perpendicular to the rolling direction.

8.4 The test samples for tensile and impact testing shall be extracted from plates after completion of the normalizing treatment.

9.0 CHEMICAL COMPOSITION:

9.1 Heat / Melt analysis (in % wt.) shall be as follows:

Element (% wt.)	C[a,b]	Si	Mn[b]	P[a]	S[a]
Minimum	--	0.15	0.85	--	--
Maximum	0.25	0.35	1.20	0.035	0.035

Note:
a) Applies to both heat and product analysis
b) For each reduction of 0.01% point below the specified maximum for carbon, an increase of 0.06% point above the specified maximum for manganese is permitted, up to a maximum of 1.50 by heat analysis and 1.60 % by product analysis.
c) The total aluminum content shall be minimum 0.020% or alternatively, 0.015% acid soluble aluminum. Aluminum content shall be reported in the test certificate.

9.2 Trace elements shall be within the following limits:

Element (Max. %wt.)	Cu	Ni	Cr	Mo	V	Cb	Ti
Heat analysis	0.40	0.40	0.30	0.12	0.03	0.02	0.03
Product analysis	0.43	0.43	0.34	0.13	0.04	0.03	0.04

Note: 1) Based on heat analysis, the sum of Cu, Ni, Cr and Mo shall not exceed 1.00 %.
2) Based on heat analysis, the sum of Cr and Mo shall not exceed 0.32 %.

10.0 MECHANICAL PROPERTIES:

The material shall comply with the following mechanical properties.

Properties	0.2 %Yield Strength N/mm^2	Tensile Strength N/mm^2	[2,3]Elongation %, min.	
			GL 200mm	GL 50mm
Minimum	260	485	17	21
Maximum	--	620	--	--

NOTE:
1. Tensile test shall be done as SA 370 or any reputed national standard.
2. Determined by either the 0.2% offset method or the 0.5% extension under-load method.
3. As per specification SA20/SA20M for elongation adjustment.
4. The above specified properties are applicable for plate thicknesses up to and including 205 mm. For plates above 205mm thickness, the properties shall be mutually agreed.

11.0 ADDITIONAL REQUIREMENTS

11.1 Vacuum Degassing (Supplementary requirement, S1 as per ASME SA20):
The plates shall be manufactured using vacuum degassed steel only. The same shall be reported in the test certificates.

11.2 Low temperature Impact (Supplementary requirement, S5 as per ASME SA20):
The plates shall be tested for low temperature impact properties as per the details given below:

Plate thickness	Test temperature ˚C	Energy absorbed, J	
		Minimum average for 3 specimen	Minimum for 1 specimen
25mm and under	-46 ˚C	20	16
Over 25mm to 50mm, Incl.	-40 ˚C	20	16
Over 50mm to 75mm, Incl.	-35 ˚C	20	16
Over 75mm to 125mm, Incl.	-29 ˚C	20	16
Over 125mm	-29 ˚C	20	16

Note: Sub-size test specimens (as mentioned in ASME SA20) may be used, if required.

11.3 Ultrasonic testing (Supplementary requirement, S8 as per ASME SA20):

All the plates shall be subjected to ultrasonic testing as per ASTM A 435.

12.0 INSPECTION AT SUPPLIER'S WORKS:

12.1 BHEL representative / BHEL appointed Inspection Agency shall have free entry and access to all areas where the manufacture of the plates is carried out. All reasonable facilities shall be extended to him including labour wherever necessary.

12.2 BHEL representative / BHEL appointed Inspection Agency shall be given sufficient advance intimation to witness the various processes, tests etc. Punching and identification of test coupons and execution of various tests shall be done in presence of BHEL representative / BHEL appointed Inspection Agency.

13.0 TEST CERTIFICATES:

The test certificates for the plates shall consist of the following:

1) Three copies of the test certificates (in English) shall be furnished as per IBR format FORM IV clearly specifying material meeting the requirements of ASME SA516 Gr.70 and HY10470 Rev.09.

2) Additionally, three copies of the Manufacturer's Test certificates explicitly stating the compliance to IS 2041 Gr. R260 and SA 516 Gr. 70 (S1, S5 & S8) & SA 20 shall also be submitted. The test certificates shall also mention the compliance to HY10470 Rev.09

14.0 IDENTIFICATION AND MARKING:

All the plates shall be identified and marked as given below to meet the requirement of SA 20

(i) IS 2041 Gr. R260 & SA 516 Gr: 70 (S1, S5, S8)
(ii) Heat No. & Plate No.
(iii) Inspection authority mark
(iv) Name/ Brand/ Trade mark of the manufacturer
(v) BHEL Order No.
(vi) HY10470 Rev.09

In addition to the above, each plate shall be marked with the Standard BIS certification marking. The use of the Standard Mark is governed by the provisions of the Bureau of Indian Standards Act, 1986 and the rules and Regulations made thereunder.

15.0 REJECTION & REPLACEMENT:

In the event of the material proving defective in the course of further processing at BHEL, the same will be rejected notwithstanding any previous acceptance. The supplier shall replace the material at his own cost and the rejected material will be returned after all the commercial conditions are satisfied