

MSC Guidelines for Refrigeration Machinery

Procedure Number E1-32

Revision Date: 07/27/10



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References:

- a. 46 CFR Part 56.50-105 – Low Temperature Piping
 - b. 46 CFR Part 58.20 – Refrigeration Machinery
 - c. 46 CFR Part 147.70 – Refrigerants
 - d. ANSI B31.5, Refrigeration Piping, 1987
 - e. ABS Rules for Building and Classing Steel Vessels 2003, Part 4 Vessel Systems and Machinery
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Contact Information:

If you have any questions or comments concerning this document, please contact the Marine Safety Center by e-mail or phone, referring to Procedure Number: **E1-32**.

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Responsibilities:

The submitter shall provide sufficient documentation and plans to indicate compliance with the applicable requirements; this includes a complete bill of materials, component technical data sheets, and arrangement plans. The submission shall be made in triplicate.

General Guidance:

- Refrigeration machinery is acceptable provided the design, material, and fabrication comply with the applicable requirements of reference (e). (46 CFR 58.20-5(a))
- Piping materials shall be suitable for handling the primary refrigerant, brine, or fluid used, and shall remain ductile at the lowest operating temperature. (46 CFR 58.20-20(a)) Acceptable materials and specifications are listed in Table 523.1 of ANSI B31.5.
- Material requirement and limitations:
 - a) For Carbon Steel pipe:
 - i. For group 2 and 3 refrigerant liquid (see Table 501.2.4) lines NPS 1 ½ inches and smaller must not be less than Schedule 80 wall thickness (ANSI B31.5, 505.1.1)

MSC Guidelines for Refrigeration Machinery

Procedure Number : E1-32

Revision Date: 07/27/10

General Guidance (cont):

- ii. No less than Schedule 40 wall thickness shall be used for group 1 refrigerant liquid lines NPS 6 inches and smaller, groups 2 and 3 refrigerant liquid lines NPS 2 inches through 6 inches, and group 1, 2, and 3 refrigerant vapor lines NPS 6" and smaller. (ANSI B31.5, 505.1.1)
 - iii. ASTM A 53 Grade F is prohibited. (ANSI B31.5, 505.1.1)
- b) Cast iron and malleable iron shall not be used for piping components in hydrocarbon or other flammable fluid service at temperatures above 300°F, nor at gage pressures above 300 psi. Cast iron or malleable iron must not be used at temperatures below -150°F.
- c) For non ferrous pipe or tube:
- i. Copper, copper alloy, aluminum, or aluminum alloy pipe and tube of any size may be used for any refrigerant service where compatible with the refrigerant used and when selected in accordance with the design rule in 504.1 and allowable stress values in Table 502.3.1. (ANSI B31.5, 505.2.1)
 - ii. Soft annealed copper tubing larger than 1 3/8 inches outer diameter must not be used for field assembled refrigerant piping, unless it is protected from mechanical damage. (ANSI B31.5, 505.2.2)
- d) For nonmetallic pressure containing components:
- i. Nonmetallic pressure containing components, such as plastics, glass, carbon, rubber, or ceramics, may be used even if not specifically listed in ASNI B31.5. If stress data are not available for establishment of allowable stresses, the components may be qualified per paragraph 504.7.

MSC Guidelines for Refrigeration Machinery

Procedure Number : E1-32

Revision Date: 07/27/10

- Piping systems must be designed in accordance with ANSI B31.5. (46 CFR 58.20-20(b))
 - a) Minimum design gage pressure must not be less than 15 psi, and must not less than the saturation pressure of the refrigerant at the following temperature:
 - i. Low sides of all system: 80°F.
 - ii. High side of water or evaporatively cooled system: 105°F
 - iii. High sides of air cooled systems: 125° (ANSI B31.5-501.2.4)
 - b) The minimum design pressure shall be as listed in Table 501.2.4 for the refrigerants used in the system. (ANSI B31.5)
 - c) The allowable stress values to be used for design calculations must conform to Table 502.3.1 of ANSI B31.5. (46 CFR 58.20-5(a).
 - d) The minimum piping wall thickness or maximum design pressure shall be determined by the following equations: (ANSI B31.5, 504.1.1)

$$t = \frac{PD}{2(S + Py)} \quad \text{or} \quad t = \frac{Pd}{2(S + Py - P)}$$

$$t_m = t + c$$

$$P = \frac{2St}{D_o - yt}$$

- t_m = minimum required thickness, in
- t = pressure design thickness, in
- c = for internal pressure of the mechanical allowances, in
- P = internal design pressure, psig
- D_o = outside diameter of pipe, in
- d = inside diameter of pipe, in
- S = applicable allowable hoop stress in accordance with 502.3.1 and Table 502.3.1, psi
- y = coefficient for materials indicated

- Valves shall be in accordance with the standards listed in Table 526.1 and within the limitations listed in the valve standard. Refrigerant gate

MSC Guidelines for Refrigeration Machinery

Procedure Number : E1-32

Revision Date: 07/27/10

valves, ball valves, and plug cocks must not be used in liquid refrigerant lines unless consideration is given to the expansion of liquid trapped in the valve cavities when the valve or cock is closed. (ANSI B31.5, 507)

General Guidance (cont):

- A relief valve is required on or near the compressor on the gas discharge side between the compressor and the first stop valve with the discharge there to the suction side. (46 CFR 58.20-20(c))
- A check valve is fitted in the atmospheric discharge line if it is led through the side of the vessel below the freeboard deck, or a shutoff valve may be fitted if it is locked in the open position. (46 CFR 58.20-20(c))

Cargo re-liquefaction systems must also comply with the following:

For Class I-L piping system:

- Class I-L piping systems designed to operate at temperature below 0 °F and pressure above 150 psi must comply with the following: (46 CFR 56.50-105(a))
 - a) Material used in low temperature piping systems must selected from among those specifications listed in Table 56.50-105.(46 CFR 56.50-105(a)(1))
 - b) Seamless tubular products must be used except when the service pressure does not exceed 250 psi. (46 CFR 56.50-105(a)(5))
 - c) The minimum service temperature as defined in 46 CFR 54.25-10(a)(2) must not be colder than that shown in Table 56.50-105. (46 CFR 56.50-105(a)(1)(i))
 - d) The material must be tested in according with 46 CFR 56.50-105(a)(1)(ii).
 - e) Single welded butt joints with backing ring left in place, socket welds, slip-on flanges, pipe joining sleeves, and threaded joints must not be used. (46 CFR 56.50-105(a)(4))

MSC Guidelines for Refrigeration Machinery

Procedure Number : E1-32

Revision Date: 07/27/10

For Class II-L piping system:

- Class II-L systems designed to operate at temperatures below 0°F and pressure not higher than 150 psi must comply with the following: (46 CFR 56.50-105(b))
 - a) Material used in low temperature piping systems must selected from among those specifications listed in Table 56.50-105.(46 CFR 56.50-105(a)(1))
 - b) The minimum service temperature as defined in 46 CFR 54.25-10(a)(2) must not be colder than that shown in Table 56.50-105. (46 CFR 56.50-105(a)(1)(i))
 - c) The material must be tested in according with 46 CFR 56.50-105(a)(1)(ii).
 - d) Socket welds in nominal sizes above 3 inches, slip-on flanges in nominal sizes above 4 inches, and threaded joints in sized above 1 inch shall not be used.

General Guidance (cont):

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.
