Designation: F3648 – 23

An American National Standard

Standard Guide for Maintenance of Marine Sanitation Devices (MSDs) and the Effects of Cleaning Agents on MSD Operations[1]

This standard is issued under the fixed designation F3648; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reapproval. A superscript epsilon (ε) indicates an editorial change since the last revision or reapproval.

1. Scope

1.1 The guide provides information and clarity to support the health and maintenance of Marine Sanitation Devices (MSDs) on maritime vessels and platforms to promote effective operations and performance throughout the lifecycle. This includes identification of chemicals and their derivatives that can be detrimental to proper MSD operations. This guide will promote better understanding of the impacts of certain chemicals on the health and operations of MSD systems, plus provide guidance to inform operators of best practices and procedures for effective operations and maintenance. This guide is designed to assist both operators and MSD Original Equipment Manufacturers (OEMs) in collaboratively working to ensure effective operations and maintenance, and to reduce performance degradations that result from the introduction of harmful chemicals. The primary application of this guide is to Type II MSDs (described in Section 4), installed on larger ships and employing biological treatment of sewage and gray water.

NOTE 1—This guide does not constitute regulations or ship classification society rules, which should be consulted where applicable.

1.2 Manufacturers preparing new product specifications or revising existing ones should follow the practices and procedures outlined herein, and be guided by the latest specifications covering similar commodities. Similarly, vessel owner/operators should consult this guide regarding in-service operations and maintenance.

1.3 *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.*

1.4 *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]

D1253 Test Method for Residual Chlorine in Water

F1166 Practice for Human Engineering Design for Marine Systems, Equipment, and Facilities

F2363 Specification for Sewage and Graywater Flow Through Treatment Systems

2.2 *IMO Regulations:*[3]

MEPC.227(64)(2012) Guidelines on implementation of effluent standards and performance tests for sewage treatment plants

2.3 *ISO Standards:*[4]

ISO 5815-1 Water quality — Determination of biochemical oxygen demand after n days (BODn) — 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

ISO 14593 Water quality — Evaluation of ultimate aerobic biodegradability of organic compounds in aqueous medium — Method by analysis of inorganic carbon in sealed vessels (CO_2 headspace test) method

2.4 *U.S. Laws and Regulations:*[5]

33 CFR Part 159 Marine sanitation devices

40 CFR Part 136 Guidelines establishing test procedures for the analysis of pollutants

46 CFR Shipping

VIDA Vessel Incidental Discharge Act

Vessel General Permit (VGP)

2.5 *Other Standards:*

SM 4600-Cl Chlorine (residual) — Standard methods for the examination of water and wastewater[6]

[1] This guide 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.

Current edition approved May 1, 2023. Published June 2023. DOI: 10.1520/F3648-23.

[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 International Maritime Organization (IMO), 4, Albert Embankment, London SE1 7SR, United Kingdom, http://www.imo.org.

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

[5] Available from Electronic Code of Federal Regulations (ECFR), http://ecfr.gov.

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

3. Terminology

3.1 *Definitions:*

3.1.1 *administrator, n*—the Administrator of the United States Environmental Protection Agency.

3.1.2 *biodegradable, n*—as defined in the Vessel Incidental Discharge Act (VIDA):

(1) for soaps, cleaners, and detergents, a product that demonstrates, within 28 days, either the removal of at least 70 % of Dissolved Organic Carbon (DOC), production of at least 60 % of the theoretical carbon dioxide, or consumption of at least 60 % of the theoretical oxygen demand. ISO 14953 provides test method.

(2) for biocides, a compound or mixture that, within 28 days, demonstrates removal of at least 70 % of DOC and production of at least 60 % of the theoretical carbon dioxide.

3.1.3 *blackwater, n*—see *sewage*.

3.1.4 *captain of the port, n*—as defined in Subpart 3.85 of 46 CFR.

3.1.5 *chlorine, n*—residual disinfectant or by-products associated with the use of chlorine or its compounds.

3.1.6 *coliform, n*—thermotolerant coliform bacteria which produces gas from lactose in 48 h at 44.5 °C.

3.1.7 *conventional pollutants, n*—the list of pollutants listed in 40 CFR 401.16.

3.1.8 *cruise vessel, n*—a passenger vessel as defined in section 2101(31) of Title 46, United States Code. The term does not include a vessel of the United States operated by the federal government or a vessel owned and operated by the government of a State.

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

3.1.10 *discharge, n*—a release, however caused, from a vessel, and includes, any escape, disposal, spilling, leaking, pumping, emitting or emptying.

3.1.11 *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. See Fig. 1.

3.1.12 *environmental compliance records, n*—the Sewage and Graywater Discharge Record Book, all discharge reports, all discharge sampling test results, as well as any other records.

3.1.13 *graywater, n*—gallery, dishwasher, bath, and laundry waste water. The term does not include other wastes or waste streams.

3.1.14 *influent, n*—liquid containing sewage, graywater, or other wastes, whether treated or untreated, flowing into the treatment system or holding tank. See Fig. 1.

3.1.15 *minimally toxic, phosphate free and biodegradable soaps, cleaners and detergents, n*—properties of a substance or mixture of substances that:

(1) have an acute aquatic toxicity value corresponding to a concentration greater than 10 ppm (generally, the concentration required to kill 50 % of the test organisms must be greater than 10 mg/L);

(2) do not produce residuals with an LC50 less than 10 ppm;

(3) are "not bioaccumulative", as defined in the Vessel General Permit for Discharges Incidental to the Normal Operation of Vessels (VGP);

(4) do not cause the pH of the receiving water to go below 6.0 or above 9.0;

(5) contain, by weight, 0.5 % or less of phosphates or derivatives of phosphate; and

(6) are *biodegradable*.

3.1.16 *navigable waters, n*—has the same meaning as in section 502 of the Federal Water Pollution Control Act, as amended.

3.1.17 *priority pollutant, n*—the list of toxic pollutants listed in 40 CFR 401.15.

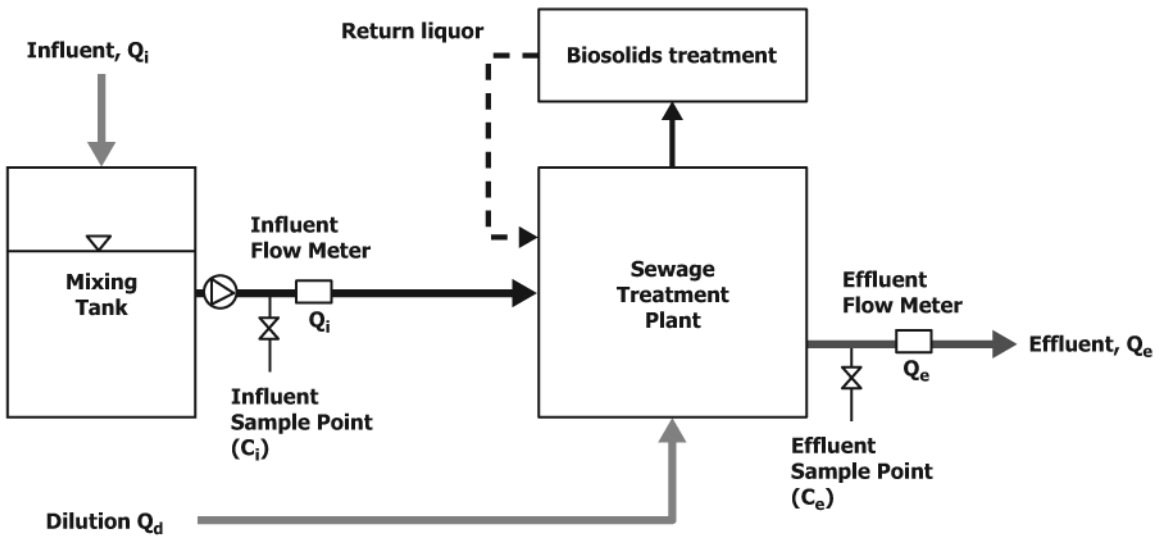

FIG. 1 System Diagram of a Sewage Treatment Plant

3.1.18 *quaternary ammonium compounds (qacs), n*—synthetic cationic surfactants used as antiseptics, sanitizers, disinfectants, and bactericides, among other uses.

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*—human body wastes and the wastes from toilets and other receptacles intended to receive or retain body waste.

3.1.21 *treated sewage, n*—sewage meeting all applicable effluent limitation standards and processing requirements of the Federal Water Pollution Control Act, as amended, and of Title XIV of Public Law 106-554 "Certain Alaskan Cruise Ship Operations", and regulations promulgated under either.

3.1.22 *untreated sewage, n*—sewage that is not treated sewage.

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

4. Classification of MSDs

4.1 A Type I marine sanitation device is a flow-through sewage treatment system that commonly uses maceration and disinfection, for installation only on vessels less than or equal to 65 ft in length and designed to meet the requirements in 33 CFR Part 159. This guide is generally not applicable to Type I MSDs.

4.2 A 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 a 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.

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, 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.

4.4 Type II-C advanced wastewater treatment systems 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 of Subpart E to 33 CFR 159.301. Cruise ships are able to discharge through this treatment system while operating in certain Alaskan waters.

4.5 Type III marine sanitation devices are considered "holding tanks" for graywater or sewage, or both. Type III MSDs are not considered processing or treatment systems, and are generally outside the scope of this guide. See also 33 CFR Part 159.

5. Summary of Best Practices

5.1 Disinfectants currently being used aboard ships and offshore structures have become sophisticated to the point where it is difficult for operators to distinguish their suitability for use with marine biological sewage treatment systems. One class of disinfectants is being increasingly used in cleaning compounds, and it threatens the ability of certified marine sewage treatment systems to meet USCG, MARPOL, and Vessel General Permit (VGP) 2013 regulations in service. These are quaternary ammonium compounds, commonly referred to as "QACs" or "quats". "N alkyl dimethyl benzyl ammonium chlorides" are an example.

5.2 QACs can be found in toilet bowl cleaners, dishwashing detergents and rinses, floor cleaners, and laundry products, all of which are used or capable of being used to clean systems and components aboard vessels.

5.3 In municipal treatment systems, there is generally substantial water dilution of the influent streams and toxic chemicals found in graywater and sewage. Much higher concentrations of waste and chemicals, and less water dilution are found aboard ships. It is possible for a biological process MSD to pass the initial certification test, but not operate reliably once put into service if certain harmful chemicals are introduced. Though the certification test protocol requires concentration of total suspended solids from the more dilute municipal sewage to a minimum required by marine regulations, that protocol does not affect the potential concentrations of toxic chemicals in ship sewage when in service.

5.4 As use of chlorine has declined, alternate disinfectants have proliferated in various cleaning agents, rinses, etc. Among these are QACs.

5.5 Unlike chlorine, QACs and other disinfectants are not oxidizing agents that are neutralized upon reacting with organic matter in sewage. Rather, they tend to accumulate over time within the bioreactor. Since the bioreactors employ cultures of naturally occurring beneficial microorganisms, attenuation of these microbial cultures results in reduced process removal of regulated contaminants and possible noncompliance with discharge standards.

5.6 This problem is generally more prevalent with passenger vessels than with cargo vessels. Passenger vessel operators have legitimate concerns with the spreading disease among the passengers, so they employ large amounts of complex persistent disinfectants in cleaners and rinses, which impacts MSD system health and performance.

5.7 Also, where cargo vessels normally operate with crew sizes not exceeding 20 to 30 persons, passenger vessels have the capacity to carry hundreds and up to thousands of persons. This large increase of persons onboard directly increases graywater and sewage volume and throughput to MSDs.

5.8 MSDs are required by regulation to be initially certified and approved prior to installation. But, with the exception of the State of Alaska, periodic testing is not currently required after shipboard installation.

5.9 The regulations specify that the installation is considered in compliance provided it is installed and maintained in accordance with the manufacturer's instructions. To ensure MSD biological processes work effectively, manufacturer guidance is to generally minimize use of harmful disinfectants and QACs. Excessive use of disinfectants may result in the beneficial culture of the MSD being killed or attenuated so that effluent characteristics do not meet regulatory requirements.

5.10 The offending chemicals in use are complex, readily available, and subject to change at any time by the formulators. They are not as easily or reliably neutralized as chlorine.

5.11 Although identifying the numerous brands of toxic compounds would be beneficial in identifying possible deterrents to proper MSD operation, it might be beyond the reasonable resources and ability for a manufacturer to analyze and evaluate every possible compound.

5.12 At a minimum, ship (particularly large passenger ship) owners/operators should use soaps and detergents that are phosphate-free, minimally-toxic, and biodegradable when used within sculleries and galleys for ship configurations where the graywater system feeds into the MSD. In addition, operators should minimize the use of products labeled "disinfectant" in toilets and other equipment connected to biological-type MSDs.

5.13 For soap, cleaner, and detergent discharges directly or indirectly into biological sewage treatment systems, "minimally-toxic" means any substance or mixture of substances which has an acute toxicity value (LE50) corresponding to a concentration greater than 10 ppm, does not produce "byproducts" with an acute toxicity value (LE50) less than 10 ppm, and must pass the Organization for Economic Co-operation and Development (OECD) 202 (Daphnia) for acute toxicity testing.

5.14 For rinses and other discharges from laundry and galley, concentration should be based upon peak hourly flow, only the volume being so discharged and not based upon average daily flow or dilution due to total flow from all sources. This is because many toxic chemicals can very rapidly destroy a beneficial microbial culture.

6. Regulatory Environment and Other Considerations

6.1 Even with EPA 2013 Vessel General Permit (VGP) in effect, and Vessel Incidental Discharge Act (VIDA) regulations proposed, there exist gaps in system configurations between vessel types, and design requirements that are unclear. Further information or guidance would assist with more effective MSD operations and maintenance. Some examples of these information gaps and needed clarifications are provided below:

6.1.1 There are inconsistent federal and international regulations for the design of onboard storage, treatment, or periodic sampling of graywater.

6.1.2 There are currently no federal or international regulations that require graywater and sewage system influent streams be combined and treated in the MSD.

6.2 Although MSDs are required to be certified as meeting discharge standards prior to installation on all ships, Alaska is the only state that requires periodic sampling of effluents of MSDs. Although sampling in areas other than Alaska is not required post-installation of approved MSDs, a periodic sampling program, coupled with a strict adherence to manufacturer's instructions, should be used to verify and validate the regular operation of a vessel's MSD.

6.3 In consideration of environmental restrictions and regulations, manufacturers should list which chemicals/cleaning products to avoid using in conjunction with the approved MSD, in order to maintain the highest level of performance. Products or chemicals, or both, known to be harmful to MSD operations should be noted in the manufacturer's manual, and updated periodically. Likewise, products known to be compatible with proper MSD operation should be listed also.

6.4 A standard testing regime should be implemented to sample and test products of the MSD during regular periods to ensure continued proper operation. This plan will provide information needed for the vessel's MSD, in accordance with manufacturer's instruction, on how a sample should be taken. The results of these tests should be recorded and examined for trend analysis.

6.5 While not required outside of certain Alaskan waters, a Quality Assurance Project Plan (QAPP) should be considered for implementation to document ship sampling procedures, methods, and actions to be taken to verify sample results are accurate and representative. Within the QAPP, notes should be taken to document what was sampled, when the sample was taken, the location of the sample, and the field results (temperature, chlorine, and pH).

6.6 The following should be considered in order to avoid faulty test results:

6.6.1 Disinfecting sample ports with rubbing alcohol to reduce potential bacterial contamination. Using chlorine products to disinfect the sample ports could lead to a higher sampled chlorine level.

6.6.2 Bacteria will continue to increase in number over time and at warm temperatures. Quality assurance should be used to ensure holding times and temperature criteria are met for sampling.

6.6.3 Samplers should make sure the sample bottles are full. A loose cap can allow volatiles to escape.

6.6.4 Influent sample points should be upstream of any return liquors, wash water, or recirculates generated from the sewage treatment plant. See Fig. 1 and Fig. 3.

6.6.5 An example figure and guidance for installation of a sampling port can be found in 46 CFR 162.050-17(d), and Fig. 2 of this guide.

6.7 Regular monitoring should be utilized for changes in the MSD performance and in changes in influent.