PIP VESSM001
Specification for Small Pressure Vessels and Heat Exchangers with Limited Design Conditions
PURPOSE AND USE OF PROCESS INDUSTRY PRACTICES

In an effort to minimize the cost of process industry facilities, this Practice has been prepared from the technical requirements in the existing standards of major industrial users, contractors, or standards organizations. By harmonizing these technical requirements into a single set of Practices, administrative, application, and engineering costs to both the purchaser and the manufacturer should be reduced. While this Practice is expected to incorporate the majority of requirements of most users, individual applications may involve requirements that will be appended to and take precedence over this Practice. Determinations concerning fitness for purpose and particular matters or application of the Practice to particular project or engineering situations should not be made solely on information contained in these materials. The use of trade names from time to time should not be viewed as an expression of preference but rather recognized as normal usage in the trade. Other brands having the same specifications are equally correct and may be substituted for those named. All Practices or guidelines are intended to be consistent with applicable laws and regulations including OSHA requirements. To the extent these Practices or guidelines should conflict with OSHA or other applicable laws or regulations, such laws or regulations must be followed. Consult an appropriate professional before applying or acting on any material contained in or suggested by the Practice.

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1. **Scope**

   This Practice provides general requirements for the design, materials, fabrication, examination, inspection, testing, certification and pressure relief of:

   a. Three classes of small pressure vessels as defined by size and MAWP in Table 1a or 1b.
   b. Heat exchangers with the limited design conditions shown in Table 1a or 1b of this Practice

   This Practice is applicable to:

   a. The standard, pre-designed pressure vessels and heat exchangers supplied as part of pre-engineered package units (e.g., refrigeration and air-compressor systems)
   b. “Off-the-shelf” vessels and exchangers
   c. Vessels (e.g., filters) or exchangers built from the Manufacturer’s standard parts

   For purposes of this Practice, it is understood that the term “vessel” includes heat exchangers.

   This Practice is not intended for the following:

   a. Vessel in “Lethal Service” (as defined in Section VIII, Division 1 of the ASME Boiler and Pressure Vessel Code (Code))
   b. Vessels for which design wall thickness is governed by loadings from wind pressure or earthquake forces
   c. Custom shell-and-tube heat exchangers outside the scope of Table 1a or 1b

2. **References**

   Applicable parts of the following Practices, industry codes and standards, and government regulations shall be considered an integral part of this Practice. The edition in effect on the date of contract award shall be used, except as otherwise noted. Short titles are used herein where appropriate.

   **2.1 Process Industry Practices (PIP)**

   - PIP VEDV1003 - *Documentation Requirements for Vessels, ASME Code Section VIII, Division 1 and 2*
   - PIP VEFV1100 - *Vessel/S&T Heat Exchanger Standard Details (US Customary Units)*
   - PIP VEFV1100M - *Vessel/S&T Heat Exchanger Standard Details (Metric Units)*
   - PIP VEFV1101 - *Vessel Nameplate Bracket*

   **2.2 Industry Codes and Standards**

   - American Society of Mechanical Engineers (ASME)
     - *ASME Boiler and Pressure Vessel Code*
     - Section VIII, Division 1 - *Pressure Vessels (Code)*
   - Standards of the Tubular Exchanger Manufacturers Association (TEMA)
2.3 Government Regulations

- US Department of Labor, Occupational Safety and Health Administration (OSHA)

3. Definitions

*Code:* The ASME Boiler and Pressure Vessel Code, Section VIII, Division 1 (or 2) and reference sections (e.g., Section II and Section IX) and any *Code* Cases permitted by the *User*. References to Division 2 are identified in braces {  }.

*construction:* An all-inclusive term comprising materials, design, fabrication, examination, inspection, testing, certification (i.e., *Code* stamp and Manufacturer’s Data Report), {Manufacturer’s Design Report}, and pressure relief. *Manufacturer:* The party who designs and constructs the vessels. In accordance with the *Code* definition, the Manufacturer is the party that possesses a valid Certificate of Authorization to manufacture pressure vessels with the ASME Mark.

*Owner:* The party who owns the facility wherein the vessel will be used. The owner is typically also the User.

*Purchase order:* Drawings, specifications, or service-specific data provided by the Purchaser for a vessel

*Purchaser:* The party who selects and specifies the mechanical design requirements (e.g., Vessel Drawing/Data Sheet {User’s Design Specification}), consistent with User criteria, for use by the Manufacturer. The Purchaser is also responsible for placing the purchase order for the vessel or vessel components. The Purchaser may also be the Owner, User, or the Owner’s or User’s Designated Agent (e.g., engineering contractor).

4. Requirements

4.1 General

4.1.1 This Practice may be used for a custom-designed vessel or exchanger if approved in writing by Purchaser.

4.1.2 The vessel or exchanger shall be constructed in accordance with:

a. The purchase order

b. This Practice

c. Purchaser’s data sheet, *PIP VEDV1003-D*. Purchaser shall provide the duty requirements for a heat exchanger in a separate specification such as the TEMA data sheet (Figure G-5.2).

d. *PIP VEFV1100* or *PIP VEFV1100M* for details

4.1.3 The Manufacturer shall be responsible for the construction of the vessel in accordance with this Practice. Mechanical design requirements provided in the purchase order shall not relieve Manufacturer of this responsibility.
4.1.4 The Manufacturer shall possess a valid ASME Certification mark with the “U” or “UM” designator.

4.1.5 All Code “U” or “UM”-stamped vessels should be registered with the National Board of Boiler and Pressure Vessel Inspectors (NB).

4.1.6 The Purchaser shall determine and specify the applicable local, county, state, and federal rules and regulations. This shall include, but is not limited to, the rules and standards established by EPA and OSHA, or equivalent national standards, if applicable.

4.1.7 Any differences between this Practice and laws or regulations of regulatory authorities shall be brought to the attention of Purchaser for resolution.

4.1.8 Purchaser shall have free access to those parts of the Manufacturer’s facility where the fabrication, examination, and testing of the vessel is being performed.

4.1.9 Documentation

4.1.9.1 Manufacturer’s Standard Vessels

1. Detailed fabrication drawings and certified design calculations are required if available.

2. Otherwise, certified outline drawings shall be provided if detailed drawings are not available for the following items:
   a. Vessels supplied as part of pre-engineered package units (e.g., air compressor and refrigeration systems, ION exchange systems, etc.)
   b. “Off-the-shelf” items
   c. Vessels fabricated from Manufacturer’s standard parts

3. Outline drawings shall be legible and shall contain all dimensional and other data necessary for complete assembly, installation, proper operation and maintenance of the vessel. The data shall include pressure bolting and gasket information.

4.1.9.2 Custom-Designed Vessels

1. Unless a release to proceed is obtained from Purchaser in writing, the drawings and calculations provided in accordance with this Section shall be reviewed by Purchaser before the start of fabrication.

2. Detailed assembly and working drawings and certified design calculations shall be provided.

3. Drawings shall be complete and shall include all relevant design, materials, fabrication, examination, and test requirements.

4. The drawings shall include the following special notes as applicable:
   a. For austenitic stainless steel vessels: “Chlorides or substances that contain chlorine that will decompose to form chlorides (e.g., coatings to prevent adhesion of weld spatter) shall not be applied to any part of the vessel.”
b. For stainless steel vessels: “Zinc-coated (galvanized or painted) components shall not be in contact (welded, bolted, or loose) with any alloy parts of the vessel.”

5. For all Code “U”-stamped vessels, a copy of the Manufacturer’s data report (Code Form U-1 or U-1A) shall be provided to Purchaser.

6. For all Code “UM”-stamped vessels, a copy of the Manufacturer’s certificate of compliance (Code Form U-3) shall be provided to Purchaser.

4.1.10 Alternative Design Proposals

4.1.10.1 A base proposal for construction of the vessel shall be provided in full compliance with the Purchaser’s request for quotation.

4.1.10.2 An alternative design proposal may also be submitted if considered a technical improvement, less costly and/or an improvement in the delivery schedule. The benefits shall be realized without losing capability or shortening the anticipated life of the vessel.

4.1.10.3 If submitted, an alternative design proposal:

   a. Shall be accompanied by the base proposal and be clearly noted as an alternative design proposal.

   b. Shall be fully and clearly described and substantiated by sketches or drawings.

   c. Shall include a list of any specific exceptions to the Purchaser’s request for quotation or this Practice.

   d. Shall clearly identify the anticipated benefit.

   e. Shall not be used unless approved in writing by the Purchaser.

4.2 Design

4.2.1 The vessel shall be designed in accordance with the requirements of Table 1a or 1b for the Vessel Class designated in the purchase order.

4.2.2 If the purchase order does not designate the Vessel Class, the Class shown in Table 1a or 1b that covers all of the design parameters and minimum construction requirements included in the purchase order shall be selected.

4.2.3 Plate coil type heat exchangers shall be designed in accordance with Table 1a or 1b, Class A without size limitations.

4.2.4 Vessels for which shock (thermal or mechanical) and/or cyclical loading is a controlling design requirement and vessels in highly hazardous chemical service as listed in OSHA 29 CFR 1910.119 Appendix A (e.g., ammonia) are not permitted to be designed in accordance with Table 1a or 1b, Class A.

4.2.5 Filter presses and plate-and-frame, spiral-plate, and spiral-tube heat exchangers shall be designed in accordance with Table 1a or 1b, Class C without size limitations.
4.2.6 The Purchaser shall determine the materials for the vessel and specify in the purchase order.

4.2.7 The construction standard for custom-designed tubular heat exchangers designed in accordance with Table 1a or 1b, Class B or C shall be in accordance with applicable requirements of the Standards of the Tubular Exchanger Manufacturers Association (TEMA), Class B.

4.2.8 The construction standard for Manufacturer’s standard exchangers, shall be in accordance with TEMA Standards as specified in the purchase order.

4.2.9 The minimum joint inspection requirements of Code paragraph UW-52 shall be met.

Table 1a – Design Requirements for Each Class of Vessels (US Customary Units)

<table>
<thead>
<tr>
<th>Vessel Class</th>
<th>Class A</th>
<th>Class B</th>
<th>Class C</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Maximum Size and MAWP</strong></td>
<td>6 inches ID and 300 psig</td>
<td>ASME Section VIII, Division 1, paragraph U-1(j)</td>
<td>24 inches OD and 300 psig</td>
</tr>
<tr>
<td><strong>Maximum External Design Pressure</strong></td>
<td></td>
<td>15 psi (Full Vacuum)</td>
<td></td>
</tr>
<tr>
<td><strong>Maximum Design Temperature</strong></td>
<td>650°F (See Section 4.3.3.2 for additional limitations.)</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Lowest MDMT</strong></td>
<td>Carbon Steel</td>
<td>Minus 20°F</td>
<td>Minus 155°F</td>
</tr>
<tr>
<td></td>
<td>Austenitic Stainless Steel, Copper, and Copper Alloy</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Construction Standard</strong></td>
<td>ASME Code Section VIII, Division 1</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>ASME Code Stamp</strong></td>
<td>Not Required But Optional</td>
<td>“U” or “UM” Stamp Required</td>
<td>“U” Stamp Required</td>
</tr>
</tbody>
</table>
Table 1b – Design Requirements for Each Class of Vessels (Metric Units)

<table>
<thead>
<tr>
<th>Vessel Class</th>
<th>Class A</th>
<th>Class B</th>
<th>Class C</th>
</tr>
</thead>
<tbody>
<tr>
<td>Maximum Size and MAWP</td>
<td>150 mm ID and 2.0 MPa</td>
<td>ASME Section VIII, Division 1, paragraph U-1(j)</td>
<td>600 mm OD and 2.0 MPa</td>
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<tr>
<td>Maximum External Design Pressure</td>
<td></td>
<td>100 kPa (Full Vacuum)</td>
<td></td>
</tr>
<tr>
<td>Maximum Design Temperature</td>
<td>345°C (See Section 4.3.3.2 for additional limitations.)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Carbon Steel</td>
<td></td>
<td>Minus 29°C</td>
<td></td>
</tr>
<tr>
<td>Austenitic Stainless Steel, Copper, and Copper Alloy</td>
<td></td>
<td>Minus 104°C</td>
<td></td>
</tr>
<tr>
<td>Construction Standard</td>
<td>ASME Code Section VIII, Division 1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>ASME Code Stamp</td>
<td>Not Required But Optional</td>
<td>“U” or “UM” Stamp Required</td>
<td>“U” Stamp Required</td>
</tr>
</tbody>
</table>

4.3 Materials

4.3.1 Materials of Construction

4.3.1.1 Materials of construction are limited to carbon steel and austenitic stainless steel, however tubing for heat exchangers may also be copper or copper alloy.

4.3.1.2 The use of other materials is outside the scope of the Practice.

4.3.1.3 Materials shall be specified by the Purchaser.

4.3.1.4 For austenitic stainless steel vessels, the carbon content shall not exceed 0.10%.

4.3.2 Swing Bolts

4.3.2.1 Swing bolts (eye bolts) shall be of one-piece construction without welding.

4.3.2.2 Hinge pins shall be solid (not rolled) and of the same material as the swing bolts.

4.3.3 Pressure-Resisting Bolting

4.3.3.1 Pressure-resisting bolting for Table 1a or 1b, Classes A (except as permitted in Section 4.3.3.2), B, and C vessels shall be either low- or high-alloy steel.
4.3.3.2 Carbon steel SA-307, Grade B bolting shall be permitted for Table 1a or 1b, Class A vessels only and shall be limited to nameplate temperatures from -29°C (-20°F) to +204°C (400°F), inclusive. Gaskets used with this type of bolting shall be self energized, elastomeric, vegetable fiber or mineral fiber with a maximum seating stress of 11.03 MPa (1600 psi).

4.4 Fabrication

4.4.1 Welding

4.4.1.1 Except as permitted in Section 4.4.1.2, all longitudinal and circumferential welded joints in pressure-resisting components (Code Categories A, B, and if used, butt-types C and D) shall be full penetration butt welds.

4.4.1.2 For vessels less than NPS 12 in non-corrosive service, welded joints attaching formed heads to shells may be any fillet-welded lap joint in accordance with Code Figure UW-13.1 and Code Table UW-12.

4.4.1.3 For vessels greater than NPS 12 or any vessel in corrosive or cyclic service, permanent weld-joint backing strips, including for butt welds with one plate edge offset [Code Figure UW-13.1, Sketch (i)], shall not be permitted.

4.4.2 Unattached (loose) liners shall not be permitted.

4.4.3 Gasket Seating Surfaces

4.4.3.1 All gasket seating surfaces shall be plane and true.

4.4.3.2 Gasket seating surfaces of fabricated flanges, fabricated lap rings, and bolted tube sheet joints (including pass-ribs) shall be machined after welding and other fabrication steps that can cause warpage or distortion from a plane and true surface. Surface finish of gasket seating surfaces shall be 3.2-6.4 μm (125-250 Ra).

4.4.4 Dimensional tolerances shall be in accordance with Manufacturer’s standard practice and the applicable requirements of the codes and standards specified in Section 4.2 and Table 1a or 1b.

4.4.5 Postweld Heat Treatment (PWHT)

4.4.5.1 Carbon steel vessels requiring PWHT for process reasons shall be Table 1a or 1b, Classes B and C.

4.4.5.2 The alternative PWHT requirements of Code Table UCS-56.1 shall not be permitted.

4.4.5.3 For austenitic stainless steel vessels, PWHT shall not be performed. See Code Paragraph UHA-32.

4.5 Painting

4.5.1 All required coatings shall be in accordance with the purchase order.

4.5.2 Only surfaces that are required by the purchase order to be painted and that will be inaccessible after assembly (e.g., mating surfaces between lap-joint flanges...
and associated nozzle necks, shells, lap rings, or stub ends, bolt holes, and welded joints) shall be painted before assembly and hydrostatic testing.

4.5.3 Except as specified in Section 4.5.2, vessel shall be painted after hydrostatic testing.

4.6 Manufacturer's Nameplates

4.6.1 Each vessel shall be provided with a nameplate made of austenitic stainless steel and attached by an austenitic stainless steel nameplate bracket in accordance with PIP VEFV1101.

4.6.2 Nameplates for Table 1a or 1b, Class A vessels shall include:

a. Maximum and minimum design temperatures and the coincident maximum allowable internal and external design pressures

b. Year built
c. Manufacturer’s name
d. Manufacturer’s serial number

4.6.3 Nameplates for Table 1a or 1b, Classes B and C vessels shall be in accordance with Code requirements.

4.7 Testing

All vessels shall be hydrostatically tested in accordance with the provisions of Code Paragraph UG-99(b). All water used to test austenitic stainless steel equipment shall have a maximum chloride content of 50 ppm.

4.8 Shipping Preparation

4.8.1 After completion of the hydrostatic test, the vessel interior shall be completely drained, thoroughly dried, and cleaned of foreign matter.

4.8.2 After completion of the hydrostatic test, if PWHT has been performed, the vessel shall have the following notice painted on two sides of the shell and insulation covering, if present, in 75 mm (3-inch) letters visible in the shipping position from grade:

POSTWELD HEAT TREATED – DO NOT BURN OR WELD

4.8.3 After completion of the hydrostatic test, vessels with nonmetallic linings shall have the following notice painted on two sides of the shell and insulation covering, if present, in 75 mm (3-inch) letters visible in the shipping position from grade:

LINED VESSEL – DO NOT BURN OR WELD

4.8.4 Preservation for shipment shall include the following:

4.8.4.1 After completion of cleaning and drying, all vessel openings shall be closed and sealed for shipment. Sufficient internal desiccant or a positive pressure inert internal atmosphere (e.g., nitrogen) shall be provided to maintain a dry internal atmosphere until the vessel is opened. If an inert internal atmosphere is used, provide a means to maintain a positive pressure until the vessel is opened.
4.8.4.2 All vessels using a positive pressure inert internal atmosphere shall have the following notice painted on the shell letters visible in the shipping position from grade. The same notice shall be stamped on stainless steel tags securely attached (wire or other means) to each flange or other opening. CAUTION - UNDER INERT ATMOSPHERE - DO NOT OPEN WITHOUT PROPER PRECAUTIONS

4.8.4.3 Bolted flanged joints, plugged couplings, and other connections specified in the purchase order to be provided with permanent blinds shall be shipped assembled if practicable.

4.8.5 For carbon and low-alloy steels, all exposed machined or threaded surfaces shall be cleaned with solvent and coated prior to shipment with a removable rust-preventative.

4.8.6 All flange faces other than those furnished with permanent blinds shall be covered with 12 mm (1/2 inch) thick wood no smaller than the flange outside diameter.

4.8.7 For shipping purposes, flange covers shall be secured with a minimum 25% of the total number of bolts, but not less than four.

4.8.8 Welding stub ends shall be provided with bevel protectors.