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Pressure Vessels

GP 05-01-01

Scope

- 1) [I] This Global Practice (GP) covers the design, fabrication, inspection, and testing of unfired pressure vessels, including all unfired steam generators and non-refrigerated carbon steel pressure storage spheres.
- 2) Additional requirements are found in [GP 09-02-01](#) for spheres, and in [GP 05-01-02](#) for vessels that meet any of the following special criteria:
 - a) Wall thickness is in excess of 2 in. (50 mm) and up to 6 in. (150 mm).
 - b) Material of construction is ferritic alloy steel (Cr-Mo, Mn-Mo, etc.).
 - c) Material of construction is Quenched and Tempered (Q&T) steel.
 - d) Material of construction has a specified yield strength that exceeds 52200 psi (360 MPa).
 - e) Vessel is in cyclic service.
- 3) [I] Small commercial vessels which are not part of process equipment (such as sandblast machines, paint sprayers, and gunite machines) are outside the scope of this practice.

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1. Required References

- 1) [R] This Global Practice requires design, fabrication, inspection, and testing of pressure vessels under the provisions of [ASME SEC VIII D1](#) or [ASME SEC VIII D2](#) and the additional requirements of this practice, except as permitted in Item (2) below.
- 2) [A] Alternatively, pressure vessels may be totally designed, fabricated, inspected, and tested under the provisions of a recognized code which is accepted by the authorities where the vessel is located and by the Owner's Engineer, plus the additional requirements of this practice. Where specific references to ASME requirements are made in this practice, the Owner's Engineer may authorize use of equivalent or more stringent provisions of the applicable recognized code.

1.1. Global Practices–ExxonMobil Engineering Practices

This Section lists the Practices, codes, standards, specifications, and publications that shall be used with this document. Unless otherwise specified herein, use the latest edition.

GP 03-16-01	Flanged Joints, Gaskets, and Bolting
GP 04-01-03	Design Loads for Structures
GP 04-06-01	Reinforced Concrete Foundations, Anchor Bolts and Grout
GP 05-03-01	Pressure Testing of Unfired Pressure Vessels
GP 18-07-01	Welding Procedures
GP 18-10-01	Additional Requirements for Materials
GP 20-01-01	Inspection of Equipment and Materials
GP 20-01-03	Quality Programs

1.2. ExxonMobil Data Sheets

[*] Complete only the Data Sheet for the specified system of units. Completion of both Data Sheets is required when specified by the Owner's Engineer.

ExxonMobil Data Sheets	Data Sheet Home Page
T050101C04	Pressure Vessels - Pressure Vessel Data - Customary Units
T050101M03	Pressure Vessels - Pressure Vessel Data - Metric Units

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2. Additional Requirements

[*] This section lists the additional Practices, codes, standards, specifications, and publications that shall be used with this document only where specified. Unless otherwise specified herein, use the latest edition.

2.1. Global Practices–ExxonMobil Engineering Practices

GP 03-18-01	Piping Fabrication Shop or Field
GP 04-01-04	Surge Vibration Design Loads
GP 04-14-01	Equipment Lifts by Cranes
GP 05-01-02	Additional Requirements for Special Criteria Pressure Vessels
GP 05-02-01	Internals for Towers, Drums, and Fixed Bed Reactors
GP 09-02-01	Additional Requirements for Pressure Storage Spheres
GP 18-04-01	Postweld Heat Treatment of Equipment Handling Alkaline Solutions
GP 18-12-01	Positive Material Identification
GP 19-01-01	Paint and Protective Coatings
GP 19-03-02	Refractory Linings for Pressure Vessels and Piping
GP 19-04-01	Glass Reinforced Plastic Tank Bottom Linings
GP 19-04-02	Natural and Synthetic Rubber Linings
GP 19-06-01	Facilities for Corrosion Monitoring in Process Equipment

2.2. API–American Petroleum Institute

API STD 620	Design and Construction of Large, Welded, Low-Pressure Storage Tanks
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2.3. ASME–American Society of Mechanical Engineers

ASME 2235	Use of Ultrasonic Examination in Lieu of Radiography Section I; Section VIII, Divisions 1 and 2; and Section XII (SUPP)
ASME B1.20.1	Pipe Threads, General Purpose (Inch)
ASME B16.5	Pipe Flanges and Flanged Fittings NPS 1/2 Through NPS 24 Metric/Inch Standard
ASME B16.20	Metallic Gaskets for Pipe Flanges Ring-Joint, Spiral-Wound, and Jacketed
ASME B16.47	Large Diameter Steel Flanges NPS 26 Through NPS 60

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ASME SEC I	BPVC Section I - Rules for Construction of Power Boilers
ASME SEC VIII D1	BPVC Section VIII - Rules for Construction of Pressure Vessels - Division 1
ASME SEC VIII D1 MA APP 2	Mandatory Appendix 2 Rules for Bolted Flange Connections with Ring Type Gaskets
ASME SEC VIII D2	BPVC Section VIII - Rules for Construction of Pressure Vessels - Division 2 Alternative Rules
Pressure Vessels and Piping, Stresses in Large Horizontal Pressure Vessels, Pressure Vessel and Piping: Design and Analysis, Vol. II: 1977.	

2.4. ASTM–American Society for Testing and Materials

ASTM F 436	Standard Specification for Hardened Steel Washers
ASTM F 436M	Standard Specification for Hardened Steel Washers (Metric)

2.5. BSI–British Standards Institute

BSI BS EN 13445	Unfired Pressure Vessels
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2.6. WRC–Welding Research Council

WRC BUL 107	Local Stresses in Spherical Cylindrical Shells Due to External Loadings
WRC BUL 297	Local Stresses in Cylindrical Shells Due to External Loading on Nozzles-Supplement to WRC Bulletin No. 107

3. Definitions

Term	[I] Description
hydrogen service	See GP 18-10-01 for definition.
MAWP	Maximum Allowable Working Pressure (MAWP) is the maximum allowable pressure at the design temperature in the corroded condition. MAWP is determined by calculation, using the actual thickness less the corrosion allowance, in accordance with ASME SEC VIII D1 , Paragraph UG-98.

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Term	[I] Description
vessel thickness	Vessel thickness is defined as the thickness required for strength of the pressure vessel shell, including corrosion allowance but excluding weld overlay, lining, integral cladding or non-integral parts.
wet H₂S service	See GP 18-10-01 for definition.

4. Proposals

- 1) Quotations shall be considered incomplete and shall be rejected if they lack the following:
 - a) Pressure part and major structural part material specifications.
 - b) The location of, and reason for, any local post-weld heat treatment (PWHT) and a description of the proposed procedure.
 - c) When applicable, the proposed method of alloy/clad lining material and general lining procedures (clad or weld overlay).
 - d) Identification of Subcontractors who will be forming and/or welding pressure parts, as well as Suppliers of nonstandard or custom made forgings.
- 2) Each Vendor shall submit to the Purchaser a base proposal for the specified equipment. The base proposal shall comply with the Request for Quotation (RFQ), the applicable project specifications, and the Global Practices. Conflicting requirements in these documents, if any, shall be resolved in writing by the parties prior to submission of the proposal. Technical and commercial questions shall be resolved between the Purchaser and the Vendor prior to award.
- 3) If significant savings or design improvements can be demonstrated, Vendors shall offer alternate proposals in addition to their base bid. A proposal that contains only an alternate bid shall not be considered.
- 4) The Vendor shall furnish all information requested in the RFQ and any accompanying documents. Descriptive literature, drawings, and additional written information necessary to permit a clear understanding of the equipment's design basis, construction, operation, and maintenance shall be furnished with the proposal.

5. Documentation

5.1. Drawings

- 1) An outline drawing shall be furnished for each vessel, and shall contain the data shown in the appropriate Data Sheet. The location of the vessel marking or nameplate, the size and orientation of all nozzles and connections, and the anchor bolt layout shall also be shown on this drawing.
- 2) A separate outline drawing for each vessel shall be furnished with appropriate markings to cross-reference each component (shell plates, heads, nozzles, flanges, forgings, skirt plates, etc.) to the applicable mill test certificates for the steels used in the construction.

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- 3) Fabrication drawings shall show weld details and shall reference applicable welding procedures. The drawings shall also include impact test requirements, showing (as applicable):
 - a) Component
 - b) Thickness for impact purposes
 - c) Material specification
 - d) Critical Exposure Temperature or Minimum Design Metal Temperature
 - e) Appropriate Charpy impact requirements (average/minimum values)
- 4) [A] Two copies of all required drawings made by the Fabricator shall be submitted for approval prior to the start of fabrication.

5.2. Data and Calculations

- 1) A Manufacturer's data report shall be furnished and shall contain the same information as required by form U-1 of [ASME SEC VIII D1](#). Certified material test reports shall be furnished, and they 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, or 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.
- 2) Six signed copies of data reports and other required documentation shall be submitted to the Inspector prior to shipment of the vessel.
- 3) [C] Welding, PWHT, and weld repair procedures shall be submitted to the Purchaser for review prior to the start of fabrication.
- 4) Two copies of design calculations (including lifting attachments and supports) made by the Fabricator shall be furnished prior to or along with submission of drawings for approval. When calculations are made using a computer, all input data, assumptions, computer program version used, and a summary of the results shall be furnished.
- 5) Fabrication—Upon completion of fabrication, the Fabricator shall supply the Purchaser with:
 - a) Copy of PWHT recording
 - b) Copy of hydrostatic test chart
 - c) Copy of NDE (RT, UT, MT, PT, WFMT, etc.) test records
 - d) Copy of Positive Material Identification (PMI) log
 - e) Copy of results of any required impact tests
 - f) Copy of completed Inspection and Test Plan (ITP).

When weld production test plates are required, the test results shall be forwarded to the Owner no later than 10 working days after the test plates are welded.

- 6) [*] When specified by the Owner's Engineer, the Vendor shall register all ASME Code stamped vessels with the National Board of Boiler and Pressure Vessel Inspectors in U.S. and Canadian locations.

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6. Materials

- 1) [S] [A] Proposals to use materials having a specified minimum tensile strength 90000 psi (620 MPa) or greater at room temperature shall be submitted to the Purchaser for approval by the Owner's Engineer.
- 2) [A] [R] External attachments and supports shall be as shown in Table 1. Proposals to use alternative materials shall be submitted to the Purchaser for approval by the Owner's Engineer.

Table 1: Materials for External Attachments and Supports

Vessel Material	Attachments and Support Material	
	Major Attachments ⁽¹⁾	Minor Attachments ⁽²⁾
Carbon steel	Carbon steel ⁽³⁾	Carbon steel
Other materials	Same material as shell	Same material as shell ⁽⁴⁾
Notes: (1) Attachments that are essential to the structural integrity of the vessel, including the top 18 in. (450 mm) of skirts, saddle wear plates, stiffening rings, and supports welded to pressure parts for platforms, piping, and equipment. (2) Includes items that are lightly loaded during operation, such as insulation clips, studs, lifting lugs, and davit clips. (3) For design temperatures over 650°F (343°C), structural quality steels, such as SA-36 and SA-283, shall not be welded to pressure parts. (4) [A] For design temperatures under 450°F (232°C), carbon steel may be welded to non-carbon steel pressure parts with approval by Owner's Engineer.		

- 3) [*] [R] The Owner shall identify any vessels in wet H₂S or HF acid service. These vessels shall be subject to additional requirements according to [GP 18-10-01](#).
- 4) [R] SA-36, SA-283, and other structural quality steel shall not be used for pressure containing parts.
- 5) [R] Castings shall not be used for pressure parts.

7. Design

7.1. Design Requirements

- 1) [*] [R] Unless otherwise specified, all vessels, except spheres designed to [API STD 620](#), operating above 1 psig (7.0 kPa), shall have a minimum design pressure of 16 psig (110 kPa).

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- 2) [*] The Owner's Engineer shall specify the design pressure and temperature, design liquid level (including fluidized and bulk solids), specific gravity, and/or design pressure at various elevations. The Manufacturer shall design the vessel for the specified design pressure, liquid level, and temperature.
- 3) [*] [R] All vessels shall be stamped for their MAWP at the design temperature unless otherwise specified by the Owner's Engineer. Nozzle reinforcement, cone-to-cylinder junction reinforcement, and saddle support designs shall not be limiting factors in determining the MAWP.
- 4) [S] [R] 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 percent greater than the maximum operating value, whichever is less.
- 5) [R] Jacketed vessels—Vessel and jacket shall be designed for the most severe condition of coincident pressure and temperature.
- 6) For purposes of determining the applicability of [GP 05-01-02](#), 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 Examination and Testing requirements of [GP 05-01-02](#). In addition, nozzle forgings for insertion into shell plates greater than 2 in. (50 mm) thick shall also meet the Nozzle and Connections design requirements of [GP 05-01-02](#).

Weld overlay, lining, integral cladding, non-integral parts, flat heads and closures, tubesheets, flanges, nozzle/manway reinforcing pads, areas of reinforcement, and areas of over-thickness up to 12 percent in excess of the specified thickness provided for plate thinning during forming or scale losses during heating, need not be considered in determining the applicability of [GP 05-01-02](#).

7.2. Design Loads

- 1) [A] [R] Loadings to be considered in designing a vessel shall be according to ASME SEC VIII and shall include cyclic conditions and erection loadings. If the vessel will be subjected to more than 1000 cycles in which the pressure range is greater than 80 percent of the design pressure, or where the temperature range is greater than 350°F (195°C), an assessment of the need for a fatigue analysis shall be conducted according to the [ASME SEC VIII D2](#), Par. AD-160, or with approval by the Owner's Engineer, according to the recognized code used for design and fabrication. If a fatigue analysis is required, then vessel is considered to be in cyclic service and is subject to additional requirements of [GP 05-01-02](#).
- 2) [R] Additional loadings—Vessels containing circulating suspensions of solids in fluids (fluid-solids processes) shall be subjected to additional horizontal loadings according to [GP 04-01-04](#).
- 3) [S] During erection, testing, startup, or operation, all applicable loads shall be considered as acting simultaneously, including either wind or earthquake, whichever governs. These loads include, but are not limited to:
 - a) Empty dead load of the vessel, attached piping and equipment.
 - b) Empty dead weight of the vessel, trays, insulation, internal attachments, ladder, platforms, and external piping.

See [GP 04-01-03](#) for additional loading requirements.

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