△1 1.2. [Deleted]

1.3. Codes and Standards

△1 1.3.1. Codes and Standards for the design, engineering, manufacturing, test and inspection of heat exchangers have been extracted from internationally prevailing Codes and Standards as follows;

Applicable Codes and Standards shall be latest edition at the time of the Contract signing. Code stamp shall not be required.

(1) ASME BOILER AND PRESSURE VESSEL CODE, Section VIII, “Pressure Vessels”, Division 1 or 2, latest edition.

(2) ASTM Standard, latest edition

(3) TEMA (Tubular Exchangers Manufacturers Association) Standard, latest edition, class B.

(4) AD-Merkblätter, "Technical Rules for Pressure Vessels".

(5) HEI (Heat Exchange Institute)

(7) Local stresses due to the piping reaction shall be investigated in accordance with WRC (Welding Research Council), BULLTIN 107 and 297, "Local Stresses in Spherical and Cylindrical Shells due to External Loadings", and Local Stresses in Cylindrical Shells due to External Loadings on Nozzles - Supplement to WRC BULLTIN No.107, if required.

(8) Manufacturer's Standards.

The strength calculations for heat exchangers shall be in accordance with ASME Codes, Section VIII, Division 1.

For the manufacturing of heat exchangers, the Contractor's Standards approved by the Owner shall be applied Subjects not covered by specified Codes and Standards will follow

the Contractor's engineering practice and/or the manufacturer's standards.

1 1.3.2. Where codes are not specified, exchangers shall be designed in accordance with Vendor's practice, generally.

1.3.3. Unless otherwise specified, all heat exchangers shall be designed in accordance with the TEMA Standard Class R.

1 1.3.4. Following wind and seismic loads shall be used for the design of heat exchangers;

(1) Wind load:

$$Fw = Q \cdot c \cdot A$$

Where,,

Fw : Wind load (kg•f)

Q = 42.5 + 0.6H: Wind pressure (kg/m2)

c = 0.7: Shape factor

A : Effective area (m^2)

H : Height from ground level (m)

(2) Seismic load:

$$F = C \cdot I \cdot K \cdot W = 0.15\ W$$

Where,

F : Horizontal seismic load

C = 0.05: Seismic design coefficient

I = 1.0 : Importance factor

K = 3. 0 : Structural

W : Weight of heat exchangers (kg•f)

1.4. Unit

Unless otherwise specified, metric, Celsius and kilogram units shall be applied as the measurement system for the drawings and documents to be submitted. However, nominal sizes of piping components shall be in accordance with inch system (B).

1.5. Drawings and Related Engineering Specifications

1.5.1. will provide either of the following drawings or data sheets for each heat exchanger.

(1) Heat Exchanger Data Sheets

(2) Formal Sketches

(3) Engineering Drawings

1.5.2. In addition, Vessel Standards are provided to supplement the above drawings or data sheets and determine the detail construction of heat exchangers.

1.5.3. The related Engineering Specifications to supplement this specification are as follows:

(1) ED-00-VS-SPC-E_D202 "Inspection & Tests of Vessels & Heat Exchangers"

(2) ED-00-PP-SPC-E0013 "Engineering Specification for piping material"

1.5.4. will provide vendor's strength calculation report at job stage.

2. DESIGN

2.1. Type Selection

2.1.1. TEMA Standard type shell and tube heat exchangers shall be used except for high pressure/temperature or other special services.

2.1.2. Generally heat exchangers shall be of horizontal type except that vertical type may be used when advantageous on arrangement or performance.

2.1.3. Normally, heat exchangers shall be designed with corrosive or fouling fluid in the tube side.

2.1.4. Fixed tube-sheet exchangers shall be used for little-fouling service on the shell side, or when chemical cleaning device is provided.

2.1.5. U-tube exchangers shall be used for little-fouling service on the tube side, or when fixed tubesheet or floating head exchangers are not practicable.

2.1.6. In case of cooling water or fouling fluid on the tube side, removable flat covers (TEMA type A) shall be provided on the channel.

2.2. Basic Dimensions

2.2.1. Nominal shell inside diameters shall be selected on every 50 mm, and limited, except for kettle type exchangers, to the maximum of 2000 mm.

2.2.2. Tube lengths of 3000, 5000, 6000, 7200 and 12000 mm shall be considered as standard. For removable bundles, a tube length of 7200 mm shall be the maximum.

2.2.3. Standard tube outside diameters and tube pitches shall be as follows:

Unit: mm

Tube Outside Diameter	Pitch
19.0	25.0
25.4	32.0

2.2.4. Standard tube patterns shall be of triangular and square. Triangular pattern shall not be used when mechanical cleaning is required on the shell side.

2.2.5. Standard tube thicknesses shall be as follows:

Unit: mm

Tube Outside Diameter	Tube Thicknesses		
	C.S. & Low Alloys (Min. Wall)	High Alloys (Avg. Wall)	Copper & Copper Alloys (Avg. Wall)
19.0	2.0	1.2	1.6
25.4	2.0	1.6	1.6

2.2.6. The effective heat transfer surface shall be defined as the outside surface of the tubes between the inner faces of tubesheets. Bent portions shall be considered as the heat transfer surfaces in U-tube exchangers.

2.2.7. When plate thicknesses are to be governed by the minimum thicknesses stipulated in TEMA in inches, the nearest thicknesses in millimetres normally available in the market shall be used.

2.3. Design Pressure

2.3.1. Design pressure, which is the basis of strength calculation, shall normally be the maximum anticipated operating pressure.

2.3.2. Unless otherwise specified, parts in contact with both shell and tube side fluids such as tubes, tubesheets and floating heads shall be designed for the pressure on one side only or the combination of the pressures, whichever that requires the maximum material thickness for the part.

2.4. Design Temperature

2.4.1. Design temperature, which is the basis of strength calculation, shall normally be the maximum anticipated operating temperature, but not less than 60℃.

2.4.2. When operating temperature is 15℃ and below, the design temperature shall be the minimum anticipated operating temperature.

2.4.3. When design temperature cannot coincide with the maximum pressure, the corresponding design pressure shall be designated together with the temperature.

2.4.4. Exchanger parts in contact with two fluids having different temperatures shall be designed for higher temperature of the two. When operating temperatures are 15℃ or less, they shall be designed for the lower temperature of the two.

2.4.5. When the shell inside is insulated from high temperature fluid, the design temperature shall be determined by heat transfer calculation.

△1 2.4.6. Minimum design metal temperature by atmospheric temperature is 0℃.

2.7. Tolerances

1 2.7.1. Unless otherwise specified, tolerances shall be in accordance with Engineering Specification "ED-00-VS-SPC-E_D202", Inspection & Tests of Vessels & Heat Exchangers.

2.7.2. The thickness after forming of any pressure holding parts shall not be less than the calculated thickness. Plates with an under tolerance of not more than the smaller value of 0.25 mm or 6% of the nominal thickness may be used.

3. DETAIL DESIGN

3.1. Shells and Channels

3.1.1. Except for kettle and U-tube types, exchangers with removable tube bundles shall be provided with bolted shell covers.

3.1.2. The angle of a conical section of kettle type exchangers shall generally be 30°.

3.1.3. Girth flanges shall have a confined gasketed joint to hold the gasket in place during assembling.

3.1.4. All girth flanges shall be of welding neck construction, except that slip-on flanges are used when exchangers are made of high alloy steels or nonferrous metals, or when design pressures are 20 kg/cm2G and less, and design temperatures are 350℃ and less.

3.1.5. Vent and drain holes of approx.6 mm in diameter provided at the highest and lowest points of each pass partition plate.

3.2. Tubes and Tube Bundles

3.2.1. Tubes shall be of seamless or welded construction.

1 3.2.2. Each U-tube shall be formed from a single length, and mean radius of U-tube bend shall not be less than 1.5 times the tube outside diameter.

3.2.3. Expanded tube-to-tubesheet joints are considered as standard.

3.2.4. When design pressures exceed 50 kg/cm2G or design temperatures exceed 350℃, or when it is absolutely necessary to avoid any leakage, tube-to-tubesheet joints shall be strength-welded. In general, seal welding shall not be used.

3.2.5. Tubesheets shall be designed in accordance with the TEMA Standard, provided that calculated thicknesses meet the code requirement.

3.2.6. Baffles and support plates shall be tied together with rods and spacers, and for horizontal exchangers they shall be provided with notches at the lowest point to permit full drainage of the shell.

3.2.7. For exchangers which are not require baffles, support plates of 45% vertical cut shall generally be provided. Support plates need not be cut for kettle type exchangers. These support plates shall be so spaced that unsupported tube length does not exceed the value indicated in the TEMA Standard.

4. FABRICATION

4.1. Plate Layout

4.1.1. Shell plates shall be laid out so that there will be a minimum of welded seams.

4.1.2. Longitudinal and circumferential welded seams shall not interfere with nozzle openings, reinforcement plates and saddle pads, as far as possible.

4.1.3. Longitudinal welded seams on adjacent shell segments shall be separated at least 4 times the wall thickness of the thickener plate but not less than 100 mm.

4.1.4. Longitudinal and circumferential welded seams shall be kept out of the internal welds insofar as practical.

4.2. Welding

4.2.1. As a rule, exchangers shall be welded by the fusion arc process. The electro gas or electro slag welding may be used.

4.2.2. Welders shall be qualified in accordance with the specified code or standard.

4.2.3. Pressure holding seams shall normally be full-penetration double-welded butt joints. Single welded butt joints which ensure full penetration may be used, where double welded butt joints are impractical.

4.2.4. Welding electrodes and wires shall have chemical compositions and mechanical properties equal to or of higher grade than the base material.

1 4.2.5. Stainless steel welding and dissimilar welding of stainless to carbon or low alloy steels shall be carried out conforming to Vessel Standard.

4.2.6. Welding procedures shall be selected to minimize the residual stress insofar as practical.

4.2.7. Preheating shall be carried out for carbon and low alloy steel welding as required. Preheating temperature shall be kept uniform from the start to the end of welding.

4.3. Heat Treatment

1 4.3.1. Preheating of welds shall be in accordance with the ASME Code, Section VIII, Division 1, Non-mandatory Appendix "R".

4.3.2. Post-weld heat treatment for enhanced steels shall be carried out at a temperature not exceeding the tempering temperature.

4.3.3. Heat treatment shall be carried out after completion of welding for low temperature exchangers made of Al-killed or 3 1/2 Ni steels.

4.3.4. Stress relief heat treatment shall be carried out for units which are installed in environment of stress corrosion cracking or units which undergo extensive cold working.

5. INSPECTION AND TESTS

1 All heat exchangers shall be inspected and tested in accordance with Engineering Specification ED-00-VS-SPC-E_D202., "Inspection & Tests of Vessels & Heat Exchangers", and the applicable Codes and/or Standards. Inspection and test reports shall be prepared in the manufacturer's form, not in the ASME Code form.

The document approval and inspection shall be done by the Inspection Authority in accordance with Codes and/or Regulations. The third party inspection shall not be required.

6. MARKING, PAINTING AND SHIPPING

6.1. Nameplate

6.1.1. A nameplate as shown in Vessel Standards shall be mounted on each exchanger.

6.1.2. Location of nameplates shall be as indicated in the drawings.

6.2. Painting

1 6.2.1. Unless otherwise specified, external surfaces of heat exchangers shall be shop painted in accordance with Engineering Specification, ED-00-CST-SPC-E0006 "Construction Specification for Painting Work"

6.2.2. All flange faces and other machined surfaces shall be coated with a readily removable rust preventive paint.

6.2.3. Weld bevels on the ends of carbon steel and low alloy steel nozzles which are to be welded to pipes at site shall be coated on the inside and outside for a distance of 75 mm from the end of the nozzle with Deoxaluminite, Taseto Silver or equivalent.

6.3. Shipping