MSC Guidelines for Review of Pressure Vessels

Procedure Number: E1-19 Revision Date: 01/28/00

References

a. 46 CFR Part 54 – Pressure Vessels

b. 46 CFR Part 56 – Piping Systems

c. MTN 01-94, Acceptance Criteria for Pressure Vessels on Reflagged Ships

Disclaimer

These guidelines were developed by the Marine Safety Center staff as an aid in the preparation and review of vessel plans and submissions. They were developed to supplement existing guidance. They are not intended to substitute or replace laws, regulations, or other official Coast Guard policy documents. The responsibility to demonstrate compliance with all applicable laws and regulations still rests with the plan submitter. The Coast Guard and the U. S. Department of Homeland Security expressly disclaim liability resulting from the use of this document.

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General Review Guidance

Pressure Vessels

- Determine Class of pressure vessel and applicable requirements. See Table 54.01-5(a) and Table 54.01-5(b) (Attachment 1).
- On foreign "reflagged" vessels, see requirements in Attachment 2.

Table 54.01-5(b) – Pressure Vessel Classification

Class	Service Contents	Limits on Pressure/Temperature	Additional Requirements
I	Vapor or gas	> 600 psig/ or > 700°F	
	Liquid	> 600 psig/ or > 400°F	
	Hazardous Materials	> 600 psig/or > 400°F	§54.20-2
I-L (Low temp)	Vapor or gas	> 250 psig/ and < 0°F	
	Liquid	> 250 psig/ and < 0°F	
	Hazardous Materials	> 250 psig/ and < 0°F	§54.20-2
II	Vapor or gas	30 through 600 psig/ or 250°F through 400°F	
	Liquid	200 through 600 psig/ or 275°F through 700°F	
	Hazardous Materials	200 through 600 psig/ or 275°F through 700°F	§54.20-2; §54.25-8(c); §54.25-10(d); §54.20-3 (c) and (f)
II-L (Low temp)	Vapor or gas	0 through 250 psig/ and < 0°F	
	Liquid	0 through 250 psig/ and < 0°F	
	Hazardous Materials	0 through 250 psig/ and < 0°F	§54.20-2
III	Vapor or gas	< 30 psig/ and 0°F through 250°F	
	Liquid	< 200 psig/ and 0°F through 250°F	
	Hazardous Materials	< 200 psig/ and 0°F through 250°F	§54.20-2; §54.25-8(c); §54.25-10(d); §54.20-3 (c) and (f)

Table 54.01-5(a) Applicable Regulation Reference for Pressure Vessels

Service/ Temperature/Pressure	**Design Requirements**
Unfired Steam Boiler (<30 psig and < 850 ºF)	Part 54
Evaporators and heat Exchangers (> 15 psig)	Part 54
Unfired Hot Water/Heating Boiler (> 15psig)	Part 54
Pressure Vessels for Human Occupancy	Part 197 (Subpart B)
Pressure Vessels for Hazardous Material	§54.20-2

MSC Guidelines for Review of Pressure Vessels

Procedure Number: E1-19 Revision Date: 01/28/00

Miscellaneous Requirements

46 CFR Part 54

- Acceptance Criteria [46 CFR Part 54]
  - Exemptions from shop inspection and plan approval per §54.01-15.
    - Vessels containing water (<=100 psig and <= 200ºF)
      - May contain air "cushion."
      - Air charging lines may be used if (< 15 psig)
    - Hot water tanks heated by steam or other indirect means if the following is met:
      - (<= 200,000 BTU/HR)
      - Water temperature (<= 200ºF)
      - Tank capacity (<= 120 gallons)
      - Pressure (<= 100 psig)
      - A safety valve of at least 1-inch diameter set below the MAWP.
    - Vessels (<= 15 psig) with no limitation on size.
      - This does not include cargo tanks.
    - Class I, II, or III pressure vessels meeting §54.01-5(c)3 and (c)4
    - Condensers and heat exchangers if:
      - Liquid is (<=100psig and <= 200 ºF)
      - Vapor is (<= 15 psig)
  - Pressure Testing
    - All pressure vessels shall pass a hydrostatic test to 1 ½ times the MAWP per §54.10-10
    - Pneumatic testing may be used if a pressure vessel cannot be filled with water. This test shall follow the procedure outlined in §54.10-15 to a test pressure of 1 ¼ times the MAWP.
  - Pressure-Relief Devices
    - All pressure vessels built to ASME Code Section VIII Div. 1 shall have pressure relief devices complying with (UG-125 through UG-136) as modified by Subpart 54.15.
  - For pressure vessels requiring plan approval, the submittal requirements of §54.01-18 shall be met.
  - Pressure Vessels for Human Occupancy
    - Shall meet the requirements of Part 197 Subchapter B per §54.01-17.

- Acceptance Criteria [46 CFR Part 54]
  - Miscellaneous pressure components shall be as required by UG-11 of the ASME Code except:
    - All pressure components conforming to an accepted ANSI standard shall be marked according to the Manufacturers 'Standardization Society SP-25 per §54.01-25.

MSC Guidelines for Review of Pressure Vessels

Procedure Number: E1-19 Revision Date: 01/28/00

- Pressure vessels fabricated by welding shall comply with UW-1 through UW-65 except where noted in Subchapter F per §54.20-1.
  - Additional welding design details are contained in §54.20-3.
  - Welding qualification and production tests shall comply with §54.20-5.
- Pressure vessels fabricated by brazing shall comply with Subpart 54.23.
- Fabrication for Hazardous Material Pressure Vessels (§54.20-2)
  - Hazardous materials are defined in §150.115.
  - Pressure vessels with hazardous materials shall meet subchapter D, I, O, or when not specified a class determined by Commandant.
  - Class III pressure vessels may not be used for stowage of hazardous material unless authorized by subchapters D, I, or O.
- Loadings (§54.01-30)
  - Shall comply with UG-22 of the ASME Code. However, the following additional cases may be required:
    - Loading imposed by a vessels attitude in roll, list, pitch, and trim.
    - Dynamic forces due to a ships motion.
- Corrosion (§54.01-35)
  - Shall generally comply with UG-25 of the ASME Code except:
    - Pressure portions of the pressure vessel shall have a corrosion allowance of 1/6 of the calculated thickness or 1/16 of an inch.
  - Be specifically evaluated in cases of unusually corrosive cargoes.
  - Are not required for corrosion resistant materials.
  - Are not required if the effective stress is 80% or less than the allowable stress values in ASME Section VIII
  - The Commandant may grant exemptions to corrosion allowances

MSC Guidelines for Review of Pressure Vessels (continued)

General Review Procedure

- External Pressure Design (§54.01-40)
  - Shall meet the requirements of UG-28 except UG-28(f) does not apply (exemption from external pressure considerations).
  - If subjected to partial vacuum, a vacuum breaker shall be used or design for not less than ½ atmosphere of external pressure.
- Materials listed for construction with carbon, alloy, and heat treated steels.
  - Steels listed in UCS-6(b) and UCS-6(c) of the ASME Code will be allowed only in Class III pressure vessels per §54.25-3.
- Mechanical Stress Relief (Subpart 54.30)
  - For pressure vessels requiring stress relief is shown in Appendix A.
  - For large pressure vessels thermal stress relief may not be possible.
  - Mechanical stress relief may be used for Class II-L pressure vessels.
    - Add'l requirements and limitations are contained in §54.30-5(a)
  - Weld joint efficiencies listed in UW-12 of the ASME Code apply, however, spot radiography is required per §54.30-3(c).
  - Methods for performing the stress relief are contained in §54.30-10.
    - Additional criteria are in §54.30-5(b).
  - Analysis requirements are contained in §54.30-15.
  - Severe cold forming is only permitted if thermal stress relief is used per 54.30(d).

➢ Acceptance Criteria [46 CFR Part 57]
- Welding and Brazing (§54.01-40)
  - Shall meet the requirements of Part 57.
  - This information is usually submitted to the OCMI.
- Marking and stamping shall comply with §54.10-20.

46 CFR Part 54

Class I, II, or III Not Containing Hazardous Materials

➢ Acceptance Criteria [46 CFR Part 54.01-5]
- Detailed plans shall have the information required in §54.01-18. Plans and calculations must be certified by a registered Professional Engineer as meeting §54.01-5(d) and Section VIII, Division 1 of the ASME Code.
- **The plans shall be made available to the Coast Guard prior to inspection per §54.10-3(c). Plan approval is not required by the MSC.**
- Pressure vessels shall be stamped with the ASME "U" symbol.

- Are exempt from shop inspection and plan approval per §54.01-15.

MSC Guidelines for Review of Pressure Vessels (continued)

General Review Procedure

- Acceptance Criteria [46 CFR Part 54.01-5]
  - Pressure relief devices shall comply with Subpart 54.15.
  - If welded meet the post weld heat treatment and radiography requirements of Table 54.01-5(b).
    - Class I, I-L, II-L vessels built of carbon and low alloy steels are required to have postweld heat treatment per §54.25-7.
    - Class I, I-L vessels require full radiography.
    - Class II-l vessels shall be spot radiographed.
    - Butt welds in Class II, III pressure vessels shall be spot radiographed
  - If a pressure vessel has more than one independent chamber:
    - If each chamber has separate classifications, each chamber shall meet the classification requirements.
    - If a single classification for the pressure vessel, the classification selected shall meet all applicable regulations per §54.01-5(f).
    - The design pressure for each interface between chambers shall be maximum allowable working pressure in the chamber with the highest pressure per §54.01-5(g).

- Acceptance Criteria [46 CFR Part 54.01-5]
  - Corrosion protection shall comply with §54.01-35.
  - A butt welded joint with one edge offset may only be used for circumferential joints of Class II and Class III pressure vessels per §54.20-3(c).
  - Steels listed in UCS-6(b) and UCS-6(c) of the ASME Code will be allowed only in Class III pressure vessels per §54.25-5.
  - If welded meet the post weld heat treatment and radiography requirements of Table 54.01-5(b).
  - Steam generating pressure vessels shall meet §54.01-10.
    - Unfired Steam Boilers must be fitted with an efficient water level indicator, pressure gauge, and blowdown valve in addition to a safety valve.
    - Evaporators and heat exchangers are not classified as unfired steam boilers. They shall be fitted with safety devices required by §54.15-15.
    - Shall be constructed to Part 54 if (< 30 psig and < 850 ºF)
    - Shall be constructed to Part 52 if (> 30 psig and > 850 ºF)

MSC Guidelines for Review of Pressure Vessels (continued)

General Review Procedure

- "Evaporators" or "Heat Exchangers" are not classified as unfired boilers.
  - Shall be fitted with safety devices per §54.15-15.
  - An evaporator where steam is generated shall have a water level indicator, pressure gauge, and blowdown valve.

- Acceptance Criteria [46 CFR Part 54.01-5]
  - Meet the inspection requirements of §54.10-3.
  - Meet marking and stamping requirements of §54.10-20.
  - Manufacturer data reports shall meet the requirements of §54.10-25.

46 CFR Part 54

Class II or III Pressure Vessels (< 5 cubic feet volume) and do not Contain Hazardous Materials

- Acceptance Criteria [46 CFR Part 53]
  - These pressure vessels must be stamped with either the ASME "U" or "UM" symbol. Compliance with other provisions of Part 54 is not required.
  - Are exempt from shop inspection and plan approval per §54.01-15.

46 CFR Part 54

Class I-L or II-L Pressure Vessels

- Acceptance Criteria [46 CFR Part 54.03]
  - Pressure vessels for low temperature operation shall be as required by section VIII of the ASME Code with the following exceptions:
    - Requirements for ferritic steels are contained in §54.25-10.
    - Requirements for high alloy steels are contained in §54.25-15.
    - Requirements for heat treated ferritic steals are contained in §54.25-20.
  - Requirements of toughness tests of product materials and weldments is contained in subpart 54.05.
  - Materials suitable for a given minimum service temperature may be used for warmer service per §54.03-5.
  - Other materials than those specified shall be specifically approved by the Commandant.

MSC Guidelines for Review of Pressure Vessels

Procedure Number: E1-19 Revision Date: 01/28/00

Attachments

1. 46 CFR Table 54.01-5(b) Pressure Vessel Classification
2. MTN 01-94, Acceptance Criteria for Pressure Vessels on Reflagged Vessels

Attachment 1 to General Guidance Procedure

TABLE 54.01–5(b)—PRESSURE VESSEL CLASSIFICATION [8]

Class	Service contents	Class limits on pressure and temperature	Joint requirements [1,6,7]	Radiography requirements, section VIII, ASME Code [5,7]	Post weld heat treatment required [5,7]	Shop inspect. required	Plan approval required
I	(a) Vapor or gas.	Over 600 p.s.i. or 700°F	(1) For category A: (1) or (2). For category B. All categories C and D must have full penetration welds extending through the entire thickness of the vessel wall or nozzle wall.	Full on all butt joints regardless of thickness. Exceptions listed in Table UCS–57 of ASME Code do not apply.	For carbon or low alloy steel, in accordance with Table UCS–56, regardless of thickness. For other materials, in accordance with section VIII, ASME Code.	Yes [4]	Yes [4].
	(b) Liquid	Over 600 p.s.i. or 400°F					
	(c) Hazardous materials [2].						
I–L Low temperature.	(a) Vapor or gas.	Over 250 p.s.i. and service temperature below 0°F	(1) for categories A and B. All categories C and D must have full penetration welds extending through the entire thickness of the vessel wall or nozzle wall.	Full on all butt joints regardless of thickness. Exceptions listed in Table UCS–57 of ASME Code do not apply.	For carbon or low alloy steel, in accordance with Table UCS–56, regardless of thickness. For other materials, in accordance with section VIII, ASME Code.	Yes	Yes.
	(b) Liquid	Over 250 p.s.i. and service temperature below 0°F					
	(c) Hazardous materials [2]						
II	(a) Vapor or gas.	30 through 600 p.s.i. or 275° through 700°F	(1) or (2). for category A. (1), (2), or (3) for category B. Categories C and D in accordance with UW–16 of ASME Code.	Spot, unless exempted by UW–11(c) of ASME Code.	In accordance with section, VIII of ASME Code.	Yes [4]	Yes [4].
	(b) Liquid	200 through 600 p.s.i. or 250° through 400°F					
	(c) Hazardous materials [2,3,6]						
II–L Low temperature.	(a) Vapor or gas.	0 through 250 p.s.i. and service temperature below 0°F through 250 p.s.i. and service temperature below 0°F	(1) for category A; (1) or (2) for category B. All categories C and D must have full penetration welds extending through the entire thickness of the vessel wall or nozzle wall. In accordance with Section VIII of AMSE Code.	Spot. The exemption of UW–II(c) of ASME Code does not apply.	Same as for I–L except that mechanical stress relief may be substituted if allowed under subpart 54.30 of this chapter.	Yes	Yes.
	(b) Liquid						
	(c) Hazardous materials [2]						
III	(a) Vapor or gas.	Under 30 p.s.i. and 0° through 275°F		Spot, unless exempted UW–II(c) of ASME Code.	In accordance with Section VIII of ASME Code.	Yes [4]	Yes [4].
	(b) Liquid	Under 200 p.s.i. and 0° through 250°F					
	(c) Hazardous materials [2,3,6]						

[1] Welded joint categories are defined under UW–3 of the ASME Code. Joint types are described in Table UW–12 of the ASME Code, and numbered "(1)," "(2)", etc.
[2] See §54.20–2.
[3] See §§ 54.25–8(c) and 54.25–10(d).
[4] See §§ 54.01–15 and 54.10–3 for exemptions.
[5] Specific requirements modifying Table UCS–56 of the ASME Code are found in §54.25–7.
[6] See §54.20–3 (c) and (f)
[7] Applies only to welded pressure vessels.

(Approved by the Office of Management and Budget under OMB control number 2130–0181)

[CGFR 68–82, 33 FR 18828, Dec. 18, 1968, as amended by CGFR 69–127, 35 FR 9076, June 17, 1970; CGD 77–147, 47 FR 21800, May 20, 1982; 55 FR 696, Jan. 8, 1990; CGD 88–057, 55 FR 24238, June 15, 1990; CGD 85–061, 55 FR 41917, Oct. 16, 1990; CGD 95–027, 61 FR 26000, May 23, 1996]

Attachment 2 to General Guidance Procedure E1-19

U.S. Department
of Transportation

United States Coast Guard — Marine Safety Center Technical Note

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Subj: Acceptance Criteria for Pressure Vessels on Reflagged Vessels

Ref: (a) NVIC 10-81 CH1, "Coast Guard Certification and Inspection of Certain Categories of Existing Vessels"

1. PURPOSE: The current Coast Guard policy for accepting pressure vessels on existing vessels that are being brought under U.S. Flag and requesting a Coast Guard Certificate of Inspection is outlined in ref. (a). Basically, the criteria is: design to an acceptable national standard, certification by a recognized classification society and successful operating experience. In addition sufficient evidence must be submitted that demonstrates a factor of safety equivalent to that of the ASME Code but lesser factors of safety will be accepted provided they exceed 3:1.

2. DISCUSSION:

a. NVIC 10-81 was published more than 10 years ago and since then the Coast Guard has reviewed numerous submittals of pressure vessels built to a myriad of foreign national standards. In many cases the design factor of safety is equivalent or very close to ASME requirements. Most importantly in every case the design factor of safety was shown to be at least 3:1. Based on this experience the MSC has confidence with foreign national standards and acceptance by classification societies.

b. One of the pillars of Maritime Regulatory Reform is harmonization of USCG regulations, IMO requirements and classification society rules and accepting of these standards as equivalent to Coast Guard regulations. The long term goal is a single set of standards for all vessels regardless of flag.

Attachment 2 to MSC Work Instruction E1-19 (continued)

c. A cornerstone of the new Coast Guard safety regime is the use of another set of eyes or hired hands such as registered professional engineers or ABS Americas who certify vessel designs comply with applicable Coast Guard regulations. The review and acceptance of the original pressure vessel design by the classification society is a very similar concept.

d. Lastly, MSC must optimize its plan review efforts by concentrating the systems with the greatest risk to safety or that are most critical to the safety of the vessel, crew, passengers and the environment.

e. Based on the above, the pressure vessel acceptance criteria outlined in reference (a) is appropriate except for the repetitive review of calculations to verify design factors of safety. Therefore, meeting this criteria should be enough unless there is clearly a greater risk or danger associated with a pressure vessel in high pressure service, low temperature service or containing of dangerous substances. For pressure vessels in these categories a more stringent acceptance criteria is appropriate to account for the higher risk.

3. ACTION: **The acceptance criteria for all pressure vessels on reflagged vessels will be a proof of design to an acceptable national standard**, **certification by a recognized classification society** and **successful operating experience**. **For class I, I-L, II-L pressure vessels and those containing dangerous substances the acceptance criteria will also include submission of calculations verifying a design factor of safety of at least 3:1 based upon the minimum tensile strength at the design temperature. Additionally for class I, I-L and II-L pressure vessels sufficient documentation or certification that the acceptable standard includes requirements for general design and independent third party shop inspection with approval of design, welding procedures, welder performance, heat treatment and non destructive examination must be submitted.**