KLM Technology Group
#03-12 Block Aronia,
Jalan Sri Perkasa 2
Taman Tampoi Utama
81200 Johor Bahru
Malaysia

PRESSURE VESSELS

(PROJECT STANDARDS AND SPECIFICATIONS)

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SCOPE

This Project Standard and Specification covers requirements governing the design, fabrication, and inspection of unfired pressure vessels, including all waste heat boilers. Small commercial vessels which are not part of process equipment such as sandblast machines, paint sprayers and gunite machines shall be per manufacturer's standards.

REFERENCES

Throughout this Standard the following dated and undated standards/codes are referred to. These referenced documents shall, to the extent specified herein, form a part of this standard. For dated references, the edition cited applies. The applicability of changes in dated references that occur after the cited date shall be mutually agreed upon by the Company and the Vendor. For undated references, the latest edition of the referenced documents (including any supplements and amendments) applies.

1. American society of Mechanical Engineers (ASME)/ American National Standards Institute (ANSI)

B16.5	Pipe Flanges and Flanged Fittings
ASME Codes	Section I: Power Boilers
	Section VIII Pressure Vessels, Alternative Rules, Division 2
ASME Publication	Pressure Vessel and Piping: Design and Analysis, Vol. II ASME Copyright 1972 "Stresses in Large Horizontal Pressure Vessels"

2. American Petroleum Institute (API)

601	Metallic Gaskets for Raised-Face Pipe Flanges and Flanged Connections (Double-Jacketed Corrugated and Spiral-Wound)
605	Large-Diameter Carbon Steel Flanges

3. American Society for Testing and Materials (ASTM)

A193/A193M	Alloy-Steel and Stainless Steel Bolting Materials for High–Temperature Service
A194/A194M	Carbon and Alloy Steel Nuts for Bolts for High–Pressure and High–Temperature Service
A320/A320M	Alloy Steel Bolting Materials for Low–Temperature Service
A453/A453M	Specification for Bolting Materials, High Temperature, 50 to 85 KSI Yield Strength with Expansion Coefficient Comparable to Austenitic Steel

D2000	Rubber Products in Automotive Applications
E21	Elevated Temperature Tension Tests of Metallic Materials
F436/F436M	Hardened Steel Washers

4. ANSI/AWS Specifications

A5.1	Covered Carbon Steel Arc Welding Electrodes
A5.17	Carbon Steel Electrodes and Fluxes for Submerged Arc Welding
A5.18	Carbon Steel Filler Metals for Gas Shielded Arc Welding

5. MSS (Manufacturers Standardization Society)

SP-44	Steel Pipe Line Flanges

6. NACE (National Association of Corrosion Engineer)

TM-01-77	Testing of Metals for Resistance to Sulfide Stress Cracking at Ambient Temperatures
TM-02-84	Evaluation of Pipeline Steels for Resistance to Stepwise Cracking

DEFINITIONS AND TERMINOLOGY

Average stress and minimum stress - stresses determined from published or manufacturer's data on the subject material.

Guaranteed tensile strength - the minimum tensile strength for the base material, deposited weld metal and weldments, as guaranteed by the vessel fabricator.

Guaranteed yield strength - the minimum yield strength (0.2% offset) for the base material, deposited weld metal and weldments, as guaranteed by the vessel fabricator.

High strength materials - those materials having a minimum yield strength at room temperature greater than 70,000 psi (485 MPa).

Vessel thickness - the thickness required for strength of the pressure vessel shell, including corrosion allowance, but excluding weld overlay, lining, integral cladding or non-integral parts.

DOCUMENTATION

An outline drawing shall be furnished for each vessel. Location of the vessel marking nameplate shall be indicated on this drawing.

A manufacturer's data report shall be furnished, and shall contain the same information as required by form U-1 of the ASME Code Section VIII Division 1. If the vessel is constructed for use at a location where the ASME Code is not mandatory, it shall be noted on the form that the vessel does not carry an ASME code symbol.

Material strength properties, specified or guaranteed, shall be included, and shall represent the properties in the as-fabricated condition. The data report shall be signed by the Manufacturer, by an Authorized Inspector as defined in par. UG-91 of the ASME Code, and as otherwise required by the applicable code. Other documentation (code papers, etc.) covering the construction of vessels built to the code of another nation shall be signed by the Manufacturer and where applicable by others having authority to sign such documentation.

Six signed copies of data reports and other required documentation shall be submitted to the Inspector prior to shipment of the vessel.

Fabrication drawings shall show weld details and reference applicable welding procedures. The drawings shall also include impact test requirements, showing (as applicable):

- Component
- Thickness for impact purposes
- Material specification
- Critical Exposure Temperature
- Appropriate Charpy impact requirements (average/minimum values)

Welding and weld repair procedures shall be submitted to the purchaser for review prior to start of fabrication.

MATERIALS

1. Materials shall be per ASME Code Section VIII. Proposals to use any other materials shall be submitted to purchaser for approval by Owner's Engineer.
2. Material production shall be by the electric furnace, basic oxygen, or open hearth processes.

3. Proposals to use materials having a specified maximum tensile strength greater than 90,000 psi (620 MPa) at room temperature shall be submitted to purchaser for approval by the Owner's Engineer.
4. For vessels in hydrogen service, external welded attachments, and at least an 18 in. (450 mm) course of all skirts, shall be of the same nominal chemistry as the materials used for the vessel.

DESIGN

Design Requirements

All vessels, except spheres, operating above 1 psig (7.0 kPa) shall have a minimum design pressure of 16 psig (110 kPa).
Vessels for vacuum service, including those in which a vacuum may be created inadvertently, shall be designed for an external pressure differential of 15 psi (103 kPa) or an external pressure differential 25% greater than the maximum design value, whichever is less.
Thickness is defined as the thickness "as ordered", provided the plates actually supplied meet the ASTM tolerances on thickness (weight). Vessel pressure components or sections which are greater than 2 in. (50 mm) in thickness shall meet the
Weld overlay, lining, integral cladding, non-integral parts, flat closures, tubesheets, flanges, nozzle/manway reinforcing pads; and areas of reinforcement or over-thickness provided for plate thinning during forming or scale losses during heating, up to 12% in excess of the specified thickness

Design Loads

Loadings to be considered in designing a vessel shall be per the ASME Code Section VIII and shall include cyclic conditions and erection loadings.
Vessels containing circulating suspensions of solids in fluids (fluid-solids processes) shall be subjected to additional horizontal loadings.
During erection, start-up, or operation, all applicable loads shall be considered as acting simultaneously, including either wind or earthquake, whichever governs.
During hydrostatic testing, wind load (wind pressure) equivalent to a 35 mph (16 m/s) wind speed shall be considered acting simultaneously with the hydrostatic test load.

Allowable Stresses

1. The maximum allowable stress in tension shall be either of the following:
   a. As specified in the applicable code.
   b. The lowest of the following values, using either the material's specified minimum or guaranteed strength properties:
      - 1/3 of the tensile strength at room or design temperature, whichever strength is lower
      - 2/3 of the yield strength at room or design temperature, whichever strength is lower
      - The average stress to cause 1% creep in 100,000 hours
      - 2/3 of the average, or 80% of the minimum, stress required to cause rupture in 100,000 hours whichever is lower
2. Longitudinal stresses. The maximum allowable stress in compression shall not exceed the following:
   a. The maximum allowable stress in tension.
   b. The compressive strength determined using procedures in the ASME Code Section VIII Division 1, par. UG23(b)(2).
3. Vessel supporting skirts. Allowable tensile and compressive stress basis for vessels shall also apply to vessel supporting skirts.
4. Earthquake-induced stresses, in combination with stresses arising from other loadings, shall be limited to the following values:
   a. The tensile stress shall neither exceed the yield strength of the material at the design temperature, nor 1-1/2 times the maximum allowable stress in tension.
   b. The compressive stress shall not exceed the maximum allowable compressive strength