

MSC Guidelines for Engine Cooling Systems

Procedure Number: E1-05

Revision Date: 12/16/2013

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References:

- a. 46 CFR 56.60, 56.50-95 & 56.50-96 (Subchapter F)
- b. 46 CFR 77.03-1 (Subchapter H)
- c. 46 CFR 90.20 & 46 CFR 96.03 (Subchapter I)
- d. 46 CFR 119.420 & 46 CFR 119.422 (Subchapter K)
- e. 46 CFR 128.420 (Subchapter L)
- f. 46 CFR 182.420 & 182.422 (Subchapter T)
- g. Standards and Recommended Practices for Small Craft, American Boat and Yacht Council, Inc. (ABYC) P-4 Marine inboard engines and transmissions
- h. The International Convention for the Safety of Life at Sea (SOLAS) 1974 Chapter II-1 Regulation 17 Openings in the shell plating of passenger ships below the margin line; and Part C: Machinery Installations
- i. ASTM F1155-98, Standard Practice for Selection and Application of Piping Systems”
- j. IMO Resolution A.753(18), “Guidelines for the Application of Plastic Pipes on Ships”

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: **E1-05**.

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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.

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General Guidance: **Vessels Subject to Subchapter F (Subchapters D, H, and I)**

Materials

- ❑ Pipe and fittings shall conform to the material specifications listed in Table 56.60-1(a) of 46 CFR 56.60, Sections I or VIII of ASME Boiler and Pressure Vessel Code or reference (i).
- ❑ Ferrous pipe used for salt water applications must be galvanized or extra heavy schedule
- ❑ Fittings and valves shall conform to an appropriate design standard listed in Table 56.60-1(b) or other acceptable standard which provides an equivalent level of safety. Fitting and valve class/pressure rating must be adequate for the application.
- ❑ Pressure containing components (strainers, filters and non-standard assemblies, etc) shall be constructed of acceptable materials and be designed to a 4: 1 safety factor (MAWP/Burst pressure).
- ❑ Non-metallic piping, fittings and pressure containing components must be in accordance with reference (j). Note that cooling system components constructed of non-metallic materials must meet the fire endurance requirements outlined in Appendix 4 of reference (j). Generally, this precludes the use of non-metallic pressure containing components (e.g. strainers with plastic or acrylic bowls)

Overboard discharges and shell connections

- ❑ Inlets and discharges shall have some means of preventing the accidental admission of water (46 CFR 56.50-95(a)(1)).
- ❑ Openings in the vessel's hull shall be kept to a minimum (46 CFR 56.50-95(a)(2)).
- ❑ The thickness of the inlet and discharge connections outboard of the shutoff valves must not be less than: (46 CFR 56.50-95(e)(3))
 - a. Schedule 80 for nominal pipe sizes through 8”.
 - b. Schedule 60 for nominal pipe sizes between 8”– 16”.
 - c. Schedule 40 for nominal pipe sizes 16” and above.

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General Guidance (continued):

- ❑ Valves required by 46 CFR 56.50-95 and piping system components in vessels of 150 GT and over shall be of steel, bronze, or ductile cast iron specification listed in Table 56.60-1(a)
 - ❑ For a resiliently seated valve located at the shell, the RSV must be category A or positive shut off. Valves certified as complying with the API 607 fire test are acceptable as Category A.
- ❑ Discharges originating at any level must be provided with an automatic, non-return valve at the shell, if penetrating the shell either: (46 CFR 56.50-95(b)(1))
 - a) more than 17.5 inches below the freeboard deck, or,
 - b) less than 23.5 inches above the summer load waterline.
- ❑ Non-return valves at the shell, unless otherwise required, may be omitted if: (46 CFR 56.50-95(b)(1))
 - a) Piping not less than Sch. 80 for nominal pipe sizes through 8”.
 - b) Piping not less than Sch. 60 for nominal pipe sizes between 8”–16”.
 - c) Piping not less than Sch. 40 for nominal pipe sizes above 16”.
- ❑ Discharges originating from spaces below the freeboard deck or from within enclosed superstructures on the freeboard deck shall be fitted with efficient and accessible means for preventing water from passing inboard. These means should take the form of one of the following: (46 CFR 56.50-95(b)(2))
 - a) Discharge shall have one automatic non-return valve with a positive means of closing it from above the freeboard deck.
 - b) Exceptions:
 - i. Vertical distance exceeds 0.01L - Where the vertical upward distance from the summer load line to the inboard end of the discharge pipe where flooding can take place exceeds 0.01L (L = Length of Vessel), discharges may have two automatic non-return valves without positive means of closing. This is provided that the inboard valve is always accessible for examination.

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ii. Vertical distance exceeds 0.02L - Where the vertical distance exceeds 0.02L, a single automatic non-return valve without positive means of closing is acceptable.

- Pipes terminating at the shell shall be fitted with bends or elbows between the outboard openings and the first rigid connection inboard. In no case shall such pipes be fitted in a direct line between the shell opening and the first inboard connection (46 CFR 56.50-95(e)(1)).

Keel Cooler Installations

- Systems shall be fitted with shutoff valves as close to the skin of the ship as possible (56.50-95(d)(1)).
 - For a resiliently seated valve located at the shell, the RSV must be category A or positive shut off. (46 CFR 56.20-15). Valves certified as complying with the API 607 fire test are acceptable as Category A.
- Shutoff valves may be locally controlled in a manned machinery space (56.50-95(d)(1)).
- Shutoff valves shall be easily accessible above the floor plates in manned machinery spaces; remotely operable from above the freeboard deck in unmanned machinery spaces (56.50-95(d)(2)).
- Shutoff valves will not be required for the inlet and discharge connections if:
 - a. The installation is forward of the collision bulkhead (56.50-96(a)(1))

OR

- b. The cooler structure is integral with the ship's hull and meets **all** of the following requirements (56.50-96(a)(2));
 - i. Is fabricated from material of the same thickness and quality as the hull plating. With exception of the hull proper, thickness need not exceed 3/8 inches. Half round pipe may be lesser thickness if specifically approved by Commandant (CG-ENG).
 - ii. The flexible connections and all openings internal to the vessel (ex. tank vents & fills) are above the deepest load

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- line. All piping components are schedule 80 or thicker below the deepest load line.
- iii. Full penetration welds are used in the fabrication of the structure and its attachment to the hull.
- iv. The forward end of the structure must be faired such that the horizontal length is no less than four times the height of the structure or must be in a protected location.

- Refer to 56.50-95(f) for specs on materials for new vessel installations or replacements in vessels of 150 gross tons and over.
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Overboard discharges and shell connections

- For closed systems, sea inlets and discharges need not comply with paragraph (b) 1 & 2 but instead shall be fitted with a shutoff valve: (46 CFR 56.50-95(d)(1))
 - a. Located as near to the shell plating as possible,
 - b. May be locally controlled in a manned machinery space, and
 - c. Valve control must be readily accessible with indication of whether the valve is closed or opened.
 - d. For unmanned spaces, shutoff valves shall be remotely operable from a position above the freeboard deck and shall meet the marking and access requirements of paragraph (b)(2).

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General Guidance
(continued):

Vessels Subject to 46 CFR Subchapter K

Engine Cooling System

- ❑ Engines must be water-cooled; exceptions exist for air cooling of diesel engines (119.420(a)).
- ❑ Engine head block and exhaust manifold must be water jacketed and cooled by water from a pump that operates whenever the engine is operating (119.420(a)(1)).
- ❑ A suitable hull strainer must be installed. Strainer shall be constructed of metallic materials; strainers with acrylic or plastic bowls are not acceptable. (119.420(a)(2) and 119.720)
- ❑ A closed fresh water system may be used.

Engine Cooling System Materials

- ❑ Engine cooling systems are vital per 119.710(a)(6) & (7). Materials must meet Subchapter F requirements.
- ❑ Use of nonferrous metallic piping materials must meet the requirements of subchapter F and 119.730.
- ❑ Nonmetallic flexible hoses must meet the requirements of 56.60-25 unless they are used in closed loop systems.

Keel Cooling System

- ❑ System must be designed to prevent flooding (119.422(a)).
- ❑ The thickness of the inlet and discharge connections outboard of required shutoff valves must be at least Schedule 80 (119.422(c)).
- ❑ Short lengths of non-metallic flexible hose, fixed by two hose clamps at each end of the hose, may be used at machinery connections (119.422(d)).
- ❑ A shutoff valve must be located where the cooler piping penetrates the shell unless:

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(continued):

- a. The penetration is forward of the collision bulkhead;
(119.422(b))

OR

- b. The grid cooler or keel cooler is integral to the hull. The structure is considered integral if it meets all of the following:
(119.422(e))
 - i. Is fabricated from material of the same thickness and quality as the hull plating.
 - ii. The flexible connections are located well above the deepest subdivision draft.
 - iii. Full penetration welds are used in the fabrication of the structure and its attachment to the hull.
 - iv. The forward end of the structure must be faired to the hull with a slope no greater than 4 to 1.
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Vessels Subject to Title 46 CFR Subchapter L

Materials

- ❑ Considered a vital system per 128.130(a)(7); refer to 56.60 for materials. The submitter may use materials other than those listed in 56.60 if the submitter shows that the material attains an equivalent level of safety to 56.60 (128.210).

Hull Penetrations

- ❑ Each piping penetration must meet the specifications detailed in subchapter F. Refer to *overboard discharges and shell connections* above (128.230(a)).
- ❑ Each overboard discharge and shell connection must meet materials and pressure design of subchapter F (128.230(b)).

Keel Cooler Installations

- ❑ Refer to 56.50-96. Procedures for complying with 56.50-96 are found above in *Keel Cooler Installations - Subchapter F* except for: (128.420(a))
 - a) Approved metallic flexible connections may be located below the deepest-load waterline if the system is a closed loop below the waterline and if its vent is located above the waterline (128.420(b)).
 - b) Fillet welds may be used in the attachment of channels and half-round pipe sections to the bottom of the vessel (128.420(c)).
 - c) Short lengths of non-metallic flexible hose fixed by metallic or non-metallic hose clamps may be used at machinery connections if: (128.420(d))
 - i. Clamps are corrosion resistant,
 - ii. Clamps do not depend on spring tension,
 - iii. Two clamps on each end per 128.420(d)(3), and
 - iv. Clamps are resistant to vibration, high temps, and brittleness.

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Non-Integral Keel Cooler (Grid Cooler) Installations

- ❑ Each hull penetration for a non-integral installation must be made through a cofferdam or at a sea chest and must be provided with isolation valves. (128.430(a)).
 - ❑ Installations in which the piping is fully welded on both sides or full strength welds are used on a single side, a valve is located at the hull penetration and schedule 80 piping is provided outboard of the valve are acceptable in lieu of a cofferdam or seachest.
 - ❑ Each non-integral keel cooler must be protected against damage from debris and grounding by protective guards or by recessing the cooler into the hull (128.430(b)).
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(continued):

Vessels Subject to 46 CFR Subchapter T

Engine Cooling

- ❑ All engines must be water cooled and meet the following requirements: (exceptions found in 182.420(b)-(e)):
 - a. Engine head, block and exhaust manifold must be water-jacketed and cooled by water from a pump that operates whenever the engine is operating (182.420(a)(1)).
 - b. A suitable hull strainer must be installed in the circulating raw water intake line of an engine cooling water system. Strainers shall be constructed of metallic materials; strainers with acrylic or plastic bowls are not acceptable (182.420(a)(2) and 182.720(a)).
 - c. A closed fresh water system may be used to cool the engine (182.420(a)(3)).
- ❑ Exceptions to the water cooled engine requirement: (182.420(b))
 - a. Vessel under 65 feet and carrying not more than 12 passengers may comply with ABYC P-4 (reference (g)) instead of the requirements above. In this case, the following requirements from ABYC P-4 apply;
 - 1. Marine engines shall be designed for saltwater (P-4).
 - 2. Cooling system temperatures shall conform to the manufacturer's recommendations.
 - 3. If a pump is used to supply seawater for cooling an engine and its systems, a self-priming pump which operates whenever the engine is running shall be used.
 - 4. Those portions of the engine through which saltwater circulates and which consist of metal alloys shall be of such area relationship as to avoid detrimental galvanic corrosion (dissimilar metals). In general, components of small relative area, such as core plugs and pipe plugs, shall be made of materials which in the galvanic series are cathodic to and close to the other metal alloys with which they are used. Exception: If a closed fresh water cooling system is provided as part of the basic engine.

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5. Drains or drain plugs shall be provided in liquid cooled engine systems.
 6. Inboard propulsion engines shall be equipped with instruments at the operator's positions to indicate the temperature of the engine.
- b. For vessels under 65 feet and carrying not more than 12 passengers refer directly to ABYC P-4 for details on air-cooled engines (182.420(c)).
- c. An auxiliary gasoline engine may be air cooled when:
1. It has a self-contained fuel system and it is installed on an open deck; (182.420(d)(1))
- OR**
2. On a vessel under 65 feet, carrying not more than 12 passengers, and is in compliance with ABYC P-4 (182.420(d)(2)).
- d. A propulsion or auxiliary diesel engine may be air cooled when: (182.420(e))
1. Installed on an open deck,
 2. Installed in an enclosed space for which ventilation for machinery cooling is provided, or
 3. Installed on a vessel of not more than 65 feet, carrying not more than 12 passengers and complying with ABYC P-4.

Integral and Non-integral Installations

- ❑ Must be designed to prevent flooding (182.422(a)).
- ❑ Shutoff valves must be located where the cooler piping penetrates the shell, as near the shell as practicable, except where the penetration is forward of the collision bulkhead (182.422(b)).
- ❑ Thickness of the inlet and discharge connections, outboard of the shutoff valves, must be Schedule 80 (182.422(c)).

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- ❑ Short lengths of approved non-metallic flexible hose, fixed by two hose clamps at each end, may be used at machinery connections for a keel cooler installation (182.422(d)).
- ❑ Shutoff valves are not required for systems that are integral to the ship and meet all of the following requirements: (182.422(e))
 - a) The cooler structure is fabricated from material of the same thickness and quality as the hull plating,
 - b) The flexible connections are located above the deepest subdivision draft,
 - c) Full penetration welds are used in the fabrication of the structure and its attachment to the hull, and
 - d) The forward end of the structure must be faired to the hull with a slope no greater than 4 to 1.

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.
