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An American National Standard

Standard Specification for Sewage and Graywater Flow Through Treatment Systems[1]

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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, health, and environmental practices and determine the applicability of regulatory limitations prior to use.*

1.5 *This international standard was developed in accordance with internationally recognized principles on standardization established in the Decision on Principles for the Development of International Standards, Guides and Recommendations issued by the World Trade Organization Technical Barriers to Trade (TBT) Committee.*

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 (Metric) A0563_A0563M

B117 Practice for Operating Salt Spray (Fog) Apparatus

B165 Specification for Nickel-Copper Alloy 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

[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] 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.

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

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.227(64)(2012) 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 *U.S. 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 breakers[5]

ANSI/ASSE 1013 Performance requirements for reduced pressure principle backflow preventers and reduced pressure principle fire protection backflow preventers[5]

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 generators[5]

DoD 4715.6-R1 Regulations on vessels owned or operated by the Department of Defense[7]

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 designation[8]

IEC 60092–350 Electrical installations in ships–Part 350: General construction and test methods of power, control, and instrumentation cables for shipboard and offshore applications[8]

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 kV[8]

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 platforms[9]

MIL-S-167-1 Test method standard for mechanical vibrations of shipboard equipment[10]

MIL-S-901 Requirements for shock tests: High-impact shipboard machinery, equipment, and systems[10]

NFPA 70 National Electrical Code[11]

SNAME T&R Bulletin 3-37 Design guide for shipboard airborne noise control[12]

SM 4600-Cl Chlorine (residual)–Standard methods for the examination of water and wastewater[13]

UL 913 Intrinsically safe apparatus and associated apparatus for use in class I, II, and III, division 1, hazardous (classified) locations[14]

UL 1203 Explosion-proof and dust-ignition-proof electrical

[3] Available from American Society of Mechanical Engineers (ASME), ASME International Headquarters, Two 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, Washington, DC 20401-0001, http://www.access.gpo.gov.

[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 Varembé, 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 DLA Document Services, Building 4/D, 700 Robbins Ave., Philadelphia, PA 19111-5094, http://quicksearch.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.

equipment for use in hazardous (classified) locations[14]
UL 1309 Marine shipboard cables[14]

3. Terminology

3.1 *Definitions:*

3.1.1 *blackwater*—see *sewage*.

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, Q_d, 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, Q_e, 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 nth 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, Q_i, 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 ≤10 % of calculated TSS. See 11.15.1.

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 requirements in 33 CFR Part 159. For U.S. flagged vessels that engage in international voyages, Type II-A devices fitted with holding tank for the temporary storage of treated sewage meet the requirements of regulation 9.1.2 of MARPOL Annex IV as a sewage comminuting and disinfecting system. This treatment system is typically a large device that is designed to be used for processing, treating, and discharging sewage continuously between individual uses. In the United States, vessels are able to discharge through this device while operating within 3 nm of

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	Total Nitrogent[B]	Total Phosphorus
I	#1000	(see Note 1)	...	...	...	...	...	...
II-A	#200	#150	...	...	...	...	...	...
II-B	#100	#35	#25	#125	<500	6–8.5	20 Q_i/Q_e[C]	1.0 Q_i/Q_e[D]
II-C	#20	#30	#30	...	#10	6–9	...	...
III	...	...	...	...	...	...	...	...

[A] Amounts 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.
[B] Total nitrogen means the sum of total Kjeldahl nitrogen (organic and ammoniacal nitrogen), nitrate-nitrogen, and nitrite-nitrogen.
[C] Or at least 70 % reduction in relation to the load of the influent.
[D] Or at least 80 % reduction in relation to the load of the influent.

land, except where otherwise prohibited. However, while operating on an international voyage, such discharges are at a distance of >3 nm from nearest land.

4.3 *Type II-B sewage treatment plant* is a flow-through treatment system of a type approved by the flag Administration for installation on a ship engaged in international voyages of 400 gross tonnage (GT) and above, and ships of <400 GT which are certified to carry >15 persons, to meet the requirements of regulation 9.1.1 of MARPOL Annex IV as amended by MEPC.227(64). Such a sewage treatment plant installed on a passenger ship is additionally type approved to meet the requirements of regulation 9.2.1 of MARPOL Annex IV when operating in a Special Area designated by MARPOL Annex IV. This treatment system is typically a large device that is designed to be used for processing, treating, and discharging sewage or graywater, or both, continuously between individual uses. While on an international voyage, vessels are able to discharge through this treatment system while operating within 3 nm of land, except where otherwise prohibited.

4.4 *Type II-C advanced wastewater treatment system* are Type II-B sewage treatment plants that are designed to treat a combined sewage and graywater influent to a more stringent standard for installation on a cruise ship authorized to carry ≥500 passengers operating in certain Alaskan waters to meet the requirements Subpart E to 33 CFR 159.301 et seq. Cruise ships are able to discharge through this treatment system while operating in certain Alaskan waters.

4.5 *Type III-A marine sanitation device* certified by the U.S. Coast Guard for installation on a U.S. flagged vessel of any length designed to prevent the overboard discharge of treated or untreated sewage to meet the requirements in 33 CFR Part 159. Typically this holding tank is used solely for the storage of wastewater (for example, sewage, graywater, flushwater) at ambient air pressure and temperatures. In the United States, vessels are able to discharge from a holding tank while operating outside of 3 nm of land, except where otherwise prohibited. However, while operating on an international voyage, such discharges occur at a distance of >12 nm from nearest land and while the vessel is en route proceeding at ≥4 kts.

4.6 *Type III-B sewage holding tank* constructed to the satisfaction of the flag Administration and having capacity for the retention of all sewage, with visual means to indicate the amount of its contents, taking into account the operation of the ship, the number of persons on board, and other relevant factors, to meet the requirements of regulation 9.1.3 of MARPOL Annex IV. Discharges are similar to Type III-A.

5. Ordering Information

5.1 *General:*

5.1.1 Purchaser shall provide treatment system manufacturer with all pertinent acquisition requirements, including items shown in 5.2.

5.2 *Acquisition Requirements:*

5.2.1 Title, number, and date of this specification.

5.2.2 Type of treatment system (for example, Type II-B) from Section 4.

5.2.3 Whether treatment system is designed to process or retain sewage or graywater, or combined sewage and graywater.

5.2.4 Maximum number of persons, including non-crew members.

5.2.5 *Design Sizing Requirements:*

5.2.5.1 Hydraulic loading for both graywater and sewage in accordance with Table 2, including method of collection, whether gravity or vacuum feed.

5.2.5.2 When specifying growth margin, it is important to consider the potential for increases in the number of crew and passengers over the life of the ship.

NOTE 2—If vacuum collection is used for graywater, then design generation rate is expected to be the same as for gravity collected graywater.

5.2.6 Organic loading for both graywater and sewage in accordance with Table 3.

5.2.7 Thermal loading for both graywater and sewage influent temperature taking into account management of variations in influent temperature.

TABLE 2 Hydraulic Loading Design Flow per Capita by Collection Method

Collection Method	Sewage, L/day [gal/day]	Graywater, L/day [gal/day]
Gravity	23 – 125 [6 – 33]	34 – 189 [9 – 50]
Vacuum, with urinals	2.3 – 13 [0.6 – 3.3]	(see Note 2)
without urinals	4.2 – 23 [1.1 – 6.1]	(see Note 2)

TABLE 3 Organic Loading Design Rate per Capita by Influent

Influent	TSS, kg/day [lb/day]	BOD_5, kg/day [lb/day]
Sewage	0.044 – 0.073 [0.096 – 0.161]	0.016 – 0.035 [0.036 – 0.078]
Graywater	0.033 – 0.061 [0.072 – 0.134]	0.118 – 0.156 [0.259 – 0.343]

5.2.7.1 Consideration should include the addition of a temperature or flow equalization tank, or other means to adjust temperature.

5.2.8 Treatment system start-up and stabilization periods.

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

5.2.10 Doorway, hatch, and compartment dimensions, including clearance restrictions for access to parts for service.

5.2.11 Operational profile of ship.

5.2.12 Additional control requirements.

5.2.13 Any additional requirements as required by purchaser to meet special needs.

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

5.2.15 Supplementary requirements, if any, from Section S1.

6. Materials and Manufacture

6.1 *Material Deterioration, Prevention, and Control:*

6.1.1 Treatment system shall be fabricated from compatible materials, inherently corrosion resistant or treated to provide protection against corrosion and deterioration for the service life of the treatment system from the following:

6.1.1.1 Internal exposure to wastestreams, chemicals, and other substances commonly found in treatment systems or as part of the treatment process; and

6.1.1.2 External exposure to petroleum products, cleaning compounds, and other substances commonly used on ships in the compartment where a treatment system will be installed.

6.1.2 A listing of common substances that a treatment system may be exposed to is provided in Table 4.

TABLE 4 Common Substances by Exposure Type[A]

Substance	Internal[B]	External[B]
Sewage, graywater, flushwater incl intermediate process fluids, vapors	X	X
Toilet bowl cleaners, pipe scale prevention chemicals incl bleach, citric acid tablets, acid-based & biological substances	X	X
Disinfectants incl solid, liquid or gas, in quantity specified by manufacturer	X	X
Fuel oils or other fuels incl diesel fuel, marine fuel oil		X
Lubricating oils incl synthetic & petroleum-based oils		X
Cleaning agents incl mineral spirits, methyl alcohol, petroleum-based solvents		X

[A] Substance list may vary by treatment system type, ship type, etc.
[B] "X" indicates the listed substance is common.

6.1.3 Manufacturer should develop a list of specific substances considered in the design of a particular treatment system.

6.1.4 Dissimilar metals shall not be used in intimate contact with each other unless protected against galvanic corrosion.

6.1.5 Treatment system shall not be damaged nor shall subsequent operational performance be degraded:

6.1.5.1 As a result of exposure to salt fog in accordance with Practice B117; and

6.1.5.2 When in a non-operating state, such as when secured for winter layup.

6.1.6 Components, such as valves, fittings, pumps, and motors shall be of corrosion resistant material suitable for the intended service and shall be standard items such as those complying with ASME B16.34, Practice F1030 and Specifications A307, A563, F992, F993, F998, F1098, F1122, F1298, F1387, F1510, and F1511, which are easy to maintain and replace.

6.1.7 Component design shall be compatible with treatment system materials.

6.1.8 Metallic holding and retention tanks shall be provided with cathodic protection, or by insulation of the galvanic coupling, to minimize corrosion due to galvanic reactions.

6.1.9 Fasteners shall be of corrosion resistant material.

6.2 *Design for Human Interface and Safety:*

6.2.1 Practice F1166 shall be used for the design, construction, and layout of the treatment system, controls, displays, equipment, and labels.

6.2.1.1 Warning and operating labels shall be affixed to treatment system where necessary in accordance with Practice F1166.

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

6.2.3 Equipment requiring routine maintenance shall be easily accessible.

6.3 *Features:*

6.3.1 *Vents*—Vents shall be designed and constructed to minimize clogging by either contents of holding and retention tanks or climatic conditions such as snow or ice.

6.3.2 *Baffles*—Baffles in holding and retention tanks, if any, shall have openings to allow contents to flow freely across the top and bottom of the tank.

6.3.3 *Level Indicator*—Holding and retention tanks, if any, shall have a means of indicating tank level that complies with Specification F2044.

6.3.4 *Chemical Level Indicator*—If the treatment system uses one or more chemicals for its effective operation, then the system shall be fitted with one of the following:

6.3.4.1 means of indicating the amount of the chemical in the retention and holding tanks; or

6.3.4.2 Means of indicating when chemicals need to be added to the retention and holding tanks for the proper continued operation of the treatment system.

6.3.5 *Independent Support*—Treatment system shall have provisions for support that are independent from connecting pipes.

6.3.5.1 Piping shall not be used to support the treatment system or its major components.

6.3.6 *Backflow Prevention*—Treatment system shall be protected from backflow of wastewater through supply and discharge piping.

6.3.6.1 Manufacturer may specify in the installation instructions backflow prevention requirements as part of ship's piping.

6.3.6.2 Where pressurized backflow is not possible, atmospheric type vacuum breaker conforming to ANSI/ASSE 1001 shall be used.

6.3.6.3 Treatment system using ship supplied potable water shall be fitted with a reduced pressure principle sanitary backflow preventer conforming to ANSI/ASSE 1013 in order to protect the ship's potable water from cross-contamination.

6.3.7 *Sampling Ports*—Treatment system shall provide for manually collecting representative samples of influent and effluent without opening tanks, voids, or vents.

6.3.7.1 Ports shall be located in: (*1*) influent line, or receiving and collection tank, for sampling influent; and (*2*) effluent line immediately downstream of treatment system for sampling effluent.

6.3.7.2 Manufacturer may specify in installation instructions additional sampling port requirements as part of ship piping.

6.3.7.3 If a sludge collection tank or discharge line is included in the treatment system design, then a sampling port is required.

6.3.7.4 For biological treatment systems, provisions shall be made on the bioreactor tank for assessing the condition of the biomass.

6.3.8 *Removal Fittings*—Standard discharge fittings, if provided with treatment system, shall be in accordance with Table 5.

6.3.8.1 Flange in Table 5 is designed to accept pipes up to a maximum internal diameter of 100 mm [3.9 in] and shall be of steel or other equivalent material having a flat face. This flange, together with a gasket, shall be suitable for a service pressure of 6 kg/cm^2 [85.3 psi].

6.3.8.2 For ships having a molded depth ≤5 m [16.4 ft], the inner diameter of the discharge connection may be 38 mm [1.5 in.].

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

TABLE 5 Standard Dimensions for Flanges for Discharge Connections

Description	Dimension
Outside diameter	210 mm [8.3 in.]
Inner diameter	According to pipe outside diameter
Bolt circle diameter	170 mm [6.7 in.]
Slots in flange	4 holes 18 mm [0.7 in.] in diameter equidistantly placed; on a bolt circle of the above diameter, slotted to the flange periphery. The slot width to be 18 mm [0.7 in.]
Flange thickness	16 mm [0.6 in.]
Bolts and nuts, quantity and diameter	4, each of 16 mm [0.6 in.] in diameter and of suitable length

6.4 *Piping:*

6.4.1 Piping shall be compatible with treatment system materials.

6.4.2 Piping selection and application shall be in accordance with Practice F1155.

6.4.3 Pipe bends, if any, shall have minimum 3:1 bend radius to diameter.

6.4.4 Inlet and outlet connections shall be in accordance with ASME B16.1, B16.5, or B16.11, or ASME B16.24 or equivalent ISO or DIN standards.

6.4.5 Piping shall be clamped to prevent damage or unintended discharge due to stress or vibration.

6.4.6 If copper-nickel alloy piping is used, then it shall meet the requirements in Specification B165.

6.4.7 If alternate materials are used other than those listed in Practice F1155, then the manufacturer shall obtain buyer approval for use.

6.5 *Electrical:*

6.5.1 *Components and Installation:*

6.5.1.1 Interior electrical equipment and enclosures for treatment system used in a machinery space, a location normally exposed to splashing, or another space with similar moisture levels shall be at least IEC 60529 IP 44 or an appropriate ANSI/NEMA 250 Type for the intended service.

6.5.1.2 Exterior electrical equipment and enclosures for treatment system exposed to weather, water washdown, or similar moisture conditions shall be at least IEC 60529 IP 65 or ANSI/NEMA 250 Type 4 or Type 4X.

6.5.1.3 Electrical equipment and installations shall be suitable for roll, pitch, and vibration of a ship while underway.

6.5.1.4 Electrical equipment for treatment system, including switches, fuses, lamp holders, etc., shall be suitable for the voltage and current utilized.

6.5.1.5 Electrical equipment and circuits for treatment system shall be clearly marked and identified on wiring diagram in 15.3.1.4 and 15.5.1.14.

6.5.1.6 Any cabinet, panel, box, or other enclosure containing more than one source of power shall be fitted with a sign warning persons of this condition and identifying the circuits to be disconnected.

6.5.1.7 Electrical equipment exposed to corrosive environments shall be corrosion resistant and of suitable construction.

6.5.1.8 Electrical equipment shall be protected from accidental contact by personnel operating or routinely servicing the equipment.

6.5.2 *Control Systems and Conductors:*

6.5.2.1 Wiring for treatment system shall be rated for the maximum operating temperature to which it has the potential to be exposed.

6.5.2.2 All control wiring between components shall have stranded copper conductors of ≥No. 18 AWG or shall have stranded copper conductors with a current-carrying capacity of ≥125 % of the expected current. Communications and radio frequency (RF) cables, such as USB, ribbon, coaxial, telephone twisted-pairs, Ethernet, or similar cables do not have to meet this requirement.

6.5.2.3 Internal wiring of cabinets or enclosures shall be of NEC or equivalent type insulated wires suitable for at least dry and damp locations.

6.5.2.4 Internal wiring within enclosure or cabinet shall terminate on terminal blocks when connection to external wiring is necessary.

6.5.2.5 When individual insulated wires are used, rather than cable, outside cabinets or enclosures on systems of >50 V, wires shall be in conduit.

6.5.2.6 Cables shall be secured with metallic band strapping such that they remain tight without damage to armor or insulation.

6.5.2.7 Metallic band strapping used for cable support shall be fabricated from steel and corrosion treated if not of a corrosion-resistant material.

6.5.2.8 Cable supports for all horizontal runs shall prevent undue sag.

6.5.2.9 Cable retention devices shall be installed on vertical and horizontal runs, as applicable.

6.5.2.10 Power cables and external control cables shall meet construction and testing standards of IEEE 1580, UL 1309, IEC 60092-350, or IEC 60092-353 with amendment 1.

6.5.2.11 When a Type metal-clad (MC) cable is used it shall be a continuous corrugated metal-clad cable.

6.5.2.12 Portable cables or flexible cords may be used for external connections of moving parts or where frequent interchange or disconnection is necessary due to calibration or maintenance of field connected devices.

6.5.2.13 Overcurrent protection shall be in accordance with Article 240 of NFPA 70 or equivalent standard as determined by the certifying body.

6.5.2.14 Electrical equipment in spaces containing machinery powered by, or fuel tanks containing, gasoline or other fuels having a flashpoint of ≤43.3°C [110°F] shall be explosion-proof or ignition-protected or be part of an intrinsically safe system.

6.5.3 *Motors:*

6.5.3.1 Motors shall be rated to operate at 50.0°C [122°F] ambient air temperature, unless it can be shown that a 40.0°C [104°F] or 45.0°C [113°F] ambient temperature will not be exceeded.

6.5.3.2 Motors shall be constructed with a minimum of Class F insulation in accordance with IEC 60085 or ANSI/NEMA MG 1.

6.5.3.3 Motors exposed to splashing or spraying oil or water shall be at least IEC 60529 IP 44 or an equivalent ANSI/NEMA 250 type for the service intended.

6.5.3.4 Motors shall be provided with a corrosion resistant nameplate specifying: (*1*) manufacture's name; (*2*) rated horsepower; (*3*) rated voltage and full-load current; (*4*) rated frequency and number of phases; (*5*) rated RPM; (*6*) rated temperature; (*7*) the Code letter; and (*8*) thermal protection, if used. For IEC motors, manufacturer shall certify the rated temperature by signed letter or other equivalent means.

6.5.3.5 Motor branch circuits, motor feeder conductors and their protection, motor overload protection, motor control circuits, motor controllers, and motor control centers shall be in accordance with Article 430 of NFPA 70 or equivalent standard as determined by the certifying body.

6.5.3.6 Motor controllers shall have a power rating in accordance with Part IV of Article 430 of NFPA 70 or equivalent standard as determined by the certifying body.

6.5.3.7 Motors shall be provided with motor running protection in accordance with Part IV of Article 430 of NFPA 70 or equivalent standard as determined by the certifying body.

6.5.3.8 Thermal protection of the motor shall be in accordance with Part III of Article 430 of NFPA 70 or equivalent standard as determined by the certifying body.

6.5.3.9 Conductors of a motor remote control, interlock, and indicator circuits shall be protected against overcurrent in accordance with Part VI of Article 430 of NFPA 70 or equivalent standard as determined by the certifying body.

6.5.3.10 Motors shall be provided with terminal leads or terminal screws in terminal boxes integral with or secured to the motor frame.

6.5.3.11 Motor terminal housing shall be in accordance with Article 430 of NFPA 70 or equivalent standard as determined by the certifying body.

6.5.4 *Pumps:*

6.5.4.1 Pumps, if fitted to a treatment system, shall be in accordance with Specifications F998 or F1510 or equivalent standard as determined by the certifying body.

6.5.4.2 Positive displacement pumps, if any, shall have a relief valve to direct flow back to the tank from which the pump takes suction. Piping to pump inlet is prohibited.

6.5.4.3 Positive displacement pumps having rubber stators shall be fitted with run dry protection.

6.6 *Hazardous Locations:*

6.6.1 Components to be installed in hazardous location shall be certified as being:

6.6.1.1 Intrinsically safe in accordance with UL 913, ANSI/ISA 60079-11, or IEC 60079-11;

6.6.1.2 Explosion proof in accordance with UL 1203, ANSI/ISA 60079-1, or IEC 60079-1 for Class I, Group D hazardous locations; or

6.6.1.3 Other equivalent standards as determined by the certifying body.

6.7 *Power Interruption:*

6.7.1 Treatment system control and motor control circuit shall provide low voltage release (LVR) feature to ensure automatic restarting of the system and system motor occurs after a momentary loss of power during operation.

6.8 *Accessibility:*

6.8.1 Treatment system shall be constructed and arranged so that major system assemblies, attachments, and any non-hull integrated holding or retention tanks are accessible for maintenance, repair, or replacement without requiring removal of major assemblies or attachments.

6.8.2 Access to any filter membranes, electrodes, or other treatment system components that require scheduled maintenance, repair, or replacement shall be provided without the need to remove major system components.