

# MSC Guidelines for Pressure Vessels

Procedure Number: E1-19

Revision Date: 02/16/2017

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## References:

- a. 46 CFR Part 54 – Pressure Vessels
  - b. ASME Boiler and Pressure Vessel Code (BPVC), Section VIII, Division 1, (1998 Edition)
  - c. [Navigation and Inspection Circular \(NVIC\) 10-81](#), “Coast Guard Certification and Inspection of Certain Categories or Existing Vessels”
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## Contact Information:

If you have any questions or comments concerning this document, please contact the Marine Safety Center (MSC) by e-mail or phone. Please refer to the Procedure Number: **E1-19**

E-mail: [msc@uscg.mil](mailto:msc@uscg.mil)

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## Responsibilities:

The submitter shall provide: design calculations, ASME Form U1-A, joint and reinforcement details, foundation and support details, a bill of materials and an arrangement diagram to indicate compliance with references (a) and (b).

The submission shall be made in triplicate. To facilitate plan review and project management, all plans and information specified in these guidelines should be submitted as one complete package through a single point of contact for the project.

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## General Guidance:

- Determine the pressure vessel *class* (I, II and III) which is based on the operating pressure and temperature and *service* (hazardous or non hazardous contents). The following sections list the general pressure vessel guidelines based on pressure vessel class and service.

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General Guidance  
(cont):

## **Class I, II, or III pressure vessels not containing hazardous materials (46 CFR 54.01-5(c)(3))**

- ❑ Pressure vessels of this class and service must be in accordance with reference (b). Pressure vessels shall be stamped with the Certification Mark with U Designator. (46CFR 54.01-5(c)(3))
- ❑ A corrosion allowance is required except when non corrosive pressure vessel materials are used or if an effective stress of 80% or less of the allowable stress is used in the thickness calculations. (46 CFR 54.01-35)
- ❑ Use of butt welded joint with one edge offset are limited to circumferential joints of Class II and Class III pressure vessels.
- ❑ Steels listed in UCS-6(b) and UCS-6(c) of the reference (b) are limited to Class III pressure vessels.
- ❑ Must be provided with a relief device meeting the requirements of 46 CFR 54.15 (requirements are listed in this guide).
- ❑ Welded pressure vessels must comply with the joint and radiography requirements listed in Table 54.01-5(b) (included in this guide).
- ❑ The Manufacturers Data Report (Form U1-A) and Professional Engineer (PE) certified plans and calculations must be provided to the USCG marine inspector prior to the installation inspection, testing and stamping. (46 CFR 54.01-5(e), 54.10-3, 54.10-20 & 54.10-25)

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## **Class II or III pressure vessels not containing hazardous materials and having a volume < 5 cubic feet (46 CFR 54.01-5(c)(4))**

- ❑ Pressure vessels of this class and service must be in accordance with reference (b); the pressure vessel must be stamped with the Certification Mark with applicable (U, UM) Designator.
- ❑ Compliance with other provisions of 46 CFR Part 54 is not required.
- ❑ These pressure vessels are exempt from shop inspection and plan approval per 46 CFR 54.01-15.
- ❑ Must be provided with a relief device meeting the requirements of 46 CFR 54.15. (requirements are listed in this guide)

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General Guidance  
(cont):

## **Class I, II, or III containing hazardous materials (46 CFR 54.01-5(c)(2))**

- ❑ Pressure vessels of this class and service must be designed and constructed in accordance with 46 CFR Part 54. Table 54.01-2(a) of 46 CFR Part 54 adopts and amends reference (b).
- ❑ PE certification of plans and calculations is NOT required for pressure vessels containing hazardous materials. The PE requirement under 46 CFR 54.01-5(e) applies to non-hazardous pressure vessels under 46 CFR 54.01-5(c)(3) and (4), and allows the Coast Guard to exempt them from plan approval and shop inspection requirements under 46 CFR 54.01-15
  - 1) Marine portable tanks, designed in accordance with 46 CFR Part 64, may be used for this CLASS and SERVICE subject to the following:
    - a. The tank must have been inspected and stamped prior to September 30, 1992
    - b. The tank capacity  $\geq$  110 gallons
    - c. The tank can be lifted when full or empty and can be filled and discharged on the vessel
    - d. The tank is not permanently attached to the vessel
  - 2) Portable tanks constructed after September 30, 1992 shall comply with 46 CFR 98.30.
- ❑ A corrosion allowance is required except when non-corrosive pressure vessel materials are used or if an effective stress of 80% or less of the allowable stress is used in the thickness calculations. (46 CFR 54.01-35)
- ❑ If subject to a partial vacuum (external pressure), the pressure vessel must be equipped with a vacuum breaker or designed to not less than one-half atmosphere of external pressure. (46 CFR 54.01-40)
- ❑ Must be provided with a relief device meeting the requirements of 46 CFR 54.15. (requirements are listed in this guide).
- ❑ Must meet be of the class and construction required by Subchapters D, I, O as appropriate for the vessel and for the cargo or contents of the pressure vessel. (46 CFR 54.20-2)
- ❑ Pressure vessels constructed by welding, including attachments for nozzles and other connections, shall be in accordance 46 CFR Subpart 54.20.
- ❑ If welded, meet the post-weld heat treatment and radiography requirements of 46 CFR Table 54.01-5(b).

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## General Guidance (cont):

- 1) Class I pressure vessels built of carbon and low alloy steels are required to have post-weld heat treatment per 46 CFR 54.25-7.
  - 2) Class I pressure vessels require full radiography on all butt joints.
  - 3) Class II, III pressure vessels require spot radiography on butt welds.
- ❑ Each butt weld of a class II or II pressure vessel type cargo tank must be radiographed for a distance of at least 10 times shell thickness from an intersection. (54.25-8(c))
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### **Additional requirements for Class I-L or II-L pressure vessels**

- ❑ Full radiography is required for Class I-L pressure vessels, regardless of shell thickness. Class II-L pressure vessels shall be spot radiographed.
  - ❑ Class I-L and II-L pressure vessels built of carbon and low alloy steels are required to have post-weld heat treatment per 46 CFR 54.25-7.
  - ❑ Requirements for heat-treated ferritic steels are contained in 46 CFR 54.25-20.
  - ❑ Toughness tests requirements for product materials and weldments for low temperature service are contained in 46 CFR 54.05.
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### **Pressure Vessels on Reflagged Vessels (See reference (c))**

- ❑ Pressure vessel other than those for low temperature service or those containing dangerous substances may be accepted primarily on the basis of design to an acceptable national standard, certification by a recognized classification society and successful operating experience.
  - ❑ Sufficient information must be submitted to establish MAWP, maximum and minimum operating temperatures and test pressure. The following must be provided:
    - 1) Plans showing arrangement, dimensions and materials specifications must be provided.
    - 2) Calculations verifying the design factor. The calculations must include a comparison to the ASME Boiler and Pressure Vessel code. Generally, pressure vessels with design factor < 3 (based on material ultimate strength) are not acceptable.
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## General Guidance (cont):

- 3) Documentation showing the pressure vessel was built to a code or standard that provides for design requirements and independent shop inspection with approval of design, welding procedures, welder performance, heat treatments and examinations.
- Loadings, corrosion allowance, external pressure design, stamping, relief devices, heat treatment and examination requirements shall be in accordance with reference (a).
  - Pressure testing shall be in accordance with 46 CFR 61.10
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**The following sections are general requirements that are referenced in the preceding sections of this guide.**

### **Shop Inspection**

- The following pressure vessels may be exempt from shop inspection and plan approval: (46 CFR 54.01-15)
    - (1) Vessels containing water in which the pressure  $\leq 100$  psig and temperature  $\leq 200^{\circ}\text{F}$ , including hydro pneumatic tanks. Note that air charging lines may be permanently attached provided air pressure  $\leq 15$  psig.
    - (2) Hot water tanks heated by steam or other indirect means having heat transfer  $< 58\text{kW}$  (200,000 BTU/Hr, water temperature  $< 200^{\circ}\text{F}$ , tank capacity  $< 120$  gallons, pressure  $< 100$  psig and a safety valve of at least 1-inch diameter set below the MAWP.
    - (3) Pressure vessels, excluding cargo tanks, with design pressure  $\leq 15$  psi, with no limitation on size.
    - (4) Class I, II, or III pressure vessels not containing hazardous materials and stamped with the Certification Mark with U Designator. (46 CFR 54.01-5(c)(3))
    - (5) Class II or III pressure vessels not containing hazardous materials, having a volume  $< 5\text{ ft}^3$  and stamped with the Certification Mark with applicable (U, UM) Designator. (46 CFR 54.01-5(c)(4))
    - (6) Condensers and heat exchangers having a liquid phase  $< 100$  psig and  $< 200^{\circ}\text{F}$ ; and, vapor phase  $< 15$  psi.
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General Guidance  
(cont):

## **Corrosion allowance**

- A corrosion allowance is required in accordance with the following:
  - 1) A corrosion allowance of 1/6 of the calculated thickness or 1/16 inch, whichever is smaller, is required
  - 2) For corrosive materials, additional allowance may be required (based on previous experience)
  - 3) An allowance is not required for corrosion resistant materials
  - 4) An allowance is not required if an effective stress of 80% or less of the allowable stress is used in the thickness calculations
  - 5) Paint and coatings are not an acceptable substitute for a corrosion allowance.

## **Relief valves and devices**

- Relief valves/devices are required on pressure vessels, including evaporators and heat exchangers. The relief valves shall meet the following requirements:
  - 1) The device on an unfired pressure, other than an unfired steam boiler, vessel must prevent a pressure increase > 10% above MAWP. The device on a fired pressure vessel or vessel subject to pressure increase due to heat must prevent pressure increase > 20% above MAWP. (46 CFR 54.15-5(b))
  - 2) Relief valves for use on compressed or flammable gas pressure vessels shall be USCG Type Approved and have relieving capacity noted in 54.15-25. (46 CFR 54.15-5(d))
  - 3) Pressure vessels filled with liquid shall be provided with liquid pressure relief valves. (46 CFR 54.15-10(h))
  - 4) The relief valve shall be installed directly on the pressure vessel unless source of pressure is external to the pressure vessel and can be directly controlled. (46 CFR 54.15-10(i))
  - 5) Materials of construction shall be suitable for the pressure, temperature and intended service. (46 CFR 4.15-10(j))

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## General Guidance (cont):

- i. Cast iron valve bodies are acceptable for pressures < 125 psi and temperatures < 450 F. Cast iron seats and disk are prohibited. (46 CFR 54.15-10(f))
- The openings in the pressure vessel must provide direct and unobstructed flow to the relief valve. An intermediate stop valve is prohibited. (46 CFR 4.15-10(k))
- Safety valves for steam service must meet the following requirements:
  - 1) Equipped with a huddling chamber
  - 2) Valve bodies for pressures < 30 psi may be of cast iron
  - 3) Meet the additional requirements listed in 46 CFR 52.01-120.
- Pilot operated relief valves are not acceptable unless the main valve will relieve at the preset pressure if the pilot valve fails. (46 CFR 54.15-10(b))
- Safety and relief valves for steam or air service shall be provided with a lifting device operable at 75% of valve set pressure. (46 CFR 54.15-10(c))
- Relief valve settings shall not be reset to a pressure greater than 10% above or below the pressure noted on the valve (for pressures ≤ 250 psi) or 5% above or below the pressure noted on the valve (for pressures > 250 psi)
- Rated relieving capacity based on flow test data and shall be certified by the manufacturer as follows:
  - 1) 120% of valve set pressure for valves rated in accordance with Compressed Gas Association Standard (CGA) S-1.2
  - 2) 110% of set pressure for valves rated in accordance with UG-131 of ASME BPVC
  - 3) 103% of set pressure for steam valves rated in accordance with PG-69 ASME BPVC.
- A relief disc may be used in series with a relief or safety valve in accordance with UG-127 of reference (b). Where pressure vessel contents may render a relief valve inoperative, the relief disc may be used in lieu of the relief valve, subject to the following:
  - 1) Complies with the general safety device requirements of 46 CFR 54.15

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## General Guidance (cont):

- 2) Has sufficient relieving capacity to prevent the pressure from exceeding 120% MAWP
  - 3) Operates at a pressure which does not fatigue the disc. (1.3 times normal operating pressure < disc burst pressure)
  - 4) Be positioned such that disc failure is directed away from personnel and vital machinery
- ❑ An evaporator operating at less than 15 psi may be fitted with a rupture disc in lieu of a relief valve. An evaporator vent valves shall not be less than 1.5 inches in diameter (46 CFR 54.15-15(a))
  - ❑ The relieving capacity for an evaporator relief valve shall be at least that of the steam supply to the evaporator. (46 CFR 54.15-15(c))

### **Design Loadings**

- ❑ Loadings must be evaluated in accordance with UG-22 of reference (b). Loading imposed by the vessel's attitude including roll, list, pitch and trim should be addressed. (46 CFR 54.01-30)

### **External Pressure Design**

- ❑ Pressure vessels designed to operate under external pressure shall comply with 46 CFR 54.01-40). If subjected to partial vacuum, a vacuum breaker shall be provided or the pressure vessel shall be designed for an external pressure not less than 1/2 atmospheres.

### **Material Restrictions**

Steels listed in UCS-6(b) and UCS-6(c) of the ASME Code will be allowed only in Class III pressure vessels (46 CFR 54.25-3).

### **Mechanical Stress Relief**

- ❑ Post weld heat treatment shall be in accordance with 46 CFR Table 54.01-5(b).
- ❑ Mechanical stress relief may be used for Class II-L pressure vessels. Additional requirements and limitations are contained in 46 CFR 54.30-5

### **Fabrication by Welding**

- ❑ Minimum joint requirements are specified in Table 54.01-5(b).



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## General Guidance (cont):

- ❑ Pressure vessels fabricated by welding shall comply with reference (b), sections UW-1 through UW-65 except as noted in 46 CFR 54.20-3
- ❑ Nozzle attachments shall be in accordance with BPVC section UW-16. When welded from one side, backing strips are required unless full *penetration welds can achieved*.
- ❑ An offset butt welded joint is limited to the circumferential joint of Class II and Class III pressure vessels.
- ❑ Joints in Class II or III cargo tanks must meet the following :
  - 1) Category A and B joints must be type (1) or (2) joints
  - 2) Category C and D joints must have full penetration welds extending through the entire thickness of the vessel or nozzle wall.
- ❑ General welding requirements, procedures, performance qualification and production testing shall be in accordance with 46 CFR Part 57. These issues are addressed to the satisfaction of the OCMI.
- ❑ Pressure vessels fabricated by brazing shall comply with 46 CFR Subpart 54.23-1.

## **Pressure Testing**

- ❑ Pressure vessel hydrostatic or pneumatic tests vary based on the edition of the code applied in the design: (46 CFR 54.10-10 & 15)
  - 1) Pre -2001: hydrostatic test to 1.5 MAWP. Pneumatic test may be used if a pressure vessel cannot be filled with water; pneumatic test to 1.25 MAWP.
- ❑ Post – 2001: hydrostatic test to 1.3 MAWP. Pneumatic test may be used if a pressure vessel cannot be filled with water; pneumatic test to 1.1 MAWP.

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## Disclaimer

This guidance is not a substitute for applicable legal requirements, nor is it itself a rule. It is not intended to nor does it impose legally-binding requirements on any party. It represents the Coast Guard's current thinking on this topic and may assist industry, mariners, the general public, and the Coast Guard, as well as other federal and state regulators, in applying statutory and regulatory requirements. You can use an alternative approach for complying with these requirements if the approach satisfies the requirements of the applicable statutes and regulations. If you want to discuss an alternative, you may contact the Marine Safety Center, the unit responsible for implementing this guidance.

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