



Standard Specification for United States Coast Guard Type II or IMO MARPOL 73/78 Annex IV Marine Sanitation Devices (Flow Through Treatment)¹

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1. Scope

1.1 This specification covers the design, manufacture, performance, operation, functioning, and testing of USCG Type II Marine Sanitation Device or IMO MARPOL 73/78 Annex IV flow through treatment device intended to process sewage and graywater generated during the ship's normal service. This specification is intended for use by purchasers, designers, and manufacturers of shipboard environmental pollution control equipment to determine the requirements for equipment purchase, equipment use, and design considerations.

1.2 The device shall be capable of meeting the effluent requirements detailed in Table 1 with respect to ship's operational area.

2. Referenced Documents

2.1 ASTM Standards:²

- A307 Specification for Carbon Steel Bolts and Studs, 60 000 PSI Tensile Strength
- A530/A530M Specification for General Requirements for Specialized Carbon and Alloy Steel Pipe
- A563 Specification for Carbon and Alloy Steel Nuts
- A999/A999M Specification for General Requirements for Alloy and Stainless Steel Pipe
- B165 Specification for Nickel-Copper Alloy (UNS N04400)* Seamless Pipe and Tube
- F467 Specification for Nonferrous Nuts for General Use
- F468 Specification for Nonferrous Bolts, Hex Cap Screws, and Studs for General Use
- F992 Specification for Valve Label Plates
- F993 Specification for Valve Locking Devices
- F998 Specification for Centrifugal Pump, Shipboard Use
- F1030 Practice for Selection of Valve Operators

- F1098 Specification for Envelope Dimensions for Butterfly Valves—NPS 2 to 24
- F1122 Specification for Quick Disconnect Couplings (6 in. NPS and Smaller)
- F1155 Practice for Selection and Application of Piping System Materials
- F1166 Practice for Human Engineering Design for Marine Systems, Equipment, and Facilities
- F1298 Specification for Flexible, Expansion-Type Ball Joints for Marine Applications
- F1323 Specification for Shipboard Incinerators
- F1510 Specification for Rotary Positive Displacement Pumps, Ships Use
- F1511 Specification for Mechanical Seals for Shipboard Pump Applications
- F2044 Specification for Liquid Level Indicating Equipment, Electrical

2.2 ANSI Standards:³

- B16.1 Cast Iron Pipe Flanges and Flange Fittings
- B16.5 Steel Pipe Flanges, Flanged Valves and Fittings 150, 300, 400, 600, 900, 1500 and 2500 lb
- B16.11 Forged Steel Fittings, Socket Welding and Threaded
- B16.24 Bronze Flanges and Flanged Fittings 150, 300 lb

2.3 Code of Federal Regulations:⁴

- 33 CFR 159 Department of Homeland Security, U.S. Coast Guard (USCG), Marine Sanitation Devices
- 40 CFR Part 136 Guidelines Establishing Test Procedures for the Analysis of Pollutants
- 40 CFR 140 Environmental Protection Agency, Marine Sanitation Device Standard, January 29, 1976
- 46 CFR Part 111 Department of Homeland Security, U.S. Coast Guard (USCG), Electrical Systems
- 46 CFR Part 147 Department of Homeland Security, U.S. Coast Guard (USCG), Hazardous Ships' Stores
- 49 CFR 171 Department of Transportation (DoT), Research and Special Programs Administration (RSPA), General Information, Regulations and Definitions

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² For referenced ASTM standards, visit the ASTM website, www.astm.org, or contact ASTM Customer Service at service@astm.org. For *Annual Book of ASTM Standards* volume information, refer to the standard's Document Summary page on the ASTM website.

³ Available from American National Standards Institute (ANSI), 25 W. 43rd St., 4th Floor, New York, NY 10036.

⁴ Available from U.S. Government Printing Office Superintendent of Documents, 732 N. Capitol St., NW, Mail Stop: SDE, Washington, DC 20401.

TABLE 1 Effluent Requirements and Operational Areas

	U.S.C.G.		MARPOL 73/78 Annex IV
	U.S. Coastal Zone Operations	Alaskan Special Area Operations ^A (Cruise Ships)	International Area Operations
Suspended Solids	150 mg/L	7 day average: 45 mg/L 30 day average: 30 mg/L 30 day average removal efficiency: 85 %	50 mg/L (in lab) 100 mg/L (shipboard)
Fecal Coliform	200/100 mL	Geometric mean for 30 day period: 20/100 mL and not more than 10 % exceeding 40/100 mL	250/100 mL
BOD ^B	Not specified	7 day average: 45 mg/L 30 day average: 30 mg/L 30 day average removal efficiency: 85 %	50 mg/L
Residual (CL)	Not specified	Total Residual Chlorine cannot exceed 10 mg/L	To the degree, practicable ^C
pH	Not specified	Maintained between 6.0 and 9.0	Not specified

^A Treated sewage and graywater discharged outside of Alaskan Special Areas, while in Alaskan waters, must meet U.S. Coastal Zone Operations requirements and be discharged while ship is underway at not less than 6 knots.

^B 5-day BOD (biochemical oxygen demand).

^C Sewage discharged when the ship is underway at not less than 4 knots.

ANSI/NFPA No. 70 National Electrical Code³

IEEE 45-2002 Recommended Practice for Electric Installations on Shipboard⁵

Instrument Society of America (RP 12.2)⁶

International Convention for the Prevention of Pollution from Ships (1973) as modified by the Protocols of 1978 (MARPOL 73/78) and 1997 and associated Annexes, Including Annex IV and Annex VI⁷

Resolution MEPC.2(IV) Recommendation on International Effluent Standards and Guidelines for Performance Tests for Sewage Treatment Plants⁷

MARPOL 73/78 Annex IV Annex B Guidelines for Performance Tests for Sewage Treatment Plants with Respect to Effluent Standards⁷

Public Law 92-500 Federal Water Pollution Control Act, October 18, 1972, as amended by Public Law 95-217, Clean Water Act, December 27, 1977, as amended⁴

Public Law 106-554 Title XIV Certain Alaskan Cruise Ship Operations, of the Miscellaneous Appropriations Act of 2001⁴

SNAME T&R Bulletin No. 3-37 Design Guide for Shipboard Airborne Noise Control⁸

Underwriters Laboratories STD 698 Industrial Control Equipment for Use in Hazardous Locations⁹

3. Terminology

3.1 Definitions of Terms Specific to This Standard:

⁵ Available from Institute of Electrical and Electronics Engineers, Inc. (IEEE), 445 Hoes Ln., P.O. Box 1331, Piscataway, NJ 08854-1331

⁶ Available from Instrumentation, Systems, and Automation Society, 67 Alexander Dr., Research Triangle Park, NC 27709.

⁷ Available from International Maritime Organization (IMO), 4 Albert Embankment, London SE1 7SR, U.K.

⁸ Available from Society of Naval Architects and Marine Engineers, 601 Pavonia Ave., Jersey City, NJ 07306.

⁹ Available from Underwriters Laboratories (UL), Corporate Progress, 333 Pfingsten Rd., Northbrook, IL 60062.

used to collect by gravity sewage or graywater, or both, prior to legal discharge or pumping to shore facility.

3.1.2 *deodorant*—substance which masks or destroys offensive odors.

3.1.3 *discharge*—includes spilling, leaking, pumping, pouring, emitting, emptying, and dumping.

3.1.4 *effluent*—discharge from a properly functioning MSD.

3.1.5 *failure*—any malfunction that causes an MSD to shut down or that, if not corrected, would preclude sewage processing or prevent the MSD from meeting the applicable performance requirements.

3.1.6 *fecal coliform bacteria*—organisms, associated with the intestines of warm-blooded animals, that commonly are used to indicate the presence of fecal material and the potential presence of organisms capable of causing human disease.

3.1.7 *gravity collection*—the method of collection for sewage and graywater used in CHT systems.

3.1.8 *graywater*—discarded water from deck drains, lavatories, showers, dishwashers, laundries, and drinking fountains. Does not include industrial wastes, infectious wastes, human body wastes, and animal wastes.

3.1.9 *holding tank*—generally designed to collect and store treated or untreated waste until it can be legally discharged or pumped to a dockside facility.

3.1.10 *hydraulic loading*—the volume of sewage or graywater, or both, applied to the surface of the filtering media per time period.

3.1.11 *manufacturer*—company that designs, assembles, or imports the various parts of the system (except where specified otherwise).

3.1.12 *marine sanitation device (MSD)*—any equipment designed to receive, retain, treat, or discharge sewage, and any process to treat such sewage.

3.1.13 *organic loading*—the concentration of pollutants applied to the surface of the filtering media per time period.

3.1.14 *recognized facility*—recognized facility means any laboratory or facility listed by the Coast Guard as a recognized facility under **33 CFR 159**.

3.1.15 *sewage*—wastes of human origin from water closets, urinals, and medical facilities transported by the ship soil drain system. It also includes animal wastes from spaces containing living animals. When graywater is combined with sewage, the waste stream is characterized as sewage.

3.1.16 *USCG Type II MSD*—a flow through device capable of producing an effluent with a fecal coliform bacterial count of not more than 200 per 100 mL and with a total suspended solids concentration of not more than 150 mg/L.

3.1.17 *vacuum collection*—the method for collection of sewage used in VCHT systems.

3.1.18 *vacuum collection, holding, and transfer tank (VCHT)*—tank utilizing vacuum suction to hold sewage and/or graywater for legal discharge or pumping ashore.

4. Ordering Information

4.1 Orders shall include the following information:

4.1.1 *Sizing Requirements:*

4.1.1.1 Design sizing requirements shall include consideration of collection method (gravity or vacuum) utilized for Marine Sanitation Device.

4.1.1.2 Hydraulic loading for both graywater and sewage generation rates.

(1) If capacity is provided in litres per day per person or gallons per day per person, the maximum number of personnel (crew and passenger) must also be supplied.

(a) When specifying growth margin, it is important to consider the potential for increases in crew size or number of passengers, or both, over the life of the ship.

4.1.1.3 Organic loading for both graywater and sewage generation rates.

4.1.1.4 Thermal loading and expected temperature variation if processing combined sewage and graywater waste streams.

(1) Take into account the management of potential influent temperature variation in applications where the MSD treats a combined sewage and graywater waste stream. Consideration might include the addition of a temperature/flow equalization tank or other means to adjust temperature to meet **6.9.1**.

4.1.2 *Processing Rate Requirements:*

4.1.2.1 Based on hydraulic and organic loading rates for target waste streams and reduced processing capability.

4.1.3 System start up times.

4.1.4 Space, weight, and service restrictions, if any.

4.1.5 Operational profile of ship.

4.1.6 Additional control requirements.

4.1.7 Any additional requirements required by the purchaser to meet special needs.

4.2 Level of operator interfacing as determined by purchaser consistent with ship operational and maintenance procedures.

5. Materials and Manufacture

5.1 The MSD shall not use dilution as a means of achieving operational effluent limits nor for purpose of passing regulatory certification requirements.

5.2 The MSD shall operate as specified herein within relative humidity limits of 5 to 95 % non-condensing.

5.3 The MSD equipment shall not be damaged nor shall subsequent operational performance be degraded as a result of exposure to salt fog.

5.3.1 When in a non-operating state, the MSD shall not be damaged nor shall subsequent operational performance be degraded as a result of external components being subjected to seawater spray.

5.4 All parts of the MSD shall minimize the effort required for their draining, accessing, cleaning, maintenance, and prevention.

5.5 The MSD shall be compliant with **Public Law 92-500** as amended and **33 CFR 159**.

5.6 Coatings or paints containing heavy metals, such as chromium, lead, or tin or other materials banned by regulatory authorities shall not be used.

5.7 Asbestos, mercury, cadmium, and polychlorinated biphenyls (PCBs) shall not be used in the construction of the MSD or any subsystem.

5.8 The MSD shall have a means installed to ensure the effluent meets fecal coliform limits.

5.8.1 If chlorine is used to meet fecal coliform limits, it is often necessary to conduct effluent dechlorination prior to releasing the effluent to the environment, based upon regulatory regime for operational area of intended service.

5.9 The MSD shall be designed to process or retain sewage wastes, or combined sewage/graywater wastes for the maximum number of assigned personnel, including non-crew members as specified by purchaser.

5.10 The MSD shall be capable of receiving wastes with freshwater, and/or seawater, or some other form of transport medium.

5.11 The MSD shall be designed and constructed to resist internal and external corrosion as found in a marine environment.

5.12 The MSD shall be capable of intermittent operation of relatively short time intervals and shall be capable of being secured for long periods without disrupting the treatment system's efficiency and ability to activate.

5.13 The MSD shall remain safe and sanitary, and shall not create dangerous or unsanitary conditions during normal operation.

5.14 MSD components, such as valves, fittings, pumps, and motors, shall be standard items, such as those complying with Practice **F1030** and Specifications **A307**, **A563**, **F992**, **F993**, **F998**, **F1098**, **F1122**, **F1298**, **F1510**, or **F1511** that are easy to maintain and replace.

5.14.1 It is recommended that collection system design and components be compatible with the materials used for the MSD.

5.14.2 Fasteners shall meet Specification **A307**, **A563**, **F467**, or **F468**.

5.15 All piping shall be selected per Practice **F1155**.

5.15.1 It is recommended that piping system components be compatible with the materials used for the MSD.

5.15.2 If nickel-copper alloy piping is used, it shall meet Specification **B165**.

5.15.3 If carbon steel or alloy steel piping is used, it shall meet Specification **A530/A530M** or **A999/A999M**.

5.15.4 If alternate materials are used other than those listed in Practice **F1155**, manufacturer shall obtain buyer approval for their use.

5.16 MSD inlet and outlet connections shall be in accordance with ANSI **B16.1**, **B16.5**, **B16.11**, or **B16.24**, or equivalent ISO or DIN standards.

5.17 The system shall be designed to function at ambient air pressure and at an ambient temperature range of 1 to 50°C and shall withstand, when empty, a range of -30 to 60°C.

5.18 The system shall be capable of operation when heeled 22.5° to either side (30° for a sailing vessel) and trimmed 10° by bow or stern and prevent escape of gases, liquids, and sewage to the exterior under the above conditions of heel or trim.

5.19 The system shall prevent escape of liquids or sewage, or both, to the interior of the vessel when heeled 45° to either side and trimmed 10° by bow or stern.

5.20 The operation of the MSD shall be automatic and shall require a minimum of crew attention.

5.21 Installation, operation, and maintenance instructions:

5.21.1 The instructions supplied by the manufacturer must contain directions for each of the following:

5.21.1.1 Installation of the device in a manner that will permit ready access to all parts of the device requiring routine service and that will provide any flue clearance necessary for fire safety.

5.21.1.2 List of cleaning materials that can be safely introduced to system without causing harm to MSD or affecting its operation.

5.21.1.3 Safe operation and servicing of the device so that any discharge meets the applicable requirements of Section 9.

5.21.1.4 Cleaning, winter lay-up, and sludge removal.

5.21.1.5 Installation of a vent or flue pipe.

5.21.1.6 The type and quantity of chemicals that are required to operate the device, including instructions on the proper handling, storage, and use of these chemicals.

5.21.1.7 Recommended methods of making required piping and electrical connections including supply circuit overcurrent protection.

5.21.2 The instructions supplied by the manufacturer must include the following information:

5.21.2.1 The name of the manufacturer.

5.21.2.2 The name and model number of the device.

5.21.2.3 Whether the device is certified for use on an inspected or uninspected vessel.

5.21.2.4 A complete parts list.

5.21.2.5 A schematic diagram showing the relative location of each part.

5.21.2.6 A wiring diagram.

5.21.2.7 A description of service for the user to perform without coming into contact with sewage or chemicals.

5.21.2.8 Average and peak capacity of the device for the flow rate for sewage or combined sewage and graywater, volume, or number of persons that the device is capable of

servicing and the period of time the device is rated to operate at peak capacity for sewage or combined sewage and graywater waste streams.

5.21.2.9 The power requirements, including voltage and current.

5.21.2.10 The maximum angles of pitch and roll at which the device operates in accordance with the applicable requirements of Section 9.

5.21.2.11 Whether the device is designed to operate in salt, fresh, or brackish water.

5.21.2.12 The maximum hydrostatic pressure at which a pressurized sewage retention tank meets the requirements of 6.5.

5.21.2.13 The maximum operating level of liquid retention components.

5.21.2.14 The device is a Type II Marine Sanitation Device.

5.21.2.15 A statement, as required by 33 CFR 159.57 Part 17, as follows:

Notes: The EPA standards state that in freshwater lakes, freshwater reservoirs, or other freshwater impoundments whose inlets or outlets are such as to prevent the ingress or egress by vessel traffic subject to this regulation, or in rivers not capable of navigation by interstate vessel traffic subject to this regulation, marine sanitation devices certified by the U.S. Coast Guard installed on all vessels shall be designed and operated to prevent the overboard discharge of sewage, treated or untreated, or of any waste derived from sewage. The EPA standards further state that this shall not be construed to prohibit the carriage of Coast Guard-certified flow through treatment devices which have been secured so as to prevent such discharges. They also state that waters where a Coast Guard-certified marine sanitation device permitting discharge is allowed include coastal waters and estuaries, the Great Lakes and interconnected waterways, freshwater lakes and impoundments accessible through locks, and other flowing waters that are navigable interstate by vessels subject to regulation 40 CFR 140.3.

(1) Prohibition pursuant to CWA section 312(f)(3): a State shall be permitted to completely prohibit the discharge from all vessels of any sewage, whether treated or not, into some or all of the waters within such State by making a written application to the Administrator, Environmental Protection Agency, and by receiving the Administrator's affirmative determination pursuant to section 312(f)(3) of the Act.

(2) Prohibition pursuant to CWA section 312(f)(4)(A): a State shall be permitted to make a written application to the Administrator, Environmental Protection Agency, under section 312(f)(4)(A) of the Act, for the issuance of a regulation completely prohibiting discharge from a vessel of any sewage, whether treated or not, into particular waters of the United States or specified portions thereof, which waters are located within the boundaries of such State.

(3) Prohibition pursuant to CWA section 312(f)(4)(B): a State shall be permitted to make written application to the Administrator, Environmental Protection Agency, under section 312(f)(4)(B) of the Act, for the issuance of a regulation establishing a drinking water intake no discharge zone which completely prohibits discharge from a vessel of any sewage,

whether treated or untreated, into that zone in particular waters, or portions thereof, within such State.

5.22 *Placard:*

5.22.1 Each device must have a placard suitable for posting on which is printed the operating instructions, safety precautions, and warnings pertinent to the device. The size of the letters printed on the placard must be 0.3175 cm (0.125 in.) or larger.

5.23 *Vents:*

5.23.1 Vents must be designed and constructed to minimize clogging by either the contents of the tank or climatic conditions such as snow or ice.

5.24 *Access to Parts:*

5.24.1 Each part of the device that is required by the manufacturer's instructions to be serviced routinely must be readily accessible in the installed position of the device recommended by the manufacturer.

5.25 *Chemical Level Indicator:*

5.25.1 The device must be equipped with one of the following:

5.25.1.1 A means of indicating the amount in the device of any chemical that is necessary for its effective operation.

5.25.1.2 A means of indicating when chemicals must be added for the proper continued operation of the device.

5.26 *Electrical Component Ratings:*

5.26.1 Electrical components shall have current and voltage ratings equal to or greater than the maximum load to be served.

5.27 *Motors:*

5.27.1 Motors must be rated to operate at 50°C (122°F) ambient air temperature.

5.27.2 Motors exposed to dripping or spraying oil or water shall be of drip-proof construction. All motors shall be fully guarded as installed.

5.27.3 Motors shall be provided with corrosion-resistant nameplate specifying information in accordance with NEC, Article 430-7.

5.27.4 Motors shall be provided with running protection by means of integral thermal protection, by overcurrent devices, or a combination of both in accordance with manufacturer's instructions that shall be based on the requirements of National Electrical Code, NFPA No. 70.

5.27.5 All motors shall be provided with terminal leads or terminal screws in terminal boxes integral with, or secured to, the motor frames.

5.27.6 All rotating or moving parts with the potential to cause injury shall be guarded to avoid accidental contact.

5.28 *Electrical Systems:*

5.28.1 The power supply to the electrical control system shall be from a two-wire branch circuit that has a grounded conductor, otherwise, an isolation transformer with a two-wire secondary shall be provided. When an isolation transformer is provided, one side of the secondary winding shall be grounded.

5.28.2 One side of all coils shall be electrically located in the grounded side of the circuit. All switches, contacts, and overcurrent devices shall be electrically located in the ungrounded or "hot" side of the circuit. All electrical contacts of every safety device installed in the same control circuit shall be

electrically connected in series. However, special consideration shall be given to arrangements when certain devices are wired in parallel.

5.28.3 All electrical components and devices shall have a voltage rating commensurate with the supply voltage of the control system.

5.28.4 All electrical devices shall be at least NEMA Type 2 (Driptight). Electric equipment exposed to the weather shall be at least NEMA Type 4.

5.28.5 All electrical and mechanical control devices shall be of a type tested and accepted by a nationally recognized testing agency for service in a shipboard environment.

5.28.6 The design of the control circuits shall be such that limit and primary safety controls shall directly open a circuit that functions to interrupt the supply of fuel to combustion units.

5.28.7 The MSD's electrical systems shall comply with **IEEE 45-2002** including the use of low smoke cables. The electrical systems shall be designed to minimize radiated and conducted electrical emissions and shall not be susceptible to electrical fields.

5.28.8 The MSD and associated control systems Electro Magnetic Interference (EMI) characteristics shall be compatible with surrounding equipment and consistent with other space machinery.

5.28.9 Electrical power supplied to MSD shall be consistent with the ship's electrical power distribution system.

5.28.10 Lighting and electronics power will be 115V -60Hz, 3-phase, 2-wire ungrounded. Supplied power will be in accordance with **IEEE 45-2002**.

5.29 *Electrical Controls and Conductors:*

5.29.1 All wiring for MSDs shall be rated for the maximum operating temperature to which it has the potential to be exposed. Such wiring shall be in accordance with National Electrical Code, NFPA No. 70. All wiring between components shall have copper conductors not less than size No. 18 AWG and constructed in accordance with the National Electrical Code, NFPA No. 70.

5.29.2 Electrical controls and conductors must be protected from exposure to chemicals and sewage.

5.30 *Conductors:*

5.30.1 Current carrying conductors must be electrically insulated from non-current carrying metal parts.

5.31 *Overcurrent Protection:*

5.31.1 Overcurrent protection must be provided within the unit to protect subcomponents of the device if the manufacturer's recommended supply circuit overcurrent protection is not adequate for these subcomponents.

5.31.2 Conductors for interconnecting wiring that is smaller than the supply conductors shall be provided with overcurrent protection based on the size of the smallest interconnecting conductors external to any control box.

5.31.3 Overcurrent protection for interconnecting wiring shall be located at the point where the smaller conductors connect to the larger conductors. However, overall overcurrent protection is acceptable if it is sized on the basis of the smallest conductors of the interconnecting wiring.

5.31.4 Overcurrent protection devices shall be accessible and their function shall be identified.

5.32 *Terminals:*

5.32.1 Terminals must be solderless lugs with ring type or captive spade ends, must have provisions for being locked against movement from vibration, and must be marked for identification on the wiring diagram required in 5.21. Terminal blocks must be nonabsorbent and securely mounted. Terminal blocks must be provided with barrier insulation that prevents contact between adjacent terminals or metal surfaces.

5.33 *Baffles:*

5.33.1 Baffles in sewage retention tanks, if any, must have openings to allow liquid and vapor to flow freely across the top and bottom of the tank.

5.34 *Level Indicator:*

5.34.1 Each sewage retention device shall have a means of indicating tank level that complies with Specification F2044.

5.35 *Sewage Removal:*

5.35.1 The device must be designed for efficient removal of nearly all of the liquid and solids in the sewage retention tank.

5.36 *Removal Fittings:*

5.36.1 If sewage removal fittings or adapters are provided with the device, they must include IMO MARPOL Annex IV Regulation 10 standard connections for international operation, as provided in Table 2 and/or USCG connections of either 1.5 in. (3.81 cm) or 4 in. (10.16 cm) nominal pipe size for operations within U.S. waters.

5.37 *Power Interruption:*

5.37.1 A discharge device must be designed so that a momentary loss of power during operation of the device prevents a discharge not meeting the requirements in Section 9.

5.38 *Independent Supporting:*

5.38.1 The device must have provisions for support that are independent from connecting pipes.

5.39 The system shall comply with Practice F1166.

6. Performance Requirements

6.1 *Testing—General:*

6.1.1 The following testing requirements are included in 33 CFR 159, Department of Homeland Security, U.S. Coast Guard Directives, Marine Sanitation Devices and are necessary to obtain U.S. Coast Guard Certification.

6.1.2 Unless otherwise authorized by the Coast Guard, a recognized facility must perform each test described in 6.2 through 6.13. The same device must be used for each test and tested in the order in which the tests are described. There must be no cracking, softening, deterioration, displacement, breakage, leakage or damage of components or materials that affects the operation or safety of the device after each test described in 6.2 through 6.8 and 6.10, and the device must remain operable after the test described in 6.9. The device must be set up in a manner simulating installation on a vessel in accordance with the manufacturer’s instructions with respect to mounting, water supply, and discharge fittings.

6.2 *Vibration Test:*

6.2.1 The device, with liquid retention components, if any, filled with water to one-half of their volume, must be subjected to a sinusoidal vibration for a period of 12 h, 4 h in each of the x, y, and z planes, at the resonant frequency of the device (or at 55 Hz if there is no resonant frequency between 10 to 60 Hz) and with a peak amplitude of 0.048 to 0.053 cm (0.019 to 0.021 in.).

6.3 *Shock Test:*

6.3.1 The device, with liquid retention components, if any, filled with water to half of their volume, must be subjected to 1000 vertical shocks that are 98.07 m/s² (10 g) and have a duration of 20 to 25 ms measured at the base of the half-sine shock envelope.

6.4 *Rolling Test:*

6.4.1 The device, with liquid retention components, if any, filled with water to half of their volume, must be subjected to 100 cycles with the axis of rotation 4 ft from the centerline of the device, no more than 15.24 cm (6 in.) below the plane of the bottom of the device, and parallel to any tank baffles. The device must then be rotated 90° on its vertical axis and subjected to another 100 cycles. This testing must be repeated with the liquid retention components filled to the maximum operating level as specified by the manufacturer in 5.21.

6.4.2 Eighty percent of the rolling action must be approximately 15° on either side of the vertical and at a cyclic rate of 3 to 4 s. Twenty percent motions must be approximately 30° , or the maximum angle specified by the manufacturer under 5.21, whichever is greater, on either side of the vertical at a cyclic rate of 6 to 8 s.

TABLE 2 IMO MARPOL 73/78 Annex IV Standard Dimensions for Flanges for Discharge Connections

Description	Dimension
Outside diameter	210 mm
Inner diameter	According to pipe outside diameter
Bolt circle diameter	170 mm
Slots in flange	Four holes 18 mm in diameter equidistantly placed; on a bolt circle of the above diameter, slotted to the flange periphery. The slot width to be 18 mm.
Flange thickness	16 mm
Bolts and nuts: quantity and diameter	Four, each of 16 mm in diameter and of suitable length.

The flange is designed to accept pipes up to a maximum internal diameter of 100 mm and shall be of steel or other equivalent material having a flat face. This flange, together with a suitable gasket, shall be suitable for a service pressure of 6 kg/cm².

For ships having a molded depth of 5 m and less, the inner diameter of the discharge connection may be 38 mm.

For ships in dedicated trades, such as passenger ferries, alternatively the ship’s discharge pipeline may be fitted with a discharge connection that can be accepted by the Administration, such as quick-connection couplings.