



Standard Specification for Sewage and Graywater Flow Through Treatment Systems¹

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INTRODUCTION

Shipboard treatment of wastewater has evolved over the years from systems using maceration and chlorination techniques to more advanced biological systems that are designed to treat a single wastestream of sewage followed more recently by complex bio-reactor systems employing advanced oxidation and high-powered UV systems that are designed to remove organic and inorganic materials from a combined wastestream of sewage and graywater.

Advancements in treatment technologies have been fueled, in part, by shipping companies wanting to adopt more environmentally friendly practices as well as by regulatory bodies imposing more stringent standards on wastewater discharges from ships.

This standard is a consolidated source of sewage and graywater treatment system requirements that combines international requirements in MARPOL Annex IV with requirements of other regulatory bodies and overlays industry best practices.

1. Scope

1.1 This specification covers the design, manufacture, performance, operation, and testing of flow through treatment systems intended to process sewage or graywater, or both, generated during a ship's normal service. This specification is intended for use by designers, manufacturers, purchasers, and operators of shipboard environmental pollution control equipment to determine the requirements for equipment design, manufacture, purchase, and in-service operation.

1.2 The treatment system shall be capable of meeting the effluent requirements detailed in Section 4 with respect to a ship's operational area.

1.3 The values stated in either SI units or inch-pound units are to be regarded separately as standard. The values stated in each system may not be exact equivalents; therefore, each system shall be used independently of the other. Combining values from the two systems may result in non-conformance with the standard.

1.4 *This standard does not purport to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use.*

¹ This specification is under the jurisdiction of ASTM Committee F25 on Ships and Marine Technology and is the direct responsibility of Subcommittee F25.06 on Marine Environmental Protection.

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2. Referenced Documents

2.1 ASTM Standards:²

- A307 Specification for Carbon Steel Bolts, Studs, and Threaded Rod 60 000 PSI Tensile Strength
- A563 Specification for Carbon and Alloy Steel Nuts
- B117 Practice for Operating Salt Spray (Fog) Apparatus
- B165 Specification for Nickel-Copper Alloy (UNS N04400) Seamless Pipe and Tube
- D1253 Test Method for Residual Chlorine in Water
- E11 Specification for Woven Wire Test Sieve Cloth and Test Sieves
- F906 Specification for Letters and Numerals for Ships
- 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

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.

Joins for Marine Applications

- F1323 Specification for Shipboard Incinerators
- F1387 Specification for Performance of Piping and Tubing Mechanically Attached Fittings
- 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 *ASME Standards:*³

- B16.1 Gray iron pipe flanges and flanged fittings: Classes 25, 125, and 250
- B16.5 Pipe flanges and flanged fittings: NPS ½ through NPS 24 metric/inch standard
- B16.11 Forged fittings, socket-welding and threaded
- B16.24 Cast copper alloy pipe flanges and flanged fittings: Classes 150, 300, 600, 900, 1500, and 2500
- B16.34 Valves flanged, threaded, and welding end

2.3 *IMO Regulations:*⁴

- MARPOL Annex IV Regulations for the prevention of pollution by sewage from ships
- MEPC.159(55) Guidelines on implementation of effluent standards and performance tests for sewage treatment plants

2.4 *ISO Standards:*⁵

- ISO 5815-1 Water quality—Determination of biochemical oxygen demand after n days (BOD_n)—Part 1: Dilution and seeding method with allylthiourea addition
- ISO 15705 Water quality—Determination of the chemical oxygen demand index (ST-COD)—Small-scale sealed-tube method

2.5 *US Laws and Regulations:*⁶

- 33 CFR Part 159 Marine sanitation devices
- 33 CFR 159.301 Subpart E—Discharge of effluents in certain Alaskan waters by cruise vessel operations
- 40 CFR Part 136 Guidelines establishing test procedures for the analysis of pollutants

2.6 *Other Standards:*

- ANSI/ASSE 1001 Performance requirements for atmospheric type vacuum breakers⁵
- ANSI/ASSE 1013 Performance requirements for reduced pressure principle backflow preventers and reduced pressure principle fire protection backflow preventers⁵
- ANSI/ISA 60079-1 Explosive atmospheres—Part 1: Equipment protection by flameproof enclosures *d*⁵
- ANSI/ISA 60079-11 Explosive atmospheres—Part 11: Equipment protection by intrinsic safety *i*⁵

- ANSI/NEMA 250 Enclosures for electrical equipment (1000 Volts Maximum)⁵
- ANSI/NEMA MG 1 Motors and generators⁵
- DoD 4715.6-R1 Regulations on vessels owned or operated by the Department of Defense⁷
- IEC 60079-1 Explosive atmospheres—Part 1: Equipment protection by flameproof enclosures *d*⁸
- IEC 60079-11 Explosive atmospheres—Part 11: Equipment protection by intrinsic safety *i*⁸
- IEC 60085 Electrical insulation—Thermal evaluation and designation⁸
- IEC 60092–350 Electrical installations in ships—Part 350: General construction and test methods of power, control, and instrumentation cables for shipboard and offshore applications⁸
- IEC 60092–353 Electrical installations in ships—Part 353: Single and multicore non-radial field power cables with extruded solid insulation for rated voltages 1 kV and 3 kV⁸
- IEC 60529 Degrees of protection provided by enclosures (IP Code)⁸
- IEEE 1580 Recommended practice for marine cable for use on shipboard and fixed or floating platforms⁹
- MIL-S-167-1 Test method standard for mechanical vibrations of shipboard equipment¹⁰
- MIL-S-901 Requirements for shock tests: High-impact shipboard machinery, equipment, and systems¹⁰
- NFPA 70 National Electrical Code¹¹
- SNAME T&R Bulletin 3-37 Design guide for shipboard airborne noise control¹²
- SM 4600-CI Chlorine (residual)—Standard methods for the examination of water and wastewater¹³
- UL 913 Intrinsically safe apparatus and associated apparatus for use in class I, II, and III, division 1, hazardous (classified) locations¹⁴
- UL 1203 Explosion-proof and dust-ignition-proof electrical equipment for use in hazardous (classified) locations¹⁴
- UL 1309 Marine shipboard cables¹⁴

3. Terminology

3.1 *Definitions:*

- 3.1.1 *blackwater*—see *sewage*.

⁷ Available from the Under Secretary of Defense (AT&L), Department of Defense, 3400 Defense Pentagon, Washington, DC 20301-3400, USA, <http://www.dtic.mil/whs/directives/corres/pub1.html>.

⁸ Available from the International Electrotechnical Commission, 3 rue de Varembe, PO Box 131, CH-1211 Geneva 20, Switzerland, <http://www.iec.ch>.

⁹ Available from Institute of Electrical and Electronics Engineers, Inc. (IEEE), 445 Hoes Ln., Piscataway, NJ 08854, <http://www.ieee.org>.

¹⁰ Available from the Document Automation and Production Service, Department of Defense, Bldg 4/D, 700 Robbins Ave, Philadelphia, PA 19111, USA, <http://dodssp.daps.dla.mil/>

¹¹ Available from National Fire Protection Association (NFPA), 1 Batterymarch Park, Quincy, MA 02169-7471, <http://www.nfpa.org>.

¹² Available from the Society of Naval Architects and Marine Engineers, 601 Pavonia Ave, Jersey City, NJ 07306, USA, www.sname.org.

¹³ Available from American Public Health Association, 800 I St N.W., Washington, DC 20001-3710, USA, www.standardmethods.org.

¹⁴ Available from Underwriters Laboratories (UL), 2600 N.W. Lake Rd., Camas, WA 98607-8542, <http://www.ul.com>.

³ Available from American Society of Mechanical Engineers (ASME), ASME International Headquarters, Three Park Ave., New York, NY 10016-5990, <http://www.asme.org>.

⁴ Available from the International Maritime Organization, 4 Albert Embankment, London SE1 7SR, United Kingdom, <http://www.imo.org>.

⁵ Available from American National Standards Institute (ANSI), 25 W. 43rd St., 4th Floor, New York, NY 10036, <http://www.ansi.org>.

⁶ Available from U.S. Government Printing Office Superintendent of Documents, 732 N. Capitol St., NW, Mail Stop: SDE, Washington, DC 20401, <http://www.access.gpo.gov>.

3.1.2 *chlorine, n*—residual disinfectant or byproducts associated with the use of chlorine or its compounds.

3.1.3 *coliform, n*—thermotolerant coliform bacteria which produce gas from lactose in 48 h at 44.5°C [112.1°F].

3.1.4 *cruise ship, n*—ship, including submersible craft, carrying at least one passenger for hire for whom consideration is contributed as a condition of carriage, whether directly or indirectly flowing to the owner, charterer, operator, agent, or any other person having an interest.

3.1.5 *deleterious effect, n*—cracking, softening, deterioration, displacement, breakage, leakage, or damage of components or materials that affects the operation or safety of a treatment system.

3.1.6 *dilution, n*—process water added to the treatment system.

3.1.7 *discharge, n*—spilling, leaking, pumping, pouring, emitting, emptying, or dumping, however caused.

3.1.8 *effluent, n*—liquid containing sewage, graywater, or other wastes, whether treated or untreated, flowing out of the treatment system or holding tank usually to be discharged.

3.1.9 *flushwater, n*—transport medium used to carry sewage or other wastes from toilets or urinals to the treatment system.

3.1.10 *geometric mean, n*—the *n*th root of the product of *n* numbers.

3.1.11 *graywater, n*—(1) drainage from galley sink and dishwater drains; (2) drainage from laundry facilities; or (3) drainage from bath, shower, and washbasin drains.

3.1.12 *holding tank, n*—tank for collecting or storing of sewage or graywater, whether treated or untreated, having suitable design, construction, fittings, and coatings for the intended purpose as designated by the certifying body.

3.1.12.1 *Discussion*—The terms sludge tank, bioreactor tank, collection tank, receiving tank, and flow equalization tank are synonymous with holding tank, but for a different purpose.

3.1.13 *influent, n*—liquid containing sewage, graywater, or other wastes, whether treated or untreated, flowing into the treatment system or holding tank.

3.1.14 *international voyage, n*—voyage from a port or place in one country to a port or place outside such country, or conversely.

3.1.15 *operational, adj*—(1) quality of performance or quality of effluent, a treatment system that continually processes, treats, and discharges wastewater to the applicable treatment standard, or is ready to do so following an individual use; (2) functional area, a description of the ship’s route, duration of voyage, and distance from nearest land; (3) daily routine, a schedule of events, meal times, and work hours for the ship’s crew.

3.1.16 *passenger ship*—see *cruise ship*.

3.1.17 *process water, n*—seawater or other liquid added to the treatment process.

3.1.18 *residual chlorine*—see *chlorine*.

3.1.19 *retention tank, n*—auxiliary tank, pressure vessel, container, reservoir, or similar component for storing liquids, solids, or gasses used or capable of being used during the treatment process.

3.1.20 *sewage, n*—(1) drainage and other wastes from any form of toilets and urinals; (2) drainage from medical premises (for example, dispensary, sick bay, etc.) by means of wash basins, wash tubs, and scuppers located in such premises; (3) drainage from spaces containing living animals; or (4) other wastewater when mixed with the drainages defined above.

3.1.21 *ship, n*—every description of watercraft, other than a seaplane on the water, used or capable of being used as a means of transportation in water.

3.1.21.1 *Discussion*—The terms ship and vessel are interchangeable and synonymous.

3.1.22 *thermotolerant coliform*—see *coliform*.

3.1.23 *tonnage, n*—a function of the moulded volume of enclosed spaces on the ship, gross or net, as indicated on the ship’s international tonnage certificate.

3.1.24 *wastestream*—see *wastewater*.

3.1.25 *wastewater, n*—liquid containing sewage, graywater, or other similar wastes, including flushwater.

3.1.25.1 *Discussion*—Wastes do not include industrial wastes, such as from fixed or floating platforms engaged in exploration, exploitation, and associated offshore processing of seabed mineral resources.

3.1.26 *vessel*—see *ship*.

4. Classification

NOTE 1—Concentration limit for solids is $\leq 10\%$ of calculated TSS. See 11.14.1.

4.1 *Type I marine sanitation device* is a flow-through sewage treatment system certified by the U.S. Coast Guard for installation on a U.S. flagged vessel ≤ 19.7 m [65 ft] in length and designed to meet the requirements in 33 CFR Part 159. This treatment system is typically a small device that is designed to be used for processing, treating, and discharging sewage “on demand” following each individual use. In the United States, vessels are able to discharge through this device while operating within three nautical miles (nm) of land, except where otherwise prohibited.

4.2 *Type II-A marine sanitation device* is a flow-through sewage treatment system certified by the U.S. Coast Guard for installation on a U.S. flagged vessel of any length to meet the

TABLE 1 Treatment Standards by Type of System^A

Type	Coliform, CFU/100 mL	TSS, mg/L	BOD ₅ , mg/L	COD, mg/L	Chlorine, µg/L	pH
I	≤ 1000	(see Note 1)	...	...	...	...
II-A	≤ 200	≤ 150	...	...	...	...
II-B	≤ 100	≤ 35	≤ 25	≤ 125	< 500	6–8.5
II-C	≤ 20	≤ 30	≤ 30	...	≤ 10	6–9
III	...	...	...	...	...	...

^AAmounts presented in this table are for comparison purposes only. For detailed requirements, consult the regulatory standard cited in 4.1 through 4.6, as appropriate.