TECHNICAL SPECIFICATIONS FOR BOILER QUALITY STEEL PLATES FOR LPG MOUNDED STORAGE VESSEL

1.0 GENERAL

This specification covers requirements for carbon steel Boiler Quality plates intended primarily for fabrications of Mounded Storage Vessels for LPG storage. The steel plates shall meet the requirements of ASME Boiler and Pressure Vessel Code. Steel Plate material shall conform to SA 537 Cl. 1(Impact tested at –30 degree C), duly normalized, ultrasonically tested, impact tested with duly certified Mills/Manufacturers test certificates by Third party, conforming to physical & chemical properties as per ASME/ASTM SA 537 Cl. 1 & other specifications enclosed to this tender document. Steel Plates supplied to this specification shall conform to specification SA-20 with additional requirements mentioned herein.

2.0 CHEMICAL COMPOSITION

The steel plate material shall conform to following Chemical Composition as per ASTM A 537 Cl 1.

<table>
<thead>
<tr>
<th>Element</th>
<th>Composition (%)</th>
<th>Heat Analysis</th>
<th>Product Analysis</th>
</tr>
</thead>
<tbody>
<tr>
<td>Carbon, C</td>
<td>0.23 max</td>
<td>0.23 max</td>
<td></td>
</tr>
<tr>
<td>Manganese, Mn</td>
<td>0.70 – 1.35 (Plate Thickness&lt;= 40mm)</td>
<td>0.64 – 1.46 (Plate Thickness&lt;= 40mm)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>1.00 – 1.60 (Plate Thickness&gt; 40mm)</td>
<td>0.92 – 1.72 (Plate Thickness&gt; 40mm)</td>
<td></td>
</tr>
<tr>
<td>Phosphorous, P</td>
<td>0.035 max</td>
<td>0.035 max</td>
<td></td>
</tr>
<tr>
<td>Sulphur, S</td>
<td>0.035 max</td>
<td>0.035 max</td>
<td></td>
</tr>
<tr>
<td>Silicon, Si</td>
<td>0.15-0.50</td>
<td>0.13-0.55</td>
<td></td>
</tr>
</tbody>
</table>

Small amount of alloying elements may be present but shall not exceed the following amounts

<table>
<thead>
<tr>
<th>Element</th>
<th>Composition (%)</th>
<th>Heat Analysis</th>
<th>Product Analysis</th>
</tr>
</thead>
<tbody>
<tr>
<td>Copper, Cu</td>
<td>0.35</td>
<td>0.38</td>
<td></td>
</tr>
<tr>
<td>Nickel, Ni</td>
<td>0.25</td>
<td>0.28</td>
<td></td>
</tr>
<tr>
<td>Chromium, Cr</td>
<td>0.25</td>
<td>0.29</td>
<td></td>
</tr>
<tr>
<td>Molybdenum, Mo</td>
<td>0.08</td>
<td>0.09</td>
<td></td>
</tr>
</tbody>
</table>

Sum of composition of Copper, Nickel, Chromium & Molybdenum (Cu+Ni+Cr+Mo) shall not exceed 0.70 % on Heat Analysis

In addition to the above, one of the following requirements for Carbon equivalent based on Heat analysis shall be satisfied-

Equation-1 : Ceq = C + Mn/6 < 0.42 %

Equation-2: Ceq=C + Mn/6 + (Cr+Mo+V)/5 + (Cu+Ni) /15 <0.43

- Equation – 1 shall be used when applicable material specification specified C and Mn only
- Equation – 2 shall be used when applicable material specified the above elements or restricted chemical requirements are specified or supplementary requirements S19 and S21 of SA –20 are specified in material requisition.

3.0 MECHANICAL PROPERTIES

The steel plate material shall conform to following Mechanical Properties as per ASTM A 537 Cl 1.

<table>
<thead>
<tr>
<th>Property</th>
<th>Values</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tensile Strength</td>
<td>70 – 90 KSI</td>
</tr>
<tr>
<td>Yield Strength</td>
<td>50 KSI</td>
</tr>
<tr>
<td>Elongation (in 50mm)</td>
<td>22% min</td>
</tr>
<tr>
<td>Elongation (in 200mm)</td>
<td>18% min</td>
</tr>
</tbody>
</table>
4.0 MANDATORY REQUIREMENTS

a. Heat Treatment: The plates shall be Normalized and the steel shall be of fine grain quality fully killed according to SA20. Accelerated cooling by liquid quenching or other means is not permitted.

b. Impact Testing: Charpy "V" Notch impact test as per S5 of specification SA-20 at (-) 30 Deg C shall be conducted for each heat no. of the plates. Impact test shall be conducted after simulation heat treatment for test plates. Energy absorbed shall be 50J min (Average of 3 specimens) and 45J min (individual).

c. Tolerance- There shall be no negative tolerance in the thickness of the plates. Tolerance in Length and Width shall be as per SA20. The tolerance in width shall be uniform across the length.

d. Ultrasonic Testing: Ultrasonic examination of all plates shall be done as per ASTM-A 435 on the entire surface of the plate with a square grid of 200 mm. UST shall be done after heat treatment and results reported in the test certificates.

e. The plates shall be free of scales and rolled in the direction of length and shall be supplied in the normalised condition. The plates shall be supplied with gas sheared edges with tolerance as per tender specifications. Manual gas cutting is not acceptable. The plates shall be free from injurious defects. Reconditioning / repair of plates by welding is not permitted.

f. Simulated Heat Treatment of Test Coupons

Test coupons cut shall be cut from the normalised plates shall undergo simulated heat treatment as per following cycles and shall meet the mechanical properties including impact test values. The test result values of the physical properties & Impact test values of the test coupons after simulated heat treatment shall be as per Clause No. 3 & 4(b) above.

The following heat treatment shall be conducted on the test coupons representative of heat treated plates before the specified mechanical testing like tensile, bend, impact tests, etc., to meet minimum PD : 5500 requirements and these details shall also be recorded on the test certificates.

Conditions of Test Coupons
  o Plate Thickness 20mm & below – 02 Renormalizing + 02 PWHT
  o Plate Thickness above 20mm – 01 Renormalizing + 02 PWHT

Cycles

<table>
<thead>
<tr>
<th>Renormalizing Cycle</th>
<th>PWHT</th>
</tr>
</thead>
<tbody>
<tr>
<td>Loading Temp : 200 Deg C and under</td>
<td>Loading Temp : 300 Deg C</td>
</tr>
<tr>
<td>Rate of Heating : 200 Deg C per hour max.</td>
<td>Rate of heating : 80 to 100 Deg C/hr. max.</td>
</tr>
<tr>
<td>Holding : 900 Deg C (Min.) 920 Deg C max</td>
<td>Holding Temp : 610 +/- 10 Deg C</td>
</tr>
<tr>
<td>Soaking Time : 2 hours</td>
<td>Soaking Time : 2 hours</td>
</tr>
<tr>
<td>Cooling Method : In still air</td>
<td>Rate of cooling : Up to 300 Deg C- Furnace cooling 100 to 120 Deg C/hr Below 300 Deg C – In Still Air</td>
</tr>
</tbody>
</table>

5.0 SCOPE OF INSPECTION

a. The Inspection of the plates shall be done by BPCL’s Approved Third Party Inspection Agencies (TPIA) at the Steel Plate manufacturer’s Work.

b. The tests shall be performed by the Steel Plate Manufacturer in accordance with relevant ASTM standards and shall be witnessed by TPIA as per following:
  i. Identification of Heat & Plate No – 100% Witness
  ii. Visual Inspection & Dimension Check- 100% Witness
  iii. Chemical / Ladle Analysis – 1 No Per Heat
  iv. Product Analysis – 1 No Per Heat
  v. Heat Treatment Cycle- 100% Witness
  vi. Tensile, Yield & % Elongation
  vii. As Supplied- 1 No Per Mother Plate
  viii. On Simulated Heat Treated Test Coupons- 2 Nos per Heat Per Thickness
ix. Impact Test  
x. As Supplied- 1 No Per Mother Plate  
xi. On Simulated Heat Treated Test Coupons- 2 Nos per Heat Per Thickness  
xii. Ultrasonic Test- 100%  
xiii. Any Other test specified in ASTM Standard SA 537 Cl 1- 1 No Random

c. List of BPCL’s Approved TPIA LRIS/DNV/ IRS/EIL /UL/ BV

6.0 MANUFACTURER’S TEST CERTIFICATE

a. The plates shall be supplied by Manufacturer’s Test certificate conforming to EN 10204 Type 3.2 (in English language only) covering following details as a minimum;

i. Heat and Plate number  
ii. Chemical Composition, Heat and Product analysis  
iii. Heat Treatment cycles  
v. Ultrasonic Test results  
vi. Result of Physical & Impact Test Valves of the Test Coupons after Simulated Heat Treatment test.

b. One product analysis of each heat shall be carried out and reported in the TC. Chemicals analysis shall be as per material specification and carbon content for plates shall in no case exceed 0.23%. Additionally one of the requirements for carbon equivalent specified in Clause 2 based on heat analysis shall be also satisfied.

7.0 MARKING

a. Unless otherwise specified, the plates shall be supplied free from any kind of Painting / Coating.

b. Following details shall be marked on each plate;

i. PO No.  
ii. ASTM Designation with Grade  
iii. Heat No.  
iv. Plate No.  
v. Length  
vi. Width  
vii. Thickness  
viii. TPIA Stamp

c. The paint / ink used for marking these details shall not contain any harmful chemical detrimental to the plates

8.0 PAYMENT

The payment & dispatch shall be made on Actual Weight basis. The weight shall be taken at the vendor own stockyard/plant/ premises & BPCL reserves the right to witness the same. Thereafter in case the plates are received at BPCL end with different dimensions (other than that invoiced & weighed at vendors end), the same shall not be accepted.

Payment & dispatch based on Theoretical Weight basis is also acceptable. However in case the plates are received at BPCL end with different dimensions (other than that invoiced at vendor end), the same shall not be accepted. In this case the density of steel shall be taken as 7850 Kg./cubic meter.

IMPORTANT NOTE: The supplies made by the vendor shall not be lower than number of plates specified in the call-off quantity. The vendor can supply higher than the call-off quantity in MT to the extent so that the call-off quantity by number of plates and its dimensions are fulfilled.