Designation: F2283 – 12

An American National Standard

Standard Specification for Shipboard Oil Pollution Abatement System[1]

This standard is issued under the fixed designation F2283; 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 This specification covers the design, manufacture, installation, performance, and operation of a shipboard oil pollution abatement system (OPAS) that collects, transfers, and processes all the oily waste generated from incidental operation of machinery spaces. This specification applies to commercial and public vessels and is intended for use by designers, manufacturers, purchasers, installers and operators of shipboard OPAS to determine the requirements for system design, equipment manufacture, equipment purchase, system integration and installation, and system in-service operation. This specification and its supplementary sections may be tailored to meet the specific user's needs to cover from OPAS new construction to retrofitting of individual OPAS equipment.

1.2 OPAS is comprised of drain tanks, bilge suctions, transfer pumps, Oily Bilge Water Holding Tanks, Oil Residue (sludge) Tanks, 15 ppm Bilge Separator systems, 15 ppm Bilge Alarm, automatic stopping device, and deck connections. The 15 ppm Bilge Separator is considered to be applicable for use to separate oily bilge water and ballast water from fuel oil tanks. Treatment of ballast water is addressed in other regulations/ standards and is not addressed herein.

1.3 This specification covers the system from the point of entering the OPAS until the oil-water mixture is treated, the clean water meeting the applicable discharge limits is discharged overboard, and the separated oil is contained for on shore disposal or further treatment. It also includes concepts for minimizing oily waste generation. The ASTM specification is intended to augment the existing regulations, provide the user options to meet their specific needs, and should not be considered a replacement for overriding regulation.

1.4 It is recognized that the development and testing of high capacity separating equipment designed for dealing with effluent from cargo tanks on tankers pose special problems and such equipment is not required to be tested under International Maritime Organization (IMO) Marine Environment Protection Committee (MEPC) resolution MEPC.107(49) nor is it covered in this specification

1.5 There are means to reduce the volume of bilge and/or process oily waste that are not considered 15 ppm Bilge Separators systems. Examples include incinerators, evaporators, combinations thereof, and other technologies. Such processes may require addressing all potential issues with the system such as toxicology and emissions to atmosphere. Such means and/or processes are out of scope of this standard.

1.6 *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.*

2. Referenced Documents

2.1 *ASTM Standards:*[2]

A530/A530M Specification for General Requirements for Specialized Carbon and Alloy Steel Pipe

A999/A999M Specification for General Requirements for Alloy and Stainless Steel Pipe

B165 Specification for Nickel-Copper Alloy (UNS N04400) Seamless Pipe and Tube

F992 Specification for Valve Label Plates

F993 Specification for Valve Locking Devices

F1155 Practice for Selection and Application of Piping System Materials

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

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

F2045 Specification for Indicators, Sight, Liquid Level, Direct and Indirect Reading, Tubular Glass/Plastic

[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.

Current edition approved June 1, 2012. Published September 2012. Originally approved in 2004. Last previous edition approved in 2009 as F2283 – 04 (2009). DOI: 10.1520/F2283-12.

[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.

F2446 Classification for Hierarchy of Equipment Identifiers and Boundaries for Reliability, Availability, and Maintainability (RAM) Performance Data Exchange

2.2 *ANSI/ASME 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 Part 155 Department of Homeland Security, U.S. Coast Guard (USCG), Oil or Hazardous Material Pollution Prevention Regulations for Vessels

46 CFR Part 147 Department of Homeland Security, U.S. Coast Guard (USCG), Hazardous Ships' Stores

40 CFR Part 171 Department of Transportation (DoT), Research and Special Programs Administration (RSPA), General Information, Regulations and Definitions

2.4 *International Maritime Organization (IMO):*[5]

MARPOL 73/78 International Convention for the Prevention of Pollution from Ships, 1973 as modified by the Protocol of 1978, Annex I—Prevention of Pollution by Oil

MEPC.107 (49) Resolution Revised Guidelines and Specifications for Pollution Prevention Equipment for Machinery Space Bilges of Ships

IMO MEPC.187 (59) Amendments to the Annex of the Protocol of 1978 Relating to the International Convention for the Prevention of Pollution from Ships, 1973

IMO MEPC.1/Circ.759 Guidelines for a Shipboard Oil Waste Pollution Prevention Plan

IMO MEPC.1 Circ 642 2008 Revised Guidelines for Systems for Handling Oily Waste in Machinery Spaces of Ships Incorporating Guidance Notes for an Integrated Bilge water Treatment System (IBTS)

IMO MEPC.1/Circ.760 Amendments to the 2008 Revised Guidelines for Systems for Handling Oily Wastes in Machinery Spaces of Ships Incorporating Guidance Notes for an Integrated Bilge Water Treatment System (IBTS) (MEPC.1/CIRC.642, as amended by MEPC.1/CIRC.676)

IMO MEPC.1 Circ 677 Guide to Diagnosing Contaminants in Oily Bilge Water to Maintain, Operate and Troubleshoot Bilge Water Treatment Systems

2.5 *Other Documents:*

ANSI/ISA 60079-13 or IEC 60079-1 Electrical apparatus for explosive gas atmospheres—Part 1: Flameproof Enclosures "d"[3]

ANSI/ NEMA MG 1 Motors and generators[3]

IEC 60085 Electrical insulation—Thermal evaluation and designation[6]

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[6]

IEC 60092-353 Electrical Installations in Ships—Part 353: Single and Multicore Non-radial Field Power Cables with Extruded Solids Insulation for Rated Voltages 1 KV and 3 KV[6]

IEC 60529 – Degrees of Protection Provided by Enclosures, International Protection Rating (IP Codes)[6]

64 Federal Register Number 173, 8 September 1999 Contiguous Zone Proclamation ANSI/NFPA No. 70 National Electrical Code[7]

IEEE 1580 Recommended Practice for Marine Cable for use on Shipboard and Fixed or Floating Marine Platforms[8]

NFPA 70 National Electrical Code[9]

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 amended Underwriters Laboratories Standard 913 (as revised April 8, 1976)[7]

UL 913 Standard for Intrinsically Safe Apparatus and Associated Apparatus for Use in Class I, II, III, Division 1, Hazardous (Classified) Locations[10]

UL 1309 Standard for Safety Marine Shipboard Cable[10]

UL 1203 Explosion-Proof and Dust-Ignition Electrical Equipment for Use in Hazardous (Classified) Locations

ISO 9377–2:2000 Water Quality—Determination of Hydrocarbon Oil Index—Part 2: Method Using Solvent Extraction and Gas Chromatography[11]

3. Terminology

3.1 *Definitions of Terms Specific to This Standard:*

3.1.1 *15 ppm bilge alarm*—an instrument that is designed to measure the oil content of oily mixtures from machinery space bilges and fuel oil tanks that carry ballast and activate an alarm at a set concentration limit. Also, referred to in this standard as Oil Content Monitor (OCM).

3.1.2 *15 ppm bilge separator*—device that may include any combinations of a separator, filter, coalescer or other means, and also a single unit designed to produce an effluent with oil content not exceeding 15 ppm. Also, referred to in this document as Oil-Water Separator (OWS).

3.1.3 *automatic stopping device*—a device that automatically stops any discharge overboard of oily mixture when the oil content of the effluent exceeds 15 ppm. Also, referred to in this document as diverter valve.

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

[4] 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.

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

[6] Available from International Electrotechnical Commission (IEC), 3 rue de Varembé, Case postale 131, CH-1211, Geneva 20, Switzerland, http://www.iec.ch.

[7] 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.

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

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

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

[11] Available from International Organization for Standardization (ISO), 1, ch. de la Voie-Creuse, CP 56, CH-1211 Geneva 20, Switzerland, http://www.iso.org.

3.1.4 *bilge primary tank*—a tank used as a means of pre-treatment for separation of oily bilge water.

3.1.5 *bulk oil*—liquid phase composed mostly of oil or oil residue.

3.1.6 *certifying administration*—any entity appropriately authorized by a government to carry out the functions prescribed in regulations pertaining to oily waste.

3.1.7 *commercial vessel*—any vessel (that is, boat or ship) engaged in commercial trade or that carries passengers for hire. This would exclude pleasure craft that do not carry passengers for hire or warships.

3.1.8 *contiguous zone*—the entire zone established by the United States under Contiguous Zone Proclamation. Source Presidential Proclamation 7219 of August 2, 1999.

3.1.9 *discharge*—includes, but is not limited to, any spilling, leaking, pumping, pouring, emitting, emptying, or dumping, however caused.

3.1.10 *diverter valve*—referred to in this document as automatic stopping device.

3.1.11 *flag state*—the authority under which a country exercises regulatory control over the commercial vessel which is registered under its flag. This involves the inspection, certification, and issuance of safety and pollution prevention documents.

3.1.12 *free oil*—oil in water that is not chemically emulsified or highly dispersed by mechanical means.

3.1.13 *GT*—gross tonnage.

3.1.14 *hazardous materials*—any material or combination of material that poses a substantial danger to human beings, plants, animals and the marine environment. A material is hazardous if it possesses one or more of the following characteristics: ignitability, corrosivity, reactivity, toxicity, and radioactivity.

3.1.15 *Integrated Bilge Water Treatment System (IBTS)*—a system to minimize the amount of oily bilge water generated in machinery spaces by treating the leaked water and oil separately. It also provides an integrated means to process the oily bilge water and oil residue (sludge).

3.1.16 *IMO*—International Maritime Organization

3.1.17 *independent laboratory*—a laboratory that is not owned or controlled by a manufacturer, supplier, or vendor of 15 ppm bilge separators, or 15 ppm bilge alarms.

3.1.18 *manufacturer*—a vendor, shipbuilder, shipyard, or any other supplier of OPAS equipment and/or components.

3.1.19 *MARPOL*—Marine Pollution convention

3.1.20 *MARPOL 73/78*—International Convention for the Prevention of Pollution from Ships, 1973 as modified by the Protocol of 1978.

3.1.21 *MARPOL 73/78 Annex I*—Prevention of Pollution by Oil

3.1.22 *MEPC*—Marine Environment Protection Committee

3.1.23 *oil*—petroleum, synthetic oil, fuel oil, bio-fuel, sludge, oil refuse, and oil mixed with wastes other than dredged soil.

3.1.24 *Oil Content Monitor (OCM)*—referred in this standard as 15 ppm Bilge Alarm.

3.1.25 *oil residue (sludge)*—the residual waste oil products generated during the normal operation of a ship such as those resulting from the purification of fuel or lubricating oil for main or auxiliary machinery, separated waste oil from oil filtering equipment, waste oil collected in drip trays, and waste hydraulic and lubricating oils. Sometimes, referred to as waste oil.

3.1.26 *Oil Residue (sludge) Tank*—a tank which holds oil residue (sludge) from which sludge may be disposed directly through the standard discharge connection or any other approved means of disposal. Sometimes, referred to as Waste Oil Tank.

3.1.27 *oily bilge water*—water which may be contaminated by oil resulting from things such as leakage or maintenance work in machinery spaces. Any liquid entering the bilge system including bilge wells, bilge piping, tank top or bilge holding tanks is considered oily bilge water.

3.1.28 *oily waste*—oil residues (sludge) and oily bilge water.

3.1.29 *Oil Pollution Abatement System (OPAS)*—system that collects, transfers, and processes all the oily waste generated during a ship's normal service and allows overboard discharge of waters meeting legal requirements.

3.1.30 *OPAS Integrator*—shipyard, installer, owner operator or any other organization responsible for providing the entire OPAS.

3.1.31 *Oil-Water Separator (OWS)*—referred in this document as 15 ppm Bilge Separator.

3.1.32 *overboard discharge*—treated bilge water which is analyzed by the Bilge Alarm and pumped to the sea.

3.1.33 *ppm*—parts of oil per million parts of water by volume.

3.1.34 *public vessel*—a vessel owned or bareboat chartered and operated by the United States, or by a State or political subdivision thereof, or by a foreign nation, except when the vessel is engaged in commerce.

3.1.35 *remove or removal*—refers to containment and removal of the oil from the water and shorelines or the taking of such other actions as may be necessary to prevent, minimize, or mitigate damage to the public health or welfare, including, but not limited to, fish, shellfish, wildlife, and public and private property, shorelines, and beaches.

3.1.36 *settleable solids*—small particles that can sink in a given liquid.

3.1.37 *synthetic oil*—oils that are not petroleum based.

3.1.38 *treated bilge water*—bilge water that has been processed by the 15 ppm Bilge Separator.

3.1.39 *United States*—the States, the District of Columbia, the Commonwealth of Puerto Rico, the Commonwealth of the Northern Mariana Islands, Guam, American Samoa, the Virgin Islands, and the Trust Territory of the Pacific Islands.

3.1.40 *vessel*—every description of watercraft or other artificial contrivance used, or capable of being used, as a means of transportation on water other than a sea plane.

3.1.41 *waste oil*—referred in this document as oil residue (sludge).

4. Ordering Information

4.1 Orders shall include the following information:

4.1.1 Sizing requirements.

4.1.2 Processing rate requirements.

4.1.3 Additional control requirements.

4.1.4 All applicable requirements contained in the supplementary requirements section.

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

5. Materials and Manufacture

5.1 *Integrated Oil Pollution Abatement System Description:*

5.1.1 The purpose of the Oil Pollution Abatement System (OPAS) is to reduce the volume of oil-contaminated water that must be held onboard the ship. This is accomplished by processing oily bilge water by the OPAS to produce treated bilge water meeting regulatory limits that can be discharged overboard through the 15 ppm Bilge Separator and 15 ppm Bilge Alarm. The system allows treatment of the oily bilge water through the 15 ppm Bilge Separator; or transfer of the oily bilge water directly to the Bilge Primary Tank or discharge through the standard deck connection. The OPAS as an integrated system is intended to operate on oily bilge water collected after segregation of oil residue and oil free water to minimize the amount of bilge water to be treated. The OPAS is composed of integrated sub-systems to accomplish the following major functions; collection, holding and transfer of oily bilge water and oil residue (sludge), and processing and monitoring of oily bilge water to reduce its oil content to not exceed 15 ppm to allow its discharge to overboard. The integrated OPAS is shown in Fig. 1.

5.1.2 *Collection Sub-system:*

5.1.2.1 The Collection sub-system consists of bilge wells, oily bilge water drain tanks, oil residue (sludge) drain tanks, oily drains and oily bilge water drains to collect oily waste generated during systems operation and maintenance, leaks, and accidental oil spills. This collected oily bilge water is transferred to the Bilge Primary Tank using the oily waste transfer pump. Collected oil residue (sludge) is transferred to the Oil Residue (sludge) Tank using oil residue (sludge) collecting pump

5.1.3 *Holding Sub-system:*

5.1.3.1 The Holding sub-system consists of the Bilge Primary Tank, Oily Bilge Water Holding Tank, and the Oil Residue (sludge) Tank to provide temporary holding of oily bilge water and oil residue (sludge) for ashore disposal or oily bilge water processing.

(1) Bilge Primary Tank—The Bilge Primary Tank is provided as a pre-treatment unit for initial separation of bulk and free oils and settleable solids from the oily bilge water prior to being sent to the Oily Bilge Water Holding Tank. Baffles divide the tank in two sections, an oily section and a water section. All oily bilge water discharges and drains are directed to the oily section. In there, bulk and free oils float and accumulate at the top, settleable solids start to sink and accumulate on the bottom. The separated oil phase is transferred by skimming or other means to the oily residue (sludge) tank for disposal ashore or disposal by other approved means. The bilge water flows under the first baffle and over the second baffle into the water section. The water phase drains or is pumped into the Oily Bilge Water Holding Tank.

(2) Oily Bilge Water Holding Tank—The Oily Bilge Water Holding Tank is provided to collect and provide temporary holding for the oily bilge water prior to its discharge, transfer, disposal or processing by the 15 ppm Bilge Separator. The separated oil phase is transferred by skimming or other means to the oily residue (sludge) tank for disposal ashore or disposal by other approved means. The Bilge Primary and Oily Bilge Water Holding Tanks may be combined to increase settling time and to reduce space.

(3) Oil Residue (sludge) Tank—An Oil Residue (sludge) Tank is provided to hold oil residue (sludge) from which oil residue (sludge) may be directly transferred ashore through the standard discharge connection or any other approved means of disposal. Any accumulated water is drained or pumped to the Bilge Primary Tank.

5.1.4 *Transfer Sub-system:*

5.1.4.1 The transfer system consists of transfer pumps, piping, valves, hose connections, and other items intended to transfer oily waste. Oily waste transfer pump(s) moves oily bilge water from the bilges via bilge wells and hose connections, oily bilge water drain tanks or other oily bilge water sources to the Bilge Primary Tank or the Oily Bilge Water Holding Tank for subsequent processing by the 15 ppm Bilge Separator system. The oily waste transfer pump(s) can also move oily bilge water from the bilges, oily bilge water drain tanks, Oily Bilge Water Holding Tank, and Bilge Primary Tank to deck connections for off-loading to shore. In addition, the oily waste transfer pump(s) can move oil from the bilges to the Oil Residue (sludge) Tank or to the deck connections in case of an oil spill in the bilge area. The oil residue (sludge) collecting pumps transfer collected oil residue (sludge) to the Oil Residue (sludge) Tank. Also, this pump may be connected to the oil removal line to move skimmed oil to the Oil Residue (sludge) Tank if gravity drain cannot be achieved.

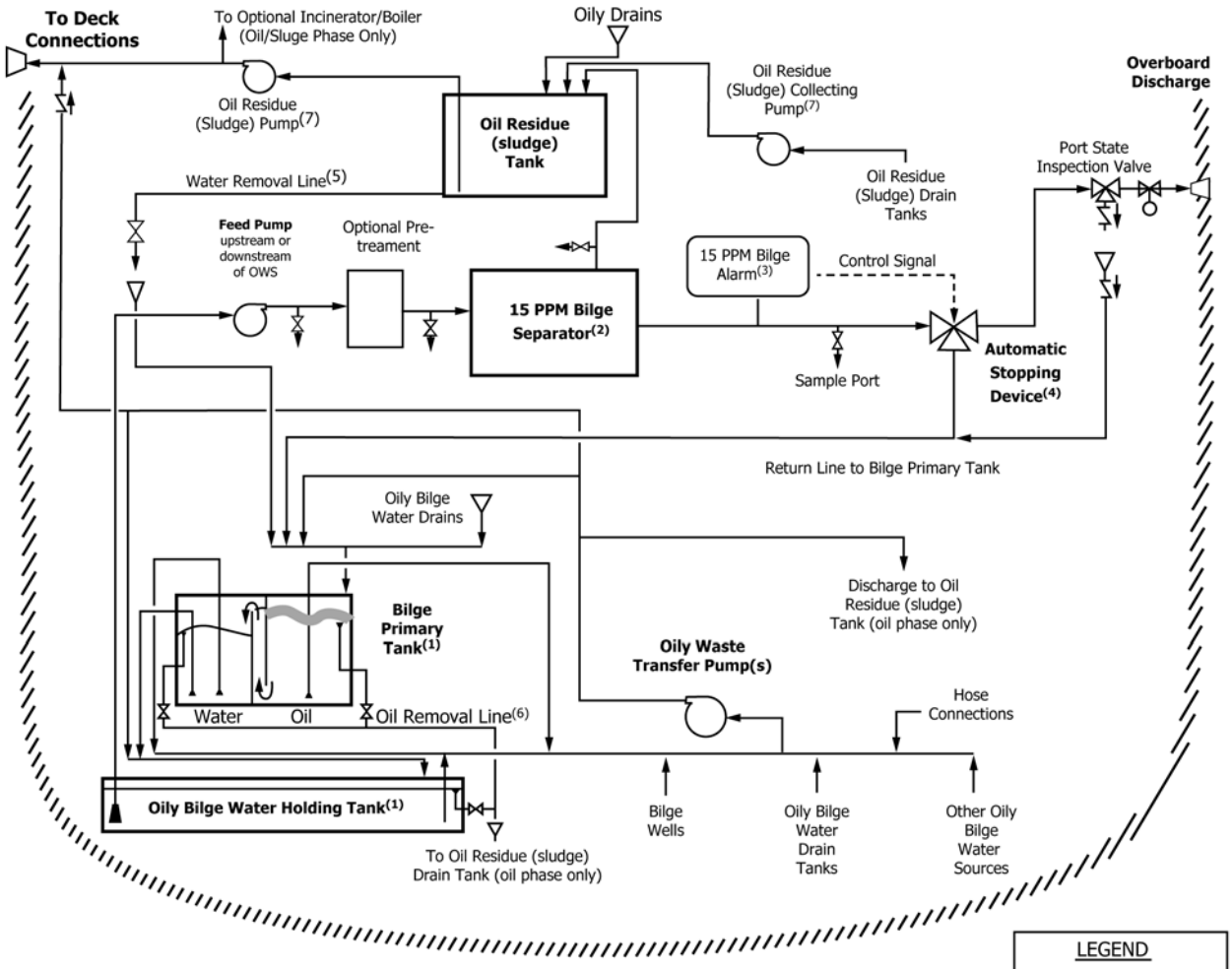
5.1.4.2 The oil residue (sludge) pump moves Oil Residue (sludge) Tank content to the deck connections for offloading to shore or to an incinerator or boiler if available.

5.1.4.3 Hose connections allow the use of hoses at the oily waste transfer pump(s) suction piping to reach any point in the bilges.

5.1.5 *Processing and Monitoring Sub-systems:*

5.1.5.1 The 15 ppm Bilge Separator and 15 ppm Bilge Alarm are installed to remove oil from the oily bilge water pumped from the Oily Bilge Water Holding Tank, send the removed oil to the Oil Residue (sludge) Tank, and send the water effluent overboard or back to the Primary Bilge Tank depending on the decision of the 15 ppm Bilge Alarm.

5.1.5.2 *Optional Pre-Treatment*—Pre-treatment units may be provided to enhance the 15 ppm Bilge Separator system performance and/or reliability.



NOTES:
1. Bilge Primary and Oily Bilge Water Holding Tanks may be combined.
2. Also, refer as Oil/Water Separator (OWS)
3. Also, refer as Oil Content Monitor (OCM)
4. Typically a 3-way diverter valve.
5. If gravity drain cannot be achieved, an alternative arrangement may be fitted, provided that it does not connect directly to the bilge piping system and that allows removal of the water phase only.
6. Maybe connected to the suction piping of the Oil Residue (Sludge) Collecting Pump if gravity drain cannot be achieved provided that tank level indicators or other means are available to allow pumping of the oil phase only. Alternatively, mechanical skimmers may be used.
7. Oil Residue (Sludge) Pump and Oil Residue (Sludge) Collecting Pump maybe combined.

FIG. 1 Notional Oil Pollution Abatement System

5.1.5.3 *Processing: 15 ppm Bilge Separator*—The 15 ppm Bilge Separator system may be a multi-staged treatment train consisting of several unit operations or separation technologies. The 15 ppm Bilge Separator system treats the oily bilge water to produce an effluent not to exceed 15 ppm unless a lower concentration is specified in the purchase contract. The separated oil is sent to the Oil Residue (sludge) Tank and the treated water phase effluent is monitored by a 15 ppm Bilge Alarm. The overboard discharge piping is provided with a Port State Inspection valve and return piping to the Bilge Primary Tank to allow system inspection and testing.

5.1.5.4 *Monitoring: 15 ppm Bilge Alarm and Automatic Stopping Device*—A 15 ppm Bilge Alarm and automatic stopping device are installed downstream of the 15 ppm Bilge Separator to ensure compliance with environmental regulations by preventing oil from being discharged overboard. The 15 ppm Bilge Alarm constantly monitors the effluent from the 15 ppm Bilge Separator and controls the automatic stopping device to allow overboard discharge only if the oil content does not exceed 15 ppm or recycled back to the Bilge Primary Tank for reprocessing if it is greater than 15 ppm. Typically, a 3-way diverter valve is used as the automatic stopping device.

5.2 *Bilge Management: Design and Maintenance (Prevention) (Ref: IMO MEPC.1 Circ 642,677 and 760):*

5.2.1 *Successful bilge water management, design and maintenance requires a three pronged strategy*—Minimizing oily waste entering the bilge; minimizing clean waste water from entering the bilge; and minimizing contaminants entering the bilge. To prevent many of the problems with the operation of

bilge treatment systems, it is important to identify potential sources of bilge water contamination and incorporate in the design of OPAS features to minimize the introduction of excessive clean operating water and contaminants. Also necessary is the management of bilge water in the daily routines of machinery space operations. These management philosophies should be incorporated into the operating and maintenance procedures of an OPAS (see Section 7). Bilge water contaminants include, but are not limited to: oil (sludge) residues, solvents, detergents, iron oxide particles (rust or "rouge"), engine room soot, and "biological" contaminants. Biological contaminants are products of bacterial and microbial decomposition. These include sewage and growth of life forms in the bilge and piping. Chemicals, particulate matter, and biological detritus in bilge water can cause the OPAS to malfunction. In a typical vessel, the main sources of oily waste, excessive water, and contamination in bilge water and Oily Bilge Water Holding Tanks include: diesel engine after coolers (clean water); sludge from decanting / bottom draining storage and sludge tanks; lube oil and fuel oil purification (oily water); fuel oil storage and settling tanks (oily water); lube oil and fuel oil filtration (oil); machinery leakages; condensate from air compressors and compressed air systems; diesel engine piston stuffing box leakages and piston underside blow-down (slow-speed diesels only); boiler water / condensate drains (different than piston cooling water because these include other types of chemicals (for example, solvents), causing different concerns); equipment and engine room washing; economizer water washing; seawater / freshwater cooling (a potential source of biological contaminants); firefighting foam; water treatment chemicals; engine coolant; grey water drains; sanitary system leaks and overflows; and air conditioning and refrigeration condensate. Figure 2 is provided for illustrative purposes. It is an example of a flow diagram of several (of many potential) sources of bilge water contamination.

Excessive clean water entering the bilge can overwork the OPAS and lead to system failure. Both the volume of waste oil to be separated and the volume of water entering the bilge are a major concern for proper management of on board bilge water. Prevention of excessive oily waste generation directly associated with the maintenance, cleaning and operation of equipment and systems within a machinery space can decrease the "wear and tear" on oily bilge water treatment systems and the likelihood of system failure.

5.2.2 An assessment of potential sources of bilge water contamination and excessive clean water should be conducted in the OPAS design phase and prior to retrofitting to assess the design features, preventive measures and procedures required in the OPAS' documentation.

5.2.3 *Design Features to Minimize Contaminants*—The items in Table 1 present means to minimize bilge contaminants and optimize bilge design. Applicability to retrofitted systems or newly installed systems is marked as appropriate.

5.3 *Design of Oil Pollution Abatement System:*

NOTE 1—The design and installation of OPAS and its components shall comply with the applicable classification and regulatory design standards and requirements. The information contained in this document is intended to complement those standards and requirements.

5.3.1 *Collection Sub-system:*

5.3.1.1 Vessels shall be designed to minimize oily bilge water generation and to facilitate segregation of oil residues, non-oily bilge water, solvents, surfactants and detergents from oily bilge water as recommended in 5.2.3.

5.3.1.2 The machinery spaces shall be provided with bilge wells, drain tanks, drain funnels, and drain pans to collect oily waste generated during systems operation and maintenance, leaks, and accidental oil spills.

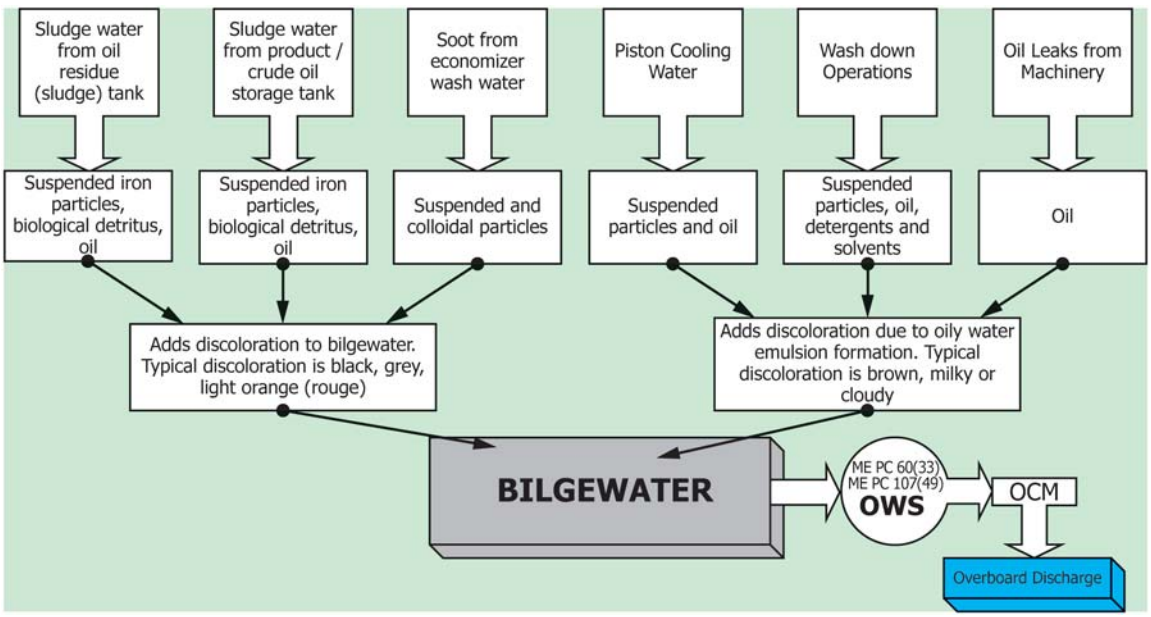


FIG. 2 Example of Shipboard Flow Diagram: Sources of Contamination in Bilge Water

TABLE 1 Design Features to Minimize Contaminants

Section Number	Design Feature	Retrofitting	New Construction
5.2.3.1	Design machinery spaces to be as dry as practical and provide means for condensation containment and diversion via clean drains to minimize the volume of water entering the bilge.		X
5.2.3.2	Incorporate oil drip pans and other oil containment devices to collect oily waste in engine room and auxiliary spaces and pipe these oily wastes directly to oil residue (sludge) tank or oil residue (sludge) drain tank.	X	X
5.2.3.3	Incorporate soot contaminated waste water collection systems, including but not limited, to particle filters and water holding tanks into systems' design.		X
5.2.3.4	Direct overflow piping from sewage systems to a containment tank or overboard with an alarm to indicate the same. Ensure that sewage drains do not comingle with engine and auxiliary space bilges.	X	X
5.2.3.5	Pipe directly overboard evaporator dump in place of dumping to bilge.	X	X
5.2.3.6	Install premium seals in order to prevent leakage into the bilge.	X	X
5.2.3.7	Incorporate mechanical seals in machinery and auxiliary space pumps. Refer to ASTM F1511.	X	X
5.2.3.8	Install skimming arrangements for Oily Bilge Water Holding Tanks and Bilge Primary Tanks in order to skim oil from the top for discharge into Oil Residue (sludge) Tanks.	X	X
5.2.3.9	Optimize slow speed diesel cylinder oil to minimize leakage.		X
5.2.3.10	Incorporate oil cooled cooling designs versus water cooled designs in slow speed diesel piston cooling systems.		X
5.2.3.11	Incorporate modern-type lip-seal systems with protections in place to minimize sea water intrusion and oil leakage in propeller shaft seal design.		X
5.2.3.12	Reduce or prevent the introduction of soot into bilge water by reducing the need for economizer water washing to reduce soot.	X	X
5.2.3.13	Segregate air compressor blow down lines by piping these to drainage systems to prevent oil contamination of existing bilge water.	X	X
5.2.3.14	Prevent the introduction of synthetic oils and emulsifying agents into bilge water or the ship's OPAS.		X
5.2.3.15	Coat bilges with corrosion resistant coatings, particularly in low point collections areas.	X	X
5.2.2.16	Install tanks and piping with corrosion resistant coatings.	X	X
5.2.2.17	Install Bilge Primary Tank with the following characteristics: High aspect ratio Heating coils Non-skin tank to minimize heat loss Internal baffling to minimize mixing due to vessel movement Access to allow cleaning/removal of heavy sludge.	X	X
5.2.2.18	Direct clean drains to prevent clean water from entering the OPAS.	X	X

5.3.1.3 When feasible, oily bilge water and oil residues shall drain directly to the Bilge Primary Tank oil section and the Oil Residue (sludge) Tank, respectively.

5.3.1.4 Oily bilge water drain tanks shall be provided to collect oily bilge water drains that cannot be directed to the oil section of the Bilge Primary Tank.

5.3.1.5 Oil Residue (sludge) drain tanks shall be provided to collect oily drains that cannot be directed to the Oil Residue (sludge) Tank.

5.3.1.6 All collected oily bilge water shall be transferred to the oil section of the Bilge Primary Tank using the oily waste transfer pump (s) or by gravity drain.

5.3.1.7 All collected oil residue (sludge) shall be transferred to the Oil Residue (sludge) Tank using the oil residue (sludge) collecting pump (s) or by gravity drain.

5.3.2 *Holding Sub-system:*

5.3.2.1 *Bilge Primary Tank:*

(1) A Bilge Primary Tank shall be provided as a pre-treatment unit for separation of bulk oil and settleable solids from the oily bilge water prior to discharge into the Oily Bilge Water Holding Tank for subsequent processing by the 15 ppm Bilge Separator. Refer to IMO MEPC.1/Circ 642.

(2) The Bilge Primary Tank shall be designed as a baffled settling tank as shown in Fig. 1. The baffles shall divide the tank in two sections, an oil section and a water section.

(a) Oily bilge water may drain directly to the oil section of this tank or can be collected in the bilges or smaller drain tanks and transferred to the oil section of this tank using the oily waste transfer pumps.

(3) All oily bilge water discharges and drains entering this tank shall be directed to the oil section and as far as possible from the baffle.

(4) Piping shall be provided to allow oily bilge water from the bottom of the water section to flow to the top of the Oily Bilge Water Holding Tank. This piping shall be as far as possible from the baffle and shall be provided with a clearance between the piping suction and the bottom of the tank to avoid suction of solids or sludge accumulated at the bottom of the tank.

(5) Each section of the tank shall be designed to allow separation of the bulk oil, large free oil droplets and settleable solids by gravity as the oily bilge water moves from the oil section to the water section of the tank. In general, tall and slender tanks are preferred over short and stout tanks to enhance oil and water gravity separation. The following design considerations are provided as guidelines:

(a) Provide enough tank height to allow separated oil to accumulate at the top of the water phase even during ship's movement.

(b) The oil is considered separated when it reaches a level that is higher than the bottom opening of the baffle in the oil section and the bottom clearance of the overflow piping to the Oily Bilge Water Holding Tank in the water section.

(c) The rise velocity of the oil droplets can be determined using Stoke's Law, which is defined as follows:

$$V = [g * d^2 \Delta \rho]/(18 \mu)$$

V = droplet rise velocity
g = gravity constant
d = diameter of oil droplet
$\Delta\rho$ = specific gravity of water – specific gravity of oil
μ = viscosity of water

(d) When feasible, design to remove the smallest free oil droplet possible (for example within the 100 to 500 micrometer range).

(e) Consider expected average and peak influent flow rates.

(f) Consider hydraulic residence time.

(6) Means shall be provided to manually or automatically transfer any accumulated bulk oil from each of the two sections of the tank to the Oil Residue (sludge) Tank. The oil may gravity drain to the Oil Residue (sludge) Tank or drain tank via an oil removal line with shut off valve and funnel to ensure that only the oil phase is drained. Alternatively:

(a) The drain piping may be connected to the suction piping of the Sludge Collecting Pump if gravity drain cannot be achieved, provided that tank level indicators or other means are available to allow pumping of the oil phase only.

(b) Or, a mechanical skimmer may be considered to accomplish this function.

(7) Means shall be provided for manually or automatically preventing the accumulated oil phase in the oil section and the water section, from moving to the water section and the Oily Bilge Water Holding Tank, respectively.

(8) Means shall be provided to easily access and remove any accumulated solids and sludge from the bottom of the oil and water sections of the Bilge Primary Tank.

(9) The bilge primary and Oily Bilge Water Holding Tanks may be combined to reduce space or for any other design constraints. If combined, the 15 ppm Bilge Separator suction shall be from the water section and all other Oily Bilge Water Holding Tank requirements shall apply to the water section.

5.3.2.2 *Oily Bilge Water Holding Tank:*

(1) An Oily Bilge Water Holding Tank shall be provided to collect oily bilge water and provide temporary holding prior to its processing, discharge, transfer or disposal.

(2) Calculations of the expected oily bilge water generation rate shall be performed to determine tank size and shall account for the propulsion plant, drainage systems, ship arrangement, auxiliary equipment, condensation, equipment and machinery cleaning, fuel stripping systems, and all other relevant information.

(3) For vessels greater than 400 gross tonnages (GT), OPAS design shall collect oily water in a dedicated Oily Bilge Water Holding Tank sized to hold the oily water production during normal routine operations of a typical voyage. Refer to MARPOL 73/78 Annex 1 and MEPC.187 (59).

(4) For vessels less than 400 GT, oily waste shall be permitted to be stored in the bilge or dedicated holding tank. If not equipped with a 15 ppm Bilge Separator, it shall have the capacity to hold oily waste for the entire duration of any voyage. Refer to MARPOL 73/78 Annex 1.

(5) Piping shall be provided from the bottom of this tank for the 15 ppm Bilge Separator suction.

(6) A clearance shall be provided between the 15 ppm Bilge Separator suction piping and the bottom of the tank to avoid suction of solids or sludge accumulated at the bottom of the tank.

(7) All the discharges entering this tank shall be directed as far as possible from the suction piping of the 15 ppm Bilge Separator.

(8) Means shall be provided to manually or automatically transfer any accumulated bulk oil on top of the water phase in the tank to the Oil Residue (sludge) Tank. The oil may gravity drain to the Oil Residue (sludge) Tank or drain tank via an oil removal line with shut off valve and funnel to ensure that only the oil phase is drained.

(a) Alternatively, the drain piping maybe connected to the suction piping of the Sludge Collecting Pump if gravity drain cannot be achieved, provided that tank level indicators or other means are available to allow pumping of the oil phase only.

(9) Means shall be provided for manually or automatically preventing the accumulated oil phase to reach the bell mouth of the suction piping of the 15 ppm Bilge Separator.

(10) Means shall be provided to easily access and remove any accumulated solids and sludge from the bottom of the tank.

5.3.2.3 *Oil Residue (sludge) Tank:*

(1) An Oil Residue (sludge) Tank shall be provided to hold oil residue (sludge) from which oil residue (sludge) may be directly transferred ashore through the standard discharge connection or any other approved means of disposal.

(2) The oily residue (sludge) tank(s) shall satisfy the requirement for sludge tanks prescribed in MARPOL 73/78 Annex 1, Regulation 12.1.

(3) Oily drains may be sent directly to Oil Residue (sludge) Tank or may be collected into oil residue (sludge) drain tanks and then transferred to the Oil Residue (sludge) Tank using the oil residue (sludge) collecting pumps.

(4) Means shall be provided to manually or automatically remove any water phase from the bottom of the tank to the oil section of the Primary Bilge Tank. The water may gravity drain to the oil section of the Primary Bilge Tank or oily bilge water drain tank via a water removal line with shut off valve and funnel to ensure that only the water phase is drained.

(a) Alternatively, this tank may be fitted with an alternative arrangement, provided that this arrangement does not connect directly to the bilge piping system and allows removal of the water phase only.

(b) If the Oil Residue (sludge) Tank will be decanted to the OPAS, a device such as a sight glass or level indictor shall be provided to monitor the oil-water interface level in the Oil Residue (sludge) Tank to prevent introduction of oily sludge into the OPAS.

(5) Means shall be provided to easily access and remove any accumulated solids and sludge from the bottom of the tank.

5.3.3 *Transfer Sub-system:*

5.3.3.1 Oily Waste Transfer pump(s) and associated piping shall be provided for handling of oily bilge water and transferring it to shore connections.

5.3.3.2 The Oily Waste Transfer pump(s) shall take suction from: bilge wells, oily bilge water drain tanks, hose connections, Oily Bilge Water Holding Tank, oil and water sections of the Bilge Primary Tank, and any other sources of bilge water.

5.3.3.3 Hose connections or other means may be provided at each space that generates oily water to allow complete access to the space by using a hose.

5.3.3.4 The Oily Waste Transfer pump(s) shall discharge to: deck connections, Oily Bilge Water Holding Tank, and the oil section of the Bilge Primary Tank. Also, this pump shall be capable of discharging to the Oil Residue (sludge) Tank in the event of an oil spill in the bilge areas.

5.3.3.5 A dedicated oil residue (sludge) pump shall be provided to transfer oil residue from the Oil Residue (sludge) Tank to shore connections or the ship's incinerator (if provided).

5.3.3.6 A dedicated oil residue (sludge) collecting pump shall be provided to transfer of oil residue from oil residue (sludge) drain tanks to the Oil Residue (sludge) Tank.

5.3.3.7 The oil residue (sludge) pump and oil residue (sludge) collecting pump may be combined.

5.3.3.8 OPAS pumps shall impart low shear force into the bilge water in all suction lines before the oil-water 15 ppm Bilge Separator, including the Oily Bilge Water Holding Tank, therefore centrifugal pumps shall not be used for this purpose.

5.3.3.9 OPAS pumps shall meet ASTM F1510 or equivalent standard.

5.3.3.10 The OPAS may be automated to take suction from oily water generating spaces by means of level switches.

5.3.3.11 A relief valve shall be installed at the discharge of each positive displacement process pump to protect them from over pressurization. The relief valve tail piping should discharge to a collecting tank via a funnel to minimize water entering into the bilges.

5.3.3.12 Pressure gauges shall be provided at the suction and discharge of each process pump to verify proper operation of the pumps.

5.3.3.13 Strainers with baskets shall be provided at the pump's suction to remove large particles that may damage the pump.

5.3.3.14 Means shall be provided such as differential pressure switch with alarm to alert the operator when the strainer basket needs to be cleaned.

5.3.3.15 *Deck Connections:*

(1) Transfer pump piping risers with standard deck discharge connections shall be provided to enable ships to discharge oily bilge waste water and oil residue (sludge) to shore facilities.

(2) An International Maritime Organization (IMO) standard discharge connections shall be provided to allow compatibility between the deck discharge connections and shore facilities at worldwide ports. (MARPOL 73/78 Annex 1, regulation 13)

(3) Deck connections shall be outfitted with a containment device as per class or Flag state requirements.

5.3.3.16 *Automated Transfer System (Optional):*

(1) This is an optional requirement and shall apply only when specified by the purchase or contract. For specific requirements, refer to Section S4 Supplementary Requirements for Automated Oily Waste Transfer (AOWT) System.

NOTE 2—This supplementary requirement may be included in the purchaser's order or contract. When so included, the supplementary requirement shall have the same force as if it were in the body of the specification. Supplementary requirements details not fully described shall be agreed upon between the purchaser and the supplier, but shall not negate any of the requirements in the body of the specification.

5.3.4 *Processing and Monitoring Sub-systems:*

5.3.4.1 15 ppm Bilge Separator and 15 ppm Bilge Alarm shall be installed to remove oil from the oily bilge water pumped from the Oily Bilge Water Holding Tank, send the removed oil to the Oil Residue (sludge) Tank, and send the water effluent overboard or back to the Bilge Primary Tank depending on the decision of the 15 ppm Bilge Alarm.

5.3.4.2 *Optional Pre-treatment:*

(1) The OPAS should aid in the separation of oil, solids and other contaminants from the oily bilge water by pretreatment prior to the oily bilge water being processed by the 15 ppm Bilge Separator. This pretreatment of oily bilge water should aid in increasing the efficiency of the 15 ppm Bilge Separator and decrease operating labor and 15 ppm Bilge Separator maintenance.

(2) Optional Pre-treatment technologies include particle removal and heat treatment among others. A table of options is contained in supplementary section Table S1.4.

NOTE 3—One or more of the supplementary requirements listed in Table S1.4 may be included in the purchaser's order or contract. When so included, the supplementary requirement shall have the same force as if it were in the body of the specification. Supplementary requirements details not fully described shall be agreed upon between the purchaser and the supplier, but shall not negate any of the requirements in the body of the specification.

5.3.4.3 *15 ppm Bilge Separator:*

(1) The 15 ppm Bilge Separator shall comply with all the MEPC.107 (49) requirements as determined by an independent laboratory and approved by an authorized government entity.

(2) Feed Pump

(a) The feed pump (or pumps) is part of the 15 ppm Bilge Separator unit and can be located upstream or downstream of this unit, or as required in a multi-staged treatment system.

(b) Low shear pumps shall be used to minimize the mixing of the oil in water entering the 15 ppm Bilge Separator system.

(c) Feed pumps shall meet ASTM F1510 or equivalent standard.

(3) A 15 ppm Bilge Separator shall be provided and shall be sized to process the oily water at a rate based on the daily generation of oily bilge water.

(4) When determining the process rate of the 15 ppm Bilge Separator, consider the clean water used to backflush any of the 15 ppm Bilge Separator stages, any of the pretreatment units,

and/or the 15 ppm Bilge Alarm. These processes require the addition of clean water to the OPAS, which may reduce the overall net processing rate of the 15 ppm Bilge Separator.

(5) The 15 ppm Bilge Separator system may be a single or multi-staged treatment train consisting of several unit operations or separation technologies. Regardless of the technology used, the 15 ppm Bilge Separator system shall effectively treat free oils and emulsified oils, and produce an effluent not to exceed 15 ppm unless a lower concentration is specified in the purchase contract.

(6) Each 15 PPM Bilge Separator shall be designed so that adjustments to valves or other equipment are not necessary to start it.

(7) Each 15 ppm Bilge Separator shall be designed to be operated both automatically and manually and shall require a minimum of crew attention.

(a) Each 15 ppm Bilge Separator to be installed in an unattended machinery space shall be capable of operating automatically for at least twenty-four (24) hours.

(b) In automatic, the 15 ppm Bilge Separator shall start when the Oily Bilge Water Holding Tank total liquid level reaches a predetermined level (for example, 50%).

(c) The 15 ppm Bilge Separator system shall automatically stop before the oil-water interface inside the Oily Bilge Water Holding Tank level reaches the suction bell mouth to allow processing only the water phase. In addition, a manual override shall be provided to stop the system at any time.

(8) The 15 ppm Bilge Separator shall be designed so that it does not rely in whole or in part on dilution of influent or effluent mixtures as a means of performing its function in meeting the regulatory requirements.

(9) The 15 ppm Bilge Separator shall have a 15 ppm Bilge Alarm complying with MEPC.107 (49) installed and other requirements listed herein.

(10) The 15 ppm Bilge Separator shall be designed and constructed to resist internal and external corrosion due to the marine environment.

(11) The 15 ppm Bilge Separator shall have a dedicated suction from the Oily Bilge Water Holding Tank or from the water section of the Bilge Primary Tank if these tanks are combined.

(12) The 15 ppm Bilge Separator shall send separated oil to the Oil Residue (sludge) Tank and shall send processed water overboard or recirculate to the water section of the Bilge Primary Water Holding Tank depending on the 15 ppm Bilge Alarm decision.

(13) The 15 ppm Bilge Separator system shall have adequate pressure indications to assess system operation. Pressure indications must be provided locally for troubleshooting purposes as well as to the interface/control station(s). At a minimum, pressures shall be determined at the pump inlet and outlet and across strainers or other equipment that may become clogged. If required by the 15 ppm Bilge Separator technology, temperature indications shall also be provided.

(14) Treated bilge water exceeding the oil content limit shall be recirculated to the Bilge Primary Tank for reprocessing.

(15) From Resolution MEPC. 107(49) the OPAS must be capable of handling any oily mixtures from the machinery space bilges and be expected to be effective over the complete range of oils which might be carried on board ship, and deal satisfactorily with oil of very high relative density, or with a mixture presented to it as an emulsion. With the possibility of emulsified bilge water always present, the 15 ppm bilge separator must be capable of separating the oil from the emulsion to produce treated bilge water with an oil content not exceeding 15 ppm.

(16) Sample Ports:

(a) An IMO sample port, as required by MEPC.107 (49) section 6.1.1, shall be installed at the 15 ppm Bilge Separator water effluent piping prior to the diverter valve as shown in Fig. 1. Alternatively, a sample port may tee off from the 15 ppm Bilge Alarm sampling line.

(b) Additional sample ports should be installed on the influent pipe to the process system (on the pressure side of the pump, if the pump is upstream of the process system), across treatment stages and on the oil discharge line in accordance with Fig. 1.

(c) The IMO sample ports should be installed in an upward, fully developed flow in a vertical pipe and be in an accessible location to allow sample collection.

(d) All sample ports shall be provided with a protective device to prevent bending and breakage from incidental contact.

(17) Additional 15 ppm Bilge Separator Device requirements (Optional): The following additional requirements for the 15 ppm Bilge Separator are optional and are contained in Supplementary Section S1:

(a) Testing the 15 ppm Bilge Separator for purchaser specified fluid “D”, Section S1.1. Fluid “D” may consist of single oil, oil mixture, and/or contaminants specified by the purchaser.

(b) Testing the 15 ppm Bilge Separator at discharge limits lower than 15 ppm, Section S1.2. Some special areas may require a discharge limit lower than 15 ppm (for example, 5 ppm).

(c) Testing the 15 ppm Bilge Separator for Reliability, Maintainability, and Availability, Section S1.3. This requirement is to ensure reliability, maintainability and availability to satisfy purchaser’s needs.

NOTE 4—One or more of these supplementary requirements may be included in the purchaser’s order or contract. When so included, the supplementary requirement shall have the same force as if it were in the body of the specification. Supplementary requirements details not fully described shall be agreed upon between the purchaser and the supplier, but shall not negate any of the requirements in the body of the specification.

5.3.4.4 *Monitoring: 15 ppm Bilge Alarm and Automatic Stopping Device*

(1) A 15 ppm Bilge Alarm and automatic stopping device shall be installed downstream of the 15 ppm Bilge Separator to ensure compliance with environmental regulations by preventing oil from being discharged overboard.

(2) 15 ppm Bilge Alarm:

(a) The 15 ppm Bilge Alarm shall comply with all the MEPC.107 (49) requirements as determined by an independent laboratory and approved by an authorized government entity.

(b) The 15 ppm Bilge Alarm shall continuously draw a sample from the 15 ppm Bilge Separator effluent, measure its oil content, and, depending on the alarm status, signal the diverter valve to send the 15 ppm Bilge Separator effluent overboard or return to the Bilge Primary Tank.

(c) Alarm conditions shall occur when the oil content exceeds the set limit or under any condition that would affect the oil content determination.

(d) The 15 ppm Bilge Alarm shall interface with the 15 ppm Bilge Separator to activate automatically whenever the 15 ppm Bilge Separator is in operation.

(e) The 15 ppm Bilge Alarm design shall provide for flushing and self-cleaning capabilities and for automatically positioning the automatic stopping device to return all effluent during these processes to the Bilge Primary Tank. It is recommended that the flushing feature be automated to provide flushing at system shut-down.

(f) The 15 ppm Bilge Alarm shall provide outputs for remote indication of; operating status, ppm readings, alarm status, any malfunction indication, and any other 15 ppm Bilge Alarm indication.

(g) The 15 ppm Bilge Alarm shall be designed to operate only when it receives a sample flow and not when the sample is stagnant.

(h) Means shall be provided to simulate alarm conditions to allow testing of the diverter valve and the alarm indicators.

(3) Additional 15 ppm Bilge Alarm System requirements (Optional): The following additional requirements for the 15 ppm Bilge Alarm are optional and are contained in Supplementary Section S2:

(a) Testing the 15 ppm Bilge Alarm for purchaser specified fluid "D", Section S2.1 Fluid "D" may consist of single oil, oil mixture, and/or contaminants specified by the purchaser.

(b) Testing the 15 ppm Bilge Alarm for discharge limits lower than 15 ppm, Section S2.2. Some special areas may require a discharge limit lower than 15 ppm (for example, 5 ppm).

(c) Testing the 15 ppm Bilge Alarm for detection of "free oil," Section S2.3. This requirement is to ensure that the 15 ppm Bilge Alarm detects large oil droplets of "free oil" that may be present in the effluent during 15 ppm Bilge Separator failure (for example, saturated filter media, membrane cracks or broken seals, and others)

(d) Testing the 15 ppm Bilge Alarm for reliability, maintainability, availability, Section S2.4. This requirement is to ensure reliability, maintainability and availability to satisfy purchaser's needs.

(e) Additional Recording Device to record additional parameters not covered by MEPC.107 (49), Section S2.5.

(f) Tamper proof design, Sections S3.1 and S3.3.

NOTE 5—One or more of these supplementary requirements may be included in the purchaser's order or contract. When so included, the supplementary requirement shall have the same force as if it were in the body of the specification. Supplementary requirements details not fully described shall be agreed upon between the purchaser and the supplier, but shall not negate any of the requirements in the body of the specification.

(4) 15 ppm Bilge Alarm sampling port and sampling device:

(a) A sampling device shall be installed through a sampling port installed in the 15 ppm Bilge Separator effluent piping, downstream of all 15 ppm Bilge Separator components, and upstream of the diverter valve to provide a sample to the 15 ppm Bilge Alarm, see Fig. 1.

(b) The recommended sampling port and sampling device installation is as follows:

(1) In a vertical section of pipe with at least ten pipe diameters of unobstructed flow upstream and downstream of the sampler (no elbows or valves).

(2) In a pipe with flow from low to high.

(3) The sampling line shall be as short as possible to minimize the travel time of the sample from the sampling connection to the 15 ppm Bilge Alarm. This sample travel time shall not exceed 15 seconds to ensure that the overall response time does not exceed 20 seconds as required by MEPC.107 (49).

(4) Multi-port Nozzle Sampling Device (Optional)—A multi-port nozzle sampling device is recommended for piping larger than 1.5 inch nominal pipe diameter to ensure a representative sample is taken. The sampler construction and installation are contained in Supplementary Section S2.6.

NOTE 6—This supplementary requirement may be included in the purchaser's order or contract. When so included, the supplementary requirement shall have the same force as if it were in the body of the specification. Supplementary requirements details not fully described shall be agreed upon between the purchaser and the supplier, but shall not negate any of the requirements in the body of the specification.

5.3.4.5 *Automatic Stopping Device: Diverter Valve:*

(1) An automatic stopping device shall be fitted downstream of the 15 ppm Bilge Separator to preclude overboard discharge of unacceptable effluent.

(2) The automatic stopping device may be a 3-way diverter valve or two 2-way valves.

(3) The position of the automatic stopping device shall be controlled by the 15 ppm Bilge alarm.

(4) The automatic stopping device shall meet the following requirements:

(a) Divert the flow to overboard when energized and return to the Bilge Primary Tank when de-energized.

(b) Return to the default de-energized position in the event of any automatic stopping device, power supply or control signal failure.

(c) Have a quick cycle time to change valve position (for example, less than 2 seconds).

(d) Rated for the system operating pressure.

(e) Provide outputs from the valve (for example, limit switches) for local and remote indication of the valve's position.

(f) The automatic stopping device may be provided with tamper-proof means as specified in Supplementary Section S3.2.

NOTE 7—This supplementary requirement may be included in the purchaser's order or contract. When so included, the supplementary requirement shall have the same force as if it were in the body of the specification. Supplementary requirements details not fully described shall be agreed upon between the purchaser and the supplier, but shall not negate any of the requirements in the body of the specification.

5.3.4.6 *Fail-Safe Design:*

(1) The OPAS shall be designed for fail-safe operation to preclude unacceptable overboard discharge of oily waste in the event of failures of any of the OPAS components or electrical power supply failure.

(2) The default start-up position of the automatic stopping device shall be to recirculate to the Bilge Primary Tank. The automatic stopping device shall immediately return to the default position in the event of system shutdown, no control signal from 15 ppm Bilge Alarm, actuator failure, or electrical supply failure.

(3) The 15 ppm Bilge Alarm installation shall provide at least a 20 seconds time delay to ensure that the 15 ppm Bilge Alarm receives and analyzes a representative sample prior to sending the control signal to the automatic stopping device to allow overboard discharge. The time delay can be built into the 15 ppm Bilge Alarm unit or a separate PLC or time delay box between the 15 ppm Bilge Alarm unit and the automatic stopping device. The 15 ppm Bilge Alarm signal to the automatic stopping device shall be immediately interrupted to return the effluent to the Bilge Primary Tank if any reading exceeds the discharge limit.

5.3.4.7 *Overboard Discharge Piping:*

(1) Overboard discharge piping shall be provided with a Port State Inspection valve downstream of the automatic stopping device as shown in Fig. 1. Refer to MECP.107(49) section 6.1.1.

(2) A check valve shall be provided on the discharge side of the Port State Inspection valve to prevent flow from the bilge through the valve.

(3) A valve with locking devise shall be provided at the overboard discharge piping, just upstream of the hull penetration, to allow locking this valve shut to secure the system. Refer to ASTM F993 for locking device requirements.

5.3.4.8 *Tamper-proof Installation Design (Optional):*

(1) The following tamper-proof installation designs are contained in Supplementary Section S3.

(a) The 3-way diverter valve (automatic stopping device) sealed wiring installation to preclude tampering, Section S3.2.

(b) The 15 ppm Bilge Alarm sampling line tamper-proof to preclude dilution of the sample by introducing clean water, Section S3.3.

(c) Tamper proof overboard discharge piping design, Section S3.4.

NOTE 8—One or more of these supplementary requirements may be included in the purchaser's order or contract. When so included, the supplementary requirement shall have the same force as if it were in the body of the specification. Supplementary requirements details not fully described shall be agreed upon between the purchaser and the supplier, but shall not negate any of the requirements in the body of the specification.

5.3.4.9 *Optional Incinerator / Boiler:*

(1) Waste oil incinerators, if provided, shall meet Specification F1323.

5.3.4.10 *Sludge Removal:*

(1) The system shall be designed for efficient removal of nearly all of the liquid and solids remaining as a result of system operation.

5.3.5 *Reliability, Availability and Maintainability (RAM) Requirements (Optional):*

5.3.5.1 Reliability, availability and maintainability (RAM) requirements for the 15 ppm Bilge Separator and 15 ppm Bilge Alarm are contained in supplementary sections S1.3 and S2.4, respectively.

5.3.5.2 *NOTE*—One or both of these supplementary requirements may be included in the purchaser's order or contract. When so included, the supplementary requirement shall have the same force as if it were in the body of the specification. Supplementary requirements details not fully described shall be agreed upon between the purchaser and the supplier, but shall not negate any of the requirements in the body of the specification.

5.3.6 *Independent Supporting:*

5.3.6.1 All equipment supports shall be independent from connecting pipes.

5.3.7 *Access to Parts:*

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

5.3.7.2 Each part of the OPAS that is susceptible to wear and tear shall be readily accessible for maintenance in its installed position.

5.3.7.3 Access for maintenance shall be provided for all applicable components.

5.3.8 *General OPAS Requirements:*

5.3.8.1 All OPAS components shall minimize the effort required for their draining, accessing, cleaning, maintenance, and preservation.

5.3.8.2 The OPAS system shall operate as specified herein within relative humidity limits of 5 to 95 %.

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

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

5.3.8.5 The OPAS shall minimize turbulent fluid flow, oil and water mixing and emulsification, and oil droplet size reduction prior to the 15 ppm Bilge Separator.

5.3.8.6 Materials used to fabricate the structure, systems, and equipment shall have material properties and behavior suitable for the manufacturing and installation processes selected, in-service environment, and function performed.

5.3.8.7 Selected materials shall support the ship's required service life without degrading the performance of ship structure, systems, and equipment during the specified ship operational profiles.

5.3.8.8 OPAS shall be designed and constructed with corrosion resistant materials having the same expected life of the vessel for valves, fittings, and piping materials given the expected operating environment.

5.3.8.9 Direct contact of electrolytically dissimilar metals is prohibited unless electrolytic corrosion precautions are used. OPAS design must be of compatible materials and components.

5.3.8.10 All equipment and systems shall minimize the production and use of hazardous materials during their manufacture and life cycle.

5.3.8.11 Alternatives to hazardous materials shall be used where practicable.

5.3.8.12 Coatings or paints shall not contain any heavy metals, such as, chromium, lead, tin or other materials banned by regulatory authorities.

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

5.3.8.14 The OPAS shall remain safe while secured or during operation.

5.3.8.15 To ensure crew safety, overflow alarms and monitors shall be installed in all operating spaces.

5.3.8.16 A stowage locker for an oil spill response kit shall be provided and be located convenient to locations of potential oil spill areas.

5.3.8.17 The OPAS 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.

5.3.8.18 All OPAS valves shall be provided with label plates in accordance with F992.

5.3.8.19 The OPAS shall be designed for human interface and safety:

(1) The criteria in ASTM Practice F1166 shall be used for the design, construction, and layout of the OPAS controls, displays, equipment and labels.

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

(3) Warning and operating labels shall be affixed to the device where necessary in accordance with Practice F1166.

(4) Equipment requiring routine maintenance shall be easily accessible.

(5) Tanks, voids and vents, if any, that require internal inspection shall be fitted with a connection point suitable for atmospheric "gas free" sampling.

5.3.8.20 *Special Government Requirements (for Government Procurement Only)*—Due to the criticality of their mission, OPAS for government vessels have special requirements. These requirements are contained in Supplementary Section S5.

NOTE 9—These supplementary requirements may be included in the purchaser's order or contract. When so included, the supplementary requirement shall have the same force as if it were in the body of the specification. Supplementary requirements details not fully described shall be agreed upon between the purchaser and the supplier, but shall not negate any of the requirements in the body of the specification.

5.4 *Tanks/Tanks Construction:*

5.4.1 *Overflows:*

5.4.1.1 Any tank with oily waste delivered under pressure shall have dedicated overflow piping.

5.4.1.2 Overflow piping from any tank containing oily waste shall not be combined with overflows or air vents from fuel tanks.

5.4.1.3 The Residue (sludge) Tank shall overflow to the Bilge Primary Tank.

5.4.1.4 The Residue (sludge) Tank and oily waste tanks shall not overflow overboard.

5.4.1.5 All overflow lines shall originate from a point low in the tank so that water at the bottom of the tank will overflow before the oil.

5.4.1.6 All overflow lines shall contain a check valve oriented in the fore and aft position.

5.4.1.7 Check valves shall be located at the high point in the overflow piping.

5.4.1.8 If multiple Oily Bilge Water Holding Tanks are present, overflows may be combined to eliminate large runs of pipe.

5.4.1.9 Overflow piping from all overflow tanks and overflow mains shall be sized to accommodate the maximum combined filling rate of all the tanks served.

5.4.1.10 The discharge point of all overflow piping shall comply with all applicable flag state requirements.

5.4.1.11 Due to the criticality of their mission, government vessels may have different requirements. These requirements are contained in Supplementary Section S5 for Special Government Requirements.

NOTE 10—One or more of these supplementary requirements may be included in the purchaser's order or contract. When so included, the supplementary requirement shall have the same force as if it were in the body of the specification. Supplementary requirements details not fully described shall be agreed upon between the purchaser and the supplier, but shall not negate any of the requirements in the body of the specification.

5.4.2 *Air Vents:*

5.4.2.1 The Oily Bilge Water Holding Tank, Oil Residue (sludge) Tank and any other tank containing oily waste shall have air vents that are separate from the overflow piping.

5.4.2.2 Air escape piping from any tank containing oily waste shall not be combined with overflows or air vents from fuel tanks.

5.4.2.3 All air vents lines shall originate from the top of the tank to avoid any air flow obstruction due to the tank's liquid content.

5.4.2.4 The air vents shall be sized in relation to the maximum filling rate to which the tank may be subjected. In general, they shall be sized to limit the air velocity to 25 feet per second when the tank is being filled at its maximum design rate, but shall be a minimum of 1.5 inch nominal pipe diameter.

5.4.2.5 The air vent opening shall be 1.5 times larger than the vent pipe and have a double screen that can be removed for cleaning.

5.4.2.6 Air vents for tanks containing oily waste (including the Oily Bilge Water Holding Tank, Bilge Primary Tank and Oil Residue (sludge) Tank) may be combined provided the junction is above the highest tank overflow level.

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

5.4.2.8 The discharge of all air vents shall comply with all applicable flag state requirements.

5.4.3 *Sounding Tubes:*

5.4.3.1 All tanks shall be provided with sounding tubes as a means of verifying the tank level indicator (TLI) receivers and eliminating a single point of failure.

5.4.4 *Tank Construction:*

5.4.4.1 Tanks shall be provided with access (for example, manholes) for easy inspection, cleaning or repairs.

5.4.4.2 Tanks with a capacity of 1,000 gallons or more shall be provided with two manholes.

5.4.4.3 All internal tank surfaces, including ladders and other ferrous structures, fittings, pipe supports, etc., shall be coated to prevent corrosion from oily waste, waste oil, and seawater. Care shall be taken to ensure complete coverage of all such surfaces. Alternative materials such as composites with acceptable mechanical and electrical (electrostatic – composites shall be electrically conductive and grounded to prevent electrostatic discharges) properties for tank ladders and related tank fixtures may also be used.

5.4.4.4 Tanks shall be provided with cathodic protection. ZHC-42 zinc anodes are recommended to be installed in the tanks at a concentration of one anode for every 80 square feet of tank surface. Anodes shall be distributed in concentrations proportional to the amount of time that the area of the tank will spend submerged. Anodes shall also be located in the vicinity of dissimilar metal combinations in the tank such as piping penetrations. The tank surface shall be coated prior to installing the anodes. After installing the anodes, the paint on the studs shall be touched-up.

5.5 *Electrical System:*

5.5.1 *Electrical Components and Installation:*

5.5.1.1 Interior electrical equipment and enclosures used in a machinery space, a location normally exposed to splashing or another space with a similar moisture level shall be at least IEC 60529 IP44 or an appropriate ANSI/NEMA250 Type for the intended service.

5.5.1.2 Exterior electrical equipment and enclosures for treatment system exposed to the weather, water wash down, or similar moisture conditions shall be at least ANSI/NEMA Type 4 or Type 4X, or IEC 60529 IP65.

5.5.1.3 Electrical equipment and components shall be protected from direct water impingement.

5.5.1.4 Electrical equipment and installations shall be suitable for the roll, pitch, and vibration of the vessel while underway.

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

5.5.1.6 Electrical equipment and circuits for treatment systems shall be clearly marked and identified on all wiring diagrams.

5.5.1.7 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.

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

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

5.5.1.10 Sufficient slack shall be provided in electrical lines to facilitate equipment removal and maintenance.

5.5.1.11 Electrical wiring diagrams shall be provided inside the corresponding electrical enclosure.

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

5.5.2 Control systems and conductors

5.5.2.1 Treatment system wiring shall be rated for the maximum operating temperature to which it has the potential to be exposed.

5.5.2.2 All control wiring between components shall have copper conductors ≥ size 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 Universal Serial Bus (USB), ribbon, coaxial, telephone twisted-pairs, Ethernet or similar cables, do not have to meet this requirement.

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

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

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

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

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

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

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

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

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

5.5.2.12 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.

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

5.5.2.14 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.

5.5.3 *Motors:*

5.5.3.1 Motors must be rated to operate at 50°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.

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

5.5.3.3 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.

5.5.3.4 Motors shall be provided with a corrosion resistant nameplate specifying; (1) the manufacturer'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) Code letter, (8) and thermal protection if used. For IEC motors, the manufacturer shall certify the rated temperature by signed letter or other equivalent means.

5.5.3.5 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.

5.5.3.6 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.

5.5.3.7 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.

5.5.3.8 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.

5.5.3.9 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.

5.5.3.10 Motors shall be provided with terminal leads or terminal screws in terminal boxes integral with, or secured to, the motor frames.

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

5.5.4 *Hazardous Locations:*

5.5.4.1 Components to be installed in hazardous location shall be certified as being: intrinsically safe in accordance with UL 913, ANSI/ISA 60079-11, or IEC 60079-11; explosion proof in accordance with UL 1203, ANSI/ISA 60079-1, or IEC 60079-1 for Class I, Group D hazardous locations; or other accepted standards as determined by the certifying body.

5.6 *Tank Level Indicator:*

5.6.1 Each OPAS shall have means of indicating tank(s) levels that is compliant with Specification F2044 or F2045-00.

5.6.2 The Bilge Primary Tank, Oily Bilge Water Holding Tank and Oil Residue (sludge) Tank, drain tanks, and any tank containing oily waste shall have tank level indicating systems.

5.6.3 Tank Level Indicators (TLIs) shall also be installed in feed water and potable water tanks to preclude their overflowing to the bilge.

5.6.4 The Bilge Primary Tank (both sections), Oily Bilge Water Holding Tank and Oil Residue (sludge) Tank shall have TLIs that display oil-water interface (that is, water level) and oil-air interface (that is, total liquid level).

5.6.5 The TLIs in the Oily Bilge Water Holding Tank may also be used to control the automatic start and stop of the 15 ppm Bilge Separator, as well as automatic bulk oil stripping from Bilge Primary Tank (both sections), Oily Bilge Water Holding Tank and Oil Residue (sludge) Tank.

5.6.6 Qualified level sensing technology shall be used provided the technology meets the following requirements for TLI systems:

5.6.6.1 Ability to adequately perform in the presence of pure water, bulk oil, emulsions, sludge, water/oil interface and water/emulsion interface.

5.6.6.2 Not susceptible to failure due to sludge accumulation.

5.6.6.3 Accessibility for cleaning and maintenance.

5.6.6.4 Ability to adequately perform under the effects of ship motion.

5.6.7 Flange mounted TLI assemblies shall be used to facilitate removal for cleaning and maintenance. Maximum indication to the top of the tank and minimum indication to the bottom of the tank are required.

5.6.8 TLI read-outs and alarms shall be available on the 15 ppm Bilge Separator and/or the automated transfer programmable logic controller (PLC) when installed.

5.6.9 Cables used for TLI systems shall be oil-proof and low-smoke.

5.6.10 High-level alarms shall be installed on all tanks that receive oily waste under pressure to give warning before overflow occurs. The high-level alarm set point shall be set not to exceed 90 to 95% of tank capacity and shall provide at least 2 minutes warning before tank overflow occurs. Additional high-level alarms may be considered for use in the Oily Bilge Water Holding Tank and Oil Residue (sludge) Tank to provide two alarms, one at the 90 to 95% capacity and one prior to this level to prompt operator action before reaching the 2-minute warning.

5.6.11 Low-level alarms shall be provided in the Oily Bilge Water Holding Tank and Oil Residue (sludge) Tank to warn the operator to stop the pump before it is run with a dry suction.

5.6.12 TLI receivers and high-level and low-level alarms shall be located in continuously manned spaces and at equipment that can cause overflow conditions, such as the controllers for the 15 ppm Bilge Separator, and all pumps which discharge to or draw suction from the Oily Bilge Water Holding Tank and Oil Residue (sludge) Tank.

5.6.13 Means shall be provided to test high level alarms without opening or filling tanks.

5.7 *Piping:*

5.7.1 Piping shall be compatible with the treatment system materials.

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

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

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

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

5.7.6 Inlet and outlet connections shall be in accordance with ASME B16.1, B16.5, or B16.11, or ASME B16.24.

6. Effluent Standards

6.1 OPAS effluent shall not exceed 15 ppm unless more stringent requirements are specified by the purchaser.

6.1.1 Requirements for testing the 15 ppm Bilge Separator and 15 ppm Bilge Alarm at a discharge limits lower than 15 ppm are contained in supplementary sections S1.2 and S2.2, respectively.

6.1.2 *NOTE*—One or both of these supplementary requirements may be included in the purchaser's order or contract. When so included, the supplementary requirement shall have the same force as if it were in the body of the specification. Supplementary requirements details not fully described shall be agreed upon between the purchaser and the supplier, but shall not negate any of the requirements in the body of the specification.

6.2 *Operating Specifications:*

6.2.1 The operating specifications in 33 CFR Part 155 apply to each U.S. flagged vessel, wherever located, and to non-U.S. flagged vessels while in the navigable waters of the United States. These regulations implement MARPOL Annex I in the United States.

6.2.2 Elsewhere, the operating specifications of the ship's flag State apply.

7. Other Requirements

7.1 *Documentation*—A complete installation, operation, maintenance, and troubleshooting instructions manual with drawings, electrical diagrams, and spare parts list shall be furnished with each major component of the OPAS.

7.1.1 The instructions manual supplied by the manufacturer shall contain directions for each of the following:

7.1.1.1 Installation of the device in a manner that will permit ready access to all parts of the device requiring routine service.

7.1.1.2 Routine cleaning and sludge removal.

7.1.1.3 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.

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

7.1.1.5 Operating procedures.

7.1.1.6 Troubleshooting and remedy procedures.

7.1.1.7 Procedures for routine and periodic maintenance of equipment and systems.

7.1.1.8 Procedures to verify that the Bilge Alarm is zeroed in accordance with the manufacturer's recommendations for testing (consistent with MEPC.107(49)) prior to running the 15 PPM Bilge Separator. Such procedures should include that these tests be recorded in an appropriate logbook.

7.1.2 The instructions manual supplied by the manufacturer shall include the following information:

7.1.2.1 The name of the manufacturer

7.1.2.2 The name and model number of the device.

7.1.2.3 A complete parts list.

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

7.1.2.5 A wiring and/or piping diagram. The diagram(s) shall identify each labeled part, switch and valve. A description of the service for the user to perform without coming into contact with oily water mixtures or chemicals.

7.1.2.6 Average and peak capacity of the device for the flow rate and volume.

7.1.2.7 The power requirements, including voltage and current.

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

7.1.2.9 Installation verification test procedures

7.2 The following documentation shall be provided by the manufacturer for the overall integrated OPAS and system interfaces:

7.2.1 Installation drawings including piping, electrical and structural. The installation drawings shall identify each labeled part, switch and valve.

7.2.1.1 The installation drawings shall be updated as required to reflect any changes in the system installation, including changes in each labeled part, switch and valve.

7.2.2 Installation verification and operating procedures for the integrated OPAS.

7.3 The following documentation shall be provided by the OPAS integrator or manufacturer on troubleshooting procedures and proper bilge management procedures to enhance system effectiveness. Refer to IMO MEPC.1 / Circular 677.

7.3.1 Detailed trouble shooting and repair procedures for general 15 ppm Bilge Separator and 15 ppm Bilge Alarm mechanical failure.

7.3.2 Trouble shooting procedures for determining the cause and remedy for constant 15 ppm Bilge Separator and 15 ppm Bilge Alarm recirculation and failure to discharge bilge at below 15 ppm.

7.3.3 Troubleshooting procedures shall include, but not be limited to the following: detailed instructions and procedures for troubleshooting 15 ppm Bilge Alarm malfunctions. Identification of contaminants related to 15 ppm Bilge Alarm or 15 ppm Bilge Separator malfunctions; detailed procedures for identifying the bilge contaminants causing the malfunctions. Procedures should address the presence of detergents and solvents, oily emulsions, non-oily emulsions, particulates (biological detritus, soot and rouge (iron oxide compounds)).

7.3.4 Bilge management procedures shall minimize bilge contaminants and should address and include but not be limited to the following: control of the amount of solvents, detergents and degreasers entering bilge; limiting of engine room chemicals that will cause problems and promote use of 15 ppm Bilge Separator friendly chemicals; run 15 ppm Bilge Separator more frequently to prevent sludge build up in pipes, pumps and holding tanks; control leaks and maintenance discharges of coolants, fuel oil, lubricants, hydraulic fluids and oil sludge into the bilge; control leaks from boiler water and condensate drains, piston cooling water and any other sources of excess water (for example, diesel engine after coolers, air conditioning and refrigeration condensate) and chemicals; prevent the discharge of sewage and food wastes into the bilge; control leakage from machinery and piping; control the discharge and build up of rust and other particles in the bilge (for example,

from scraping and maintenance of machinery space equipment); keep bilge areas clean to ensure leakages can be identified quickly and repaired; do not decant the Oil Residue (sludge) Tank to the OPAS; avoid the use of cleansing agents, emulsifiers, solvents, or surfactants used for cleaning purposes that may cause the bilge water to emulsify.

7.3.5 Provide the tools to conduct testing for regular monitoring of contaminants in bilge water.

7.4 *Training*—The OPAS integrator or manufacturer shall provide the following training modules for incorporation into the ship's training program:

7.4.1 Training module on bilge water management and the regular monitoring of contaminants in bilge water.

7.4.2 Training module on the operation and maintenance for the integrated OPAS.

8. Safety Concerns

8.1 The design of the OPAS shall minimize potential for human error during operation and maintenance, under routine, non-routine and emergency conditions.

8.2 The manual handling of hazardous materials by users shall be limited as far as possible.

8.3 Shafts, couplings, gears, and similar items shall have adequate guards installed for protection of personnel.

8.4 OPAS components shall:

8.4.1 Be free of design defects such as rough or sharp edges with the potential to cause bodily injuries or that would allow toxic substances to escape to the interior of the vessel;

8.4.2 Be vented or provided with a means to prevent an explosion or over pressurization as a result of an accumulation of gases; and

8.4.3 Meet all other safety requirements of the regulations applicable to the type of vessel for which it is certified.

8.4.4 Where chemicals are specified or provided by the manufacturer for use in the operation of a device and are defined as a hazardous material as in accordance with 49 CFR 171.8, they shall be labeled, stowed and used as required by 46 CFR 147.

8.4.5 Current carrying components shall be protected from accidental contact by personnel operating or routinely servicing the device. All current carrying components shall as a minimum be of drip-proof construction or be enclosed within a drip-proof compartment.

8.4.6 Owner/operator is responsible to ensure compliance with all the applicable flag state safety requirements.

9. Test Methods

9.1 The 15 ppm Bilge Separator shall be approved in accordance with Resolution MEPC.107(49).

9.2 Optional Test Methods for 15 ppm Bilge Separator - In addition, one or more supplementary requirements listed below and contained in the Supplementary Section S1 shall apply only when specified in the purchaser's order or contract.

9.2.1 Test 15 ppm Bilge Separator with purchaser's specified fluid "D" - Fluid "D" may consist of single oil, oil mixture, and/or contaminants specified by the purchaser.

9.2.2 Test 15 ppm Bilge Separator at discharge limits lower than 15 ppm - Some special areas may require a discharge limit lower than 15 ppm (for example, 5 ppm).

9.2.3 15 ppm Bilge Separator Reliability, Maintainability, Availability Tests - This requirement is to ensure system reliability, maintainability and availability to satisfy purchaser's needs.

9.2.4 *NOTE*—One or more of these supplementary requirements may be included in the purchaser's order or contract. When so included, the supplementary requirement shall have the same force as if it were in the body of the specification. Supplementary requirements details not fully described shall be agreed upon between the purchaser and the supplier, but shall not negate any of the requirements in the body of the specification.

9.3 The Bilge Alarm shall be approved in accordance with Resolution MEPC.107(49).

9.4 *Optional Test Methods for 15 ppm Bilge Alarm*—In addition, one or more supplementary requirements listed below and contained in the Supplementary Section S2 shall apply only when specified in the purchaser's order or contract.

9.4.1 *Test 15 ppm Bilge Alarm with purchaser specified fluid "D"*—Fluid "D" may consist of single oil, oil mixture, and/or contaminants specified by the purchaser.

9.4.2 *Test 15 ppm Bilge Alarm at discharge limits lower than 15 ppm*—Some special areas may require a discharge limit lower than 15 ppm (for example, 5 ppm).

9.4.3 *15 ppm Bilge Alarm Free Oil Test*—This requirement is to ensure that the 15 ppm Bilge Alarm detects large oil droplets of "free oil" that may be present during 15 ppm Bilge Separator failure (for example, saturated filter media, membrane cracks or broken seals, and others)

9.4.4 *15 ppm Bilge Alarm Reliability, Maintainability, Availability Tests*—This requirement is to ensure system reliability, maintainability and availability to satisfy purchaser's needs.

9.4.5 *NOTE*—One or more of these supplementary requirements may be included in the purchaser's order or contract. When so included, the supplementary requirement shall have the same force as if it were in the body of the specification. Supplementary requirements details not fully described shall be agreed upon between the purchaser and the supplier, but shall not negate any of the requirements in the body of the specification.

9.5 A test report shall be generated in accordance with Resolution MEPC.107 (49).

9.6 Testing of OPAS effluent oil-in-water shall be in accordance with ISO 9377–2:2000.

10. Inspection

10.1 The manufacturer shall afford the purchaser's inspector all reasonable facilities necessary to satisfy the purchaser that the material is being furnished in accordance with this specification. Inspection by the purchaser shall not interfere unnecessarily with the manufacturer's operations. All examinations and inspections shall be made at the place of manufacture, unless otherwise agreed upon.

10.2 Owner/operator is responsible to ensure compliance with all the applicable flag state inspection requirements.

11. Certification

11.1 Manufacturer's certification that an OPAS has been constructed, installed, and is operational in accordance with this specification shall be provided (by letter or certificate).

11.2 Responsibility rests with the purchaser to ensure that an OPAS procured to this standard meets all regulatory requirements for areas in which it is to be operated.

11.3 Owner/operator is responsible to ensure compliance with all the applicable flag state certification requirements.

12. Product Marking

12.1 Each 15 ppm Bilge Separator and 15 ppm Bilge Alarm manufactured under a certifying administration shall be plainly marked by the manufacturer with the information listed in 12.3.

12.2 The marking shall be made of a durable and corrosion proof material and shall be securely fastened to the item.

12.3 Each marking shall include the following information:

12.3.1 Name of the manufacturer.

12.3.2 Name or model number of the item.

12.3.3 The maximum throughput and the maximum influent pressure at which it is designed to operate.

12.3.4 The month and year of completion of manufacture.

12.3.5 The manufacturer's serial number for the item.

12.3.6 The certifying administration number assigned to the item in the certificate of approval.

12.3.7 A warning placard or label to refer to the equipment manual for a list of bilge cleaners, solvents, and other chemical compounds that do impair operation of the item.

12.3.8 If the item is a 15 ppm Bilge Separator that uses replaceable filter or coalescer elements, the part numbers of the elements.

12.3.9 Any additional approved test listed in Supplementary Sections S1 and S2 for the 15 ppm Bilge Separator and 15 ppm Bilge Alarm, respectively.

13. Quality Assurance

13.1 OPAS shall be designed, manufactured, and tested in a manner that ensures the requirements of this specification are met.

13.2 The OPAS shall conform to human engineering principles in accordance with ASTM F1166 to the degree that it can be operated and maintained by a 52 cm (5 ft) tall male or female as well as 185 cm (6 ft 1 in.) tall male or female.

13.3 OPAS design shall reflect system and personnel safety factors, including the elimination or minimization of the potential for human error during operation and maintenance, under both routine and non-routine or emergency conditions. Machinery, systems, equipment, and fixtures shall be intrinsically safe as far as practicable, and in the event of failure, shall fail to a safe mode.

13.4 The OPAS manufacturer shall maintain the production quality of the OPAS that are designed, tested and marked in accordance with this specification. At no time shall an OPAS be sold with this standard designation that does not meet the requirements herein (see Certification).

14. Keywords

14.1 15 ppm bilge separator; 15 ppm bilge alarm; automatic stopping device; bilge primary tank; bilge water; diverter valve; marine environmental protection; MEPC.107(49); MEPC.1 Circ 642; MEPC.1 Circ 677; oil content monitor; oil pollution abatement; oil-water mixture; oil water separator; oil residue (sludge) tank; oily bilge water holding tank; oily wastemarine environmental protection

SUPPLEMENTARY REQUIREMENTS

One or more of the supplementary requirements described below may be included in the purchaser's order or contract. When so included, a supplementary requirement shall have the same force as if it were in the body of the specification. Supplementary requirements details not fully described shall be agreed upon between the purchaser and the supplier, but shall not negate any of the requirements in the body of the specification.

S1. Supplementary requirements for 15 ppm Bilge Separator

S1.1 **Test 15 ppm Bilge Separator with purchaser specified fluid "D"**

S1.1.1 This test is in addition to the MEPC.107 (49) approval requirements.

S1.1.2 Add an additional run to the MEPC.107 (49) test to include a purchaser specified fluid "D". This fluid "D" may consist of a single oil, oil mixtures, and/or contaminants specified by the purchaser. The purchaser will determine the test conditions and concentrations.

S1.1.3 The results of this run are not part of the MEPC.107 (49) approval and shall be reported to the purchaser in a separate document.

S1.2 **Test 15 ppm Bilge Separator at discharge limits lower than 15 ppm**

S1.2.1 Some special areas may required an overboard discharge with an oil content lower than the 15 ppm limit. Therefore, the purchaser should ensure that the Bilge Separator to be installed meets the required lower discharge limit.

S1.2.2 This test is in addition to the MEPC.107 (49) approval requirements.

S1.2.3 In addition to the 15 ppm discharge limit, use the purchaser's specified lower discharge limit (for example, 5 ppm) to analyze the results from the MEPC.107(49) test.

S1.2.4 The results analysis at the lower discharge limit are not part of the MEPC.107 (49) approval and shall be reported to the purchaser in a separate document.

S1.3 **15 ppm Bilge Separator Reliability, Availability and Maintainability(RAM) Tests**

S1.3.1 This test is in addition to the MEPC.107 (49) approval requirements.

S1.3.2 The purchaser shall pre-determine the minimum reliability, availability and maintainability requirements.

NOTE: Section S5.8 and Table S5.1 contain RAM requirements recommended for government use. ASTM F2446 may be used as reference for the exchange of equipment RAM performance data.

S1.3.3 Modify the MEPC.107 (49) test set-up to recycle back to the feed tank to allow for continuous long term operation of the unit.

S1.3.4 Operate the unit in a closed loop for a minimum of 6 hours alternating between test fluid runs (for example, A, B, C and/or D (if applicable)). The initial fluid concentration shall be at least 1 % by volume. Means shall be provided to mix the feed tank content to preclude phase separation in the tank. The test shall be performed with no interruptions for system maintenance or adjustments (for example, changing of filters, changing controller set points, etc.) unless otherwise previously agreed with the purchaser.

S1.3.5 Record operating status and parameters, and any other relevant information.

S1.3.6 Continue test until the system: reaches the predetermined total operating time, is not capable of producing an effluent with less than 15 ppm oil content, or a mechanical failure occurs.

S1.3.7 Determine reliability, availability and maintainability based on the test results.

S1.3.8 The results of this test are not part of the MEPC.107 (49) approval and shall be reported to the purchaser in a separate document.

S1.4 Examples of optional pre-treatments for the 15 ppm Bilge Separator are contained in Table S1.4.

S2. Supplementary requirements for Bilge Alarms

S2.1 **Test 15 ppm Bilge Alarm with purchaser specified fluid "D"**

TABLE S1.4 Optional Pre-Treatment

Section	Pre-treatment	Description
S1.4.1	Particle Removal	Self-cleaning strainers are recommended upstream of the 15 ppm Bilge Separator to remove small particles that may clog the filter media. Backwash from self-cleaning strainers contains high concentration of solid particles and shall be directed to the Oil Residue (sludge) Tank. The timing of the backwash cycle should be optimizing to minimize excessive water being sent to the Oil Residue (sludge) Tank.
S1.4.2	Heat Treatment	Heat treatment is recommended to enhance the oil-in-water separation and break chemical emulsions. Heating elements can be installed inside the Oily Bilge Water Holding Tank and/or the Bilge Primary Tank
S1.4.3	Gas/Air Flotation	Gas/air flotation systems are recommended to enhance the oil-in-water separation. These systems work by introducing small gas bubbles into the oily wastewater being treated. As the gas bubbles rise they attach to the oil droplets and carry them to the surface where the oil is separated from the water into an oil layer. The small gas bubbles can be introduced at the bottom of the Oily Bilge Water Holding Tank and/or the Bilge Primary Tank.

S2.1.1 Add an additional run to the MEPC.107 (49) test to include a purchaser specified fluid "D". This fluid "D" may consist of a single oil, oil mixtures, and/or contaminants specified by the purchaser. The purchaser will determine the test conditions and concentrations.

S2.1.2 The results of this run shall not affect the MEPC.107 (49) approval and shall be reported to the purchaser in a separate document.

S2.2 **Test 15 ppm Bilge Alarm at discharge limits lower than 15 ppm**

S2.2.1 Some special areas may required an overboard discharge with an oil content lower than the 15 ppm limit. Therefore, the purchaser should ensure that the Bilge Alarm to be installed meets the required lower discharge limit.

S2.2.2 This test is in addition to the MEPC.107 (49) approval requirements.

S2.2.3 Set the Bilge Alarm to the desired alarm set point as per its original equipment manufacture's (OEM's) instructions.

NOTE: Most commercial Bilge Alarms allow changing the alarm limit set point as long as it is lower than 15 ppm.

S2.2.4 Perform additional MEPC.107 (49) test runs using the specified ppm alarm limit instead of 15 ppm.

S2.2.5 The results analysis at the lower discharge limit are not part of the MEPC.107 (49) approval and shall be reported to the purchaser in a separate document.

S2.3 **15 ppm Bilge Alarm Free Oil Test**

S2.3.1 This test is in addition to the MEPC.107 (49) approval requirements.

S2.3.2 Perform additional MEPC.107(49) test runs with the high shear pump off to ensure that the Bilge Alarm is capable to accurately measure the content of "free" or non-dispersed oils.

S2.3.3 The results analysis of the free oil test are not part of the MEPC.107 (49) approval and shall be reported to the purchaser in a separate document.

S2.4 **15 ppm Bilge Alarm Reliability, Availability and Maintainability (RAM) Tests**

S2.4.1 This test is in addition to the MEPC.107 (49) approval requirements.

S2.4.2 The purchaser shall pre-determine the minimum reliability, maintainability, and availability requirements.

NOTE: Section S5.8 and Table S5.2 contain RAM requirements recommended for government use. ASTM F2446 may be used as reference for the exchange of equipment RAM performance data.

S2.4.3 Modify the MEPC.107 (49) test set-up to recycle back to the feed tank to allow for continuous long term operation of the unit.

S2.4.4 Operate the unit for a minimum of 6 hours per run alternating between test fluid runs (for example, fluid A, B, C, and/or D (if applicable)) at concentrations greater than 15 ppm, clean water runs, and short (for example, 10 minutes) 15 ppm injection checks. Means shall be provided to mix the feed tank content to preclude phase separation in the tank.

S2.4.5 Record operating status and parameters and any other relevant information.

S2.4.6 The test shall be performed with no interruptions for system maintenance or adjustments (for example, recalibration, unit cleaning, changing controller set points, etc.) unless otherwise previously determined by the purchaser.

S2.4.7 Continue test until the system: reaches the pre-determined total operating time, is not capable to read 0 and 15 ppm oil content, or any failure occurs.

S2.4.8 Determine reliability, availability and maintainability based on the test results.

S2.4.9 The results of this test are not part of the MEPC.107 (49) approval and shall be reported to the purchaser in a separate document.

S2.5 **Additional Recording Device**

S2.5.1 An additional recording device shall be provided if it is required to record additional parameters not covered by MEPC.107 (49).

S2.5.2 Alternatively, the additional parameters can be recorded by the 15 ppm Bilge Separator PLC controller.

S2.6 **Supplementary requirement for multi-port nozzle sampling device**

S2.6.1 A multi-port nozzle sampling device is recommended for piping larger than 1.5 inch nominal pipe diameter to ensure a representative sample is taken. The sampler construction and installation are shown in Fig. S1.1 and described below:

S2.6.1.1 The sampling device shall be constructed from pipe or tubing of corrosion resistant material (for example, ⅜ " 70/30 copper-nickel class 3300, 0.049" wall thickness) with a plug welded on one end.

S2.6.1.2 Symmetrically oriented holes shall be drilled into one side of the sampling device near the plugged end (not drilled through both walls of the sampler).

S2.6.1.3 The holes locations are calculated to be in positions to cover equal areas across the pipe flow profile, which ensures that representative isokinetic samples are taken.

S2.6.1.4 The sampling device shall be oriented so that the holes face into the flow (for example, holes face down if pipe flow is from low to high). These requirements ensure that the flow has a uniform profile so that the calculated port spacing remains appropriate.

S2.6.1.5 The sampling device installation shall allow for the sampling device to be removed for cleaning purposes.

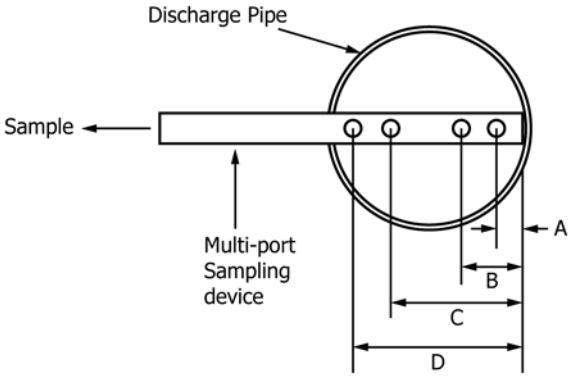
S3. Supplementary requirements for Tamper-proof installation

S3.1 The 15 ppm Bilge Alarm shall comply with MEPC.107 (49), which requires a seal to protect from calibration tampering and a system design to alarm whenever clean water is used to avoid sample dilution.

S3.2 The automatic stopping device (3-way diverter valve) shall be provided with a sealed wiring installation to preclude tampering.

S3.2.1 All the electrical interconnecting wires of the automatic stopping device shall be installed to allow visible inspection of the complete wire runs. These wires may be run separate from other wires to avoid confusion.

S3.2.2 Seals shall be provided to the access of any component that can control the position of the diverter valves including: valve actuator, signal output connector from 15 ppm



NOTES:
1. A = 0.067 d, B = 0.250 d, C = 0.750 d, D = 0.933 d, where *d* is the corrected pipe diameter to account for arc formed between plugged sampling device end and pipe wall.
   $d = [(ID\ discharge\ pipe)^2 - (OD\ tube\ sampler)^2]^{0.5}$
2. Total area of ports shall be less than the cross-sectional area of the sampling device tubing to ensure that the flow is determined by sampling ports.
3. The sampling device shall not occupy more than 25% of the discharge pipe cross-sectional area.

FIG. S1.1 Multi-port Sampling Device

Bilge Alarm, and corresponding interconnecting cables and electrical junction boxes. If any component is required to be opened for repair or replaced such action will be required to be logged in an appropriate logbook.

S3.2.2.1 Alternatively, a sealed automatic stopping device may be installed if available. In regards to sealing the automatic stopping device the complete cable + valve actuator + automatic stopping device must be one piece sealed molded by the manufacturer. If a problem were to arise with any of the 3 (cable + solenoid valve + automatic stopping device) the total needs to be replaced without user serviceable parts and logged in an appropriate logbook. The other end of the cable going to the Control box must be sealed at the point of penetration in to the Control Box. The Control Box itself can easily have a seal where, if required to be opened for repair can again be logged in an appropriate logbook.

S3.3 The 15 ppm Bilge Alarm sampling line shall be tamper proof to preclude dilution of the sample by introducing clean water.

S3.3.1 This sampling line shall be connected from the sampling port, at the 15 ppm Bilge Separator overboard discharge pipe, to the sample inlet connection of the 15 ppm Bilge Alarm. No other piping or tubing shall be connected to this sampling line. Quick connections shall not be used on this line.

S3.3.2 Any component on the sampling line (for example, cut off valve, pressure gauge connection, etc.) shall be brazed or flanged to avoid tampering. All the flanges shall be provided with at least one flange bolt drilled through both the bolt and nut and tagged with a tamper-proof seal.

S3.3.3 Any threaded connector or removable component (for example, valve stem, check valve cap, etc.) shall be provided with a tamper proof seal such as tamper proof shrink sleeve seals.

S3.3.4 Tamper proof seals should be uniquely numbered non-reusable seals. For flanges it may be either plastic or metal pull-up type. Flanges shall be stamped with an identifying number. Seal numbers should be recorded in an appropriate record book to with the dated fitted, identifying flange number and seal number. In the event a seal should be removed, the reason for removal should be noted in an appropriate logbook.

S3.4 All piping connected to the overboard discharge shall be brazed or flanged to avoid tampering.

S3.4.1 Any threaded connector or removable component (for example, valve stem, check valve cap, etc.) shall be provided with a tamper proof seal such as tamper proof shrink sleeve seals.

S3.4.2 All these flanges shall be provided with at least one flange bolt drilled through both the bolt and nut and tagged with a tamper-proof seal. Tamper proof seals should be uniquely numbered non-reusable seals, either plastic or metal pull-up type. Flanges to be stamped using with an identifying number. Seal numbers should be recorded in an appropriate record book to with the dated fitted, identifying flange number and seal number. In the event a seal should be removed, the reason for removal should be noted in an appropriate logbook.

S4. Supplementary requirements for Automated Oily Waste Transfer (AOWT) System

S4.1 The transfer system shall be designed as an automated oily waste transfer (AOWT) system to provide practical automatic monitoring, control, operation, and oily waste management. The AOWT system is intended to improve reliability, reduce operator interaction, reduce maintenance, reduce chance for operator error, avoid equipment damage, enhance survivability, more effectively manage oily waste, and help minimize the chance of oily waste being discharged overboard in an emergency situation. The system shall facilitate the processing of oily waste to ultimately evacuate clean water overboard as quickly as possible.

S4.2 The AOWT system shall provide main operator interfaces and controls at a continuously manned space that has personnel with authority to monitor and operate any portion of the entire AOWT system. The main interface/control station shall be capable of monitoring and operating the entire AOWT system and shall have data logging capabilities. Local operator

interfaces and control stations shall also be provided in each space equipped with a transfer pump. The local interface/control station shall be capable of monitoring the entire AOWT system but shall allow control for only the operations directly associated with its local equipment. Audible and visual alarms shall be provided at the main and local interface/control stations.

S4.3 The AOWT system main and local interface/controls shall utilize screen graphics to display at-a-glance status of the entire transfer system including active flow paths, system operating data, tank levels (total and interface levels), major automated valve positions, pump flow rates, operating pressures, and 15 ppm Bilge Separator and 15 ppm Bilge Alarm status. The AOWT control system shall be capable of being operated by simple keystrokes and/or touch screens.

S4.4 The AOWT system shall be designed such that centralized information is available for all pumping stations, and will also be localized so each pumping station can operate independently if needed. Components required for each pumping station (pump, automated valves, transducers, etc.) shall be logically grouped so that loss of communications of one pumping station does not prevent operation of the remaining AOWT system. Each pumping station and its associated components and controllers shall be powered by independent sources, so that downtime of any station does not affect information sharing or operational capabilities of the other stations.

S4.5 The AOWT system shall provide distinct modes of operation as listed below:

S4.5.1 One mode shall be provided whereby the AOWT control system automatically monitors the entire transfer system and recommends OWT operations that will initiate only with operator approval from either the main interface/control station or from the local interface/control station where the operation will occur. Once approved by the operator, the AOWT control system shall automatically align all necessary valves and start pump(s) to perform the operation. Additionally, the operator shall be provided the option of initiating any allowed transfer system operation at any time by inputting the desired source (for example, bilges and tanks) and target tanks and pump(s). Upon completion of the operation, the AOWT control system shall automatically stop pumps and return valves to their default position. A means for the operator to secure operations at any time shall be provided. The control system shall immediately secure operations if an alarm shutdown condition is detected.

S4.5.2 One mode shall be provided whereby the AOWT control system automatically monitors the entire transfer system and automatically conducts internal shipboard transfer operations without operator approval. Transfer operations that involve offloading oily waste to shore, sweep hoses, or pump hose connections shall not be permitted without operator approval. The AOWT control system shall automatically align all necessary valves and start pumps to perform the operation. Upon completion of the operation, the AOWT control system shall automatically stop pumps and return valves to their default position. A means for the operator to secure operations at any time shall be provided. The control system shall immediately secure operations if an alarm shutdown condition is detected.

S4.5.3 One mode shall be provided with password protection or other means to limit access whereby an authorized operator can remotely operate any individual automated device. In this mode, remote control of transfer operations is allowed but the operator must individually specify the pumps and automated valves via the interface/control station. Although all readings, indicators and visual/audible alarm and caution conditions shall be displayed, the control system shall not take any safeguards to secure the AOWT system operation. However, mechanical safeguards (relief valves, vacuum breaks, overload protectors, etc.) shall still be in effect. In this mode, the operator shall manually secure each pump and valve at the interface/control station.

S4.6 The AOWT control system shall be capable of integrating with a 15 ppm Bilge Separator control system. Tank level data and other shared signals shall be provided to both the AOWT control system and the 15 ppm Bilge Separator control system. Sensing equipment shall not be duplicated to independently serve the transfer and 15 ppm Bilge Separator systems.

S4.7 The AOWT system shall not use intermediate monitoring devices for components that can directly communicate with the AOWT control system. Such intermediate devices present an unnecessary point of system failure.

S4.8 The AOWT control system shall use a minimum amount of controllers to reduce cost and ease troubleshooting. Controllers should be consolidated to achieve this purpose. Program software and control system hardware shall be standardized to the maximum extent possible.

S4.9 The AOWT system shall have the features and capabilities listed below.

S4.9.1 At a minimum, the AOWT system shall automatically start a transfer operation when any of the following conditions occur:

S4.9.1.1 A source tank or bilge reaches a high set point and a target tank is below the high set point.

S4.9.1.2 An operator initiates a transfer operation.

S4.9.2 At a minimum, the AOWT system shall automatically stop a transfer operation when any of the following conditions occur:

S4.9.2.1 The source tank or bilge reaches a low set point. Low set points shall be located to prevent air from being routinely drawn into the suction bell mouth.

S4.9.2.2 The target tank reaches a high set point.

S4.9.2.3 An operator stops a transfer operation.

S4.9.2.4 An alarm shut down condition occurs.

S4.9.3 The AOWT control system shall display viable options for source and target tanks when the operator initiates a transfer in a mode that supports automated alignment.

S4.9.4 To accommodate peak demand periods, the AOWT control system logic shall be capable of automatically coordinating and conducting simultaneous transfer operations that do not negatively impact or conflict with each other.

S4.9.5 The AOWT system shall be survivable. Capability shall be provided to allow the AOWT system to operate as automatically as possible in the event of one or more device failures.

S4.9.6 Notification shall be provided to alert the operator of an automatic system shut down as well as that an abnormal condition exists that is not sufficiently serious to warrant a system shutdown. The notification shall contain enough detail to provide the operator adequate information to correct the problem.

S4.9.7 Audible and visual alarms shall be provided to alert the operator that a serious abnormal condition exists and requires immediate action by the operator. Alarms shall be designed to avoid nuisance alarms that occur too frequently or at unaffected operating stations. The notification shall contain enough detail to provide the operator adequate information to correct the problem.

S4.9.8 Certain critical alarms shall cause the AOWT system to automatically secure when the system is in the appropriate operating mode. At a minimum, the following conditions shall cause an alarm shut down:

S4.9.8.1 Low pump suction pressure (high vacuum)

S4.9.8.2 High pump discharge pressure

S4.9.8.3 Receiving tank at a high level

S4.9.8.4 High differential pressure at pump strainer

S4.9.8.5 Valves failures

S4.9.8.6 Tank level indication inconsistency

S4.9.9 The AOWT control system shall receive total liquid level and oil-water interface levels in the Oily Bilge Water Holding Tank, Primary Bilge Tank, Oil Residue (sludge) Tank, and other oily waste collection tanks via the continuous level methods.

S4.9.10 A means shall be provided to automatically transfer the contents of bilges and oily waste drain tanks to the oil section of the Bilge Primary Tank or other oily waste collection tanks at pre-determined set points.

S4.9.11 Bi-directional communication shall be used between the AOWT and 15 ppm Bilge Separator system so that each system can facilitate the other system's operation and performance. For instance, the AOWT can trigger the 15 ppm Bilge Separator to start processing early if the AOWT detects large quantities of bilge water being generated. If the 15 ppm Bilge Separator cannot reach 15 ppm, the 15 ppm Bilge Separator can request the AOWT transfer bilge water (for example, that maybe available in bilges or tanks) to dilute the Oily Bilge Water Holding Tank contents.

S4.9.12 The AOWT system shall provide bulk oil stripping capabilities to allow bulk oil in both sections of the Bilge Primary Tank and the Oily Bilge Water Holding Tank to be automatically stripped to the Oil Residue (sludge) Tank. High and low bell mouths shall be included in these tanks to facilitate this feature. The following criteria should be used during oil strip of these tanks:

S4.9.12.1 There should be sufficient room in the Oil Residue (sludge) Tank before commencing stripping operations.

S4.9.12.2 Oil hide-out shall be considered in compartmentalized/baffled Bilge Primary Tank and Oily Bilge Water Holding Tank designs.

S4.9.12.3 Water carryover during the bulk oil stripping process shall be minimized to ensure low total water content in the Oil Residue (sludge) Tank (for example, not to exceed 5 % of tank contents).

S4.9.13 The AOWT system shall provide water phase stripping capabilities to allow water in the Oil Residue (sludge) Tank to be automatically stripped to the oil section of the Primary Bilge Tank. The following criteria should be used during water strip of the Oil Residue (sludge) Tank:

S4.9.13.1 There should be sufficient room in the Oily Bilge Water Holding Tank to receive overflow from the Bilge Primary Tank before commencing stripping operations.

S4.9.13.2 Oil carryover during the water stripping process shall be minimized.

S4.9.14 Feature(s) shall be provided to monitor pump performance and provide a clear indication to the operator that pump capacity has fallen outside the pump's normal operation window. Means to accomplish this requirement include tracking change in tank level over time, monitoring pump pressure, and installing and monitoring flow meters.

S4.9.15 Means shall be provided via devices or processes (for example, pressure, flow rate, etc.) to prevent pumps from operating under conditions that can cause pump damage. For example, pumps shall be protected from being run while dry. Protection may include automatic pump priming or other suitable features.

S4.9.16 The AOWT system shall be capable of logging and holding data for Logged at least 18 months and retrieving the logged data for review at the interface/control station(s) for troubleshooting purposes. At a minimum, the logged data shall include the following parameters with date and time stamp by the main interface/control station:

S4.9.16.1 Notification of abnormal conditions (for example, notifications and alarms that do not cause a shutdown)

S4.9.16.2 Alarm shutdown conditions

S4.9.16.3 Pump run time

S4.9.16.4 System pressures

S4.9.17 All transfer pump operations shall automatically be secured prior to overflow of a target tank.

S4.9.18 All bulkhead isolation valves shall be automated.

S4.9.19 All automated valves in the AOWT system should be motor-operated ball valves (full-port ball is recommended to prevent shearing of oil droplets). Solenoid valves are not recommended due to reliability issues.

S4.9.20 All automated valves shall be provided with manual operators (that is, hand wheels) or a bypass.

S4.9.21 Key automated valves shall have a failsafe return feature to provide system isolation in the event of a power or control system loss.

S4.9.22 AOWT system shall be capable of monitoring total and interface level in the Bilge Primary (both sections), Oily Bilge Water Holding, and Oil Residue (sludge) tanks, and total level in the other collecting tanks and bilges.

S4.9.23 The AOWT control system shall be capable of prioritizing transfer operation in a continuous basis and adjusting transfer operation accordingly (for example, stop pumping into a tank when it is reaching a high level).

S4.9.24 To account for AOWT control system failure, the AOWT system shall be provided with means to manually operate the system via manual/external pump control and valve bypass / handle.

S5. Special Government Requirements

S5.1 For Government Procurement Only

S5.1.1 Except as otherwise specified in the contract, the contractor is responsible for the performance of all inspection and test requirements specified herein. Except as otherwise specified in the contract, the contractor shall be permitted to use his own or any other suitable facilities for the performance of the inspection and test requirements specified herein, unless disapproved by the purchaser at time of purchase. The purchaser shall have the right to perform any of the inspections and tests at the same frequency as set forth in this specification where such inspections are deemed necessary to assure that material conforms to prescribed requirements.

S5.2 Reference Documents F1166 Practice for Human Engineering Design for Marine Systems, Equipment and Facilities F1337 Practice for Human Engineering Program Requirements for Ships and Marine Systems, Equipment, and Facilities MIL-STD-167-1 Mechanical Vibrations of Shipboard Equipment (Type I & II) MIL-STD-882 System Safety Program Requirements MIL-S-901D Grade B Shock Requirements for Shock Tests, Shipboard Machinery, Equipment and Systems MIL-STD-461 Electromagnetic Emission and Susceptibility Requirements for the Control of Electromagnetic Interference MIL-STD-462 Electromagnetic Interference Characteristics, Measurements of

S5.3. Design Considerations

S5.3.1 The services that are available for the OPAS system are:

S5.3.1.1 440V, 60-Hz, 3-phase electrical power, 3 wires, ungrounded.

S5.3.1.2. 120V, 60-Hz, 3-phase electrical power, 3 wire ungrounded.

S5.3.1.3 Seawater—at 791 to 1,308 kPa (100 to 175 psig). (Actual value will vary over time and depending on shipboard location.)

S5.3.1.4 Fresh Water—515 kPa (60 psig) up to 10 GPM; 70°F (21°C).

S5.3.1.5 Ship Service Compressed Air—At 963 kPa (125 psig) (air supply to the space at a maximum temperature of 32°C (90°F) with a wet bulb temperature of 32°C (81°F)

S5.3.1.6 Compartment Ventilation—As Required.

S5.3.1.7 Material degradation restoration and material replacement shall be limited to ship scheduled availability periods.

S5.3.1.8 The ship service power generation system shall supply the worst-case functional operating load, with service life growth margin, with one ship service generator set not in use.

S5.3.2 If a waste oil incinerator or other means of destroying oil residue (sludge) is provided, the Oil Residue (sludge) Tank shall hold a minimum of seven days of waste.

S5.3.3 A swing check valve shall be installed near the shell penetration in all overflows which discharge overboard.

S5.3.4 The Oily Bilge Water Holding Tank overboard overflow piping shall discharge at least one deck height above the full load waterline via a swing check valve.

S5.3.5 All valves at the suction side of pumps shall be ball valves to minimize suction.

S5.3.6 All rotating machinery shall be installed with the axis of rotation as nearly horizontal and parallel to the centerline of the ship as practical.

S5.3.7 Due to the criticality of the mission of military vessels, an overboard discharge connection shall be provided for the oily waste transfer pump to allow dewatering of the bilges in case of emergency. This emergency overboard discharge connection shall be provided with a swing check valve, double valve protection, and a valve locking device to keep the valve shut.

S5.3.8 The hull penetration for the overboard discharge piping shall be above the ship's water line.

S5.3.9 Oily Waste Transfer pump, Oil Residue (sludge) pump, and Oil Residue (sludge) Collecting pump may be combined.

S5.4. Hazardous Substance Minimization

S5.4.1 Equipment and systems provided shall minimize the production and use of hazardous materials.

S5.4.2 Lead paint shall not be used.

S5.4.3 The OPAS shall not utilize chlorinated plastics in its construction or any subsystem.

S5.5 Human Engineering

S5.5.1 Human engineering principles and design standards shall be applied in the ship design, system and equipment selection, systems integration, hardware, software, architectural aspects, and human-machine interfaces.

S5.5.2 Practice F1166 specific criteria shall be applied in the design of compartments, spaces, systems, work and control stations, and facilities. Factors affecting both normal and emergency conditions, such as illumination and environmental conditions shall be as outlined in Practice F1337.

S5.5.3 Operation, maintenance, and repair activities and procedures shall minimize the requirement for manual handling operations and shall accommodate a wide range of individual physical capability.

S5.5.4 Accommodation of the needs of the 5th percentile female as well as 95th percentile male shall be incorporated.

S5.5.5 The level of training required for operating personnel shall be no more than two (2) hours of on-the-job training; training required for maintenance personnel shall be no more than five (5) hours.

S5.6 System Safety

S5.6.1 Man-machine interfaces shall minimize both the potential for and the consequence of human error.

S5.6.2 Ship's systems, equipment, and arrangement shall ensure the safety of personnel, systems, equipment, and the environment during operation, maintenance, and support evolutions necessary to fulfill the ship's mission and required capabilities.

S5.6.3 System safety shall be in accordance with MIL-STD-882.

S5.6.4 The ship design shall reflect system and personnel safety factors, including the elimination or minimization of the potential for human error during operation and maintenance, under routine, non-routine, and emergency conditions.

S5.6.5 System safety shall be integrated into the design to avoid hazardous manual handling operations as far as reasonably practicable, and shall limit activities to the required range of physical capabilities.

S5.7 Process Monitoring

S5.7.1 The system shall provide for sufficient process monitoring and the automated controls necessary to maintain the set point operating conditions.

S5.7.2 Set Points for parameters required by the manufacturer to control the treatment process are to be determined by the manufacturer.

S5.7.3 The OPAS control/operator interface shall clearly communicate all information to the operator that is required to ensure efficient and safe operation of the OPAS process.

S5.8 System Supportability

S5.8.1 Reliability, Availability and Maintainability (RAM) Requirements-The reliability, availability, and maintainability characteristics of the OPAS shall be such to ensure that the crew of a ship can, with a high degree of confidence, consistently dispose of the waste stream as defined by purchaser.

S5.8.1.1 All OPAS equipment, including 15 ppm Bilge Separator, 15 ppm Bilge Alarm, automatic stopping device, and transfer pumps shall meet the reliability, availability and maintainability requirements this section. All tests shall be performed by an independent test facility and/or witnessed by an authorized government representative unless otherwise specified. Any change to or substitutions for major equipment components shall warrant re-verification that the requirements contained herein are met.

S5.8.1.2 The manufacturer shall provide proof or certification that systems conform to the requirements specified herein. Applicable records shall include drawings, specifications, design data, receiving inspection records, processing and quality control standards, vendor catalogs and certifications, industry standards, test reports, and rating data.

S5.8.1.3 A summary of reliability, maintainability, and availability requirements is provided in Table S5.1

S5.8.1.4 The service life of the OPAS shall be 15 years minimum with an operating life expectancy of 10,000 hours minimum. A Reliability Development Growth Test (RDGT) shall be performed to verify the service life during first article testing.

S5.8.1.5 For reliability, the Mean-Time-Between-Failure (MTBF) of the system shall be 400 hours at a 90% level of confidence. MTBF shall be determined when the system is operated at rated capacity during first article testing. With no failures, the actual run time statistically required to meet the MTBF goal is 922 hours. For testing purposes, a failure is defined by adjustment, repair, or replacement action using controls, on-equipment tools or parts, and which causes or may cause:

S5.8.1.5.1 Failure to commence operation, cessation of operation, or degradation of performance below specified levels.

S5.8.1.5.2 Damage to the system by continued operation.

S5.8.1.5.3 Safety hazard to personnel.

S5.8.1.5.4 Any mechanical or electrical malfunction that causes the system to be inoperative for more than five hours during the operational test, or which cause the system not to meet performance objectives.

S5.8.1.6 Failures for OPASs shall be classified as follows:

S5.8.1.6.1 *Critical*—Any failure that prevents attainment of a key performance parameter (for example, 15 ppm Bilge Separator system effluent concentration, pump suction lift, 15 ppm Bilge Alarm decision making).

S5.8.1.6.2 *Major*—Any failure that causes the system to lose capability to process oily waste, or a malfunction that requires more than 5 hours of corrective maintenance action to remedy.

S5.8.1.6.3 *Minor*—Any failure that affects operation, but does not prevent the processing of oily wastewater.

S5.8.1.7 All critical, major, and minor failures shall also be classified as either relevant or non-relevant. Examples of relevant failure include equipment design defects or equipment manufacturing defects. Examples of non-relevant failure can be attributed to operator or procedural error, or accident, mishandling, and improper storage or installation.

S5.8.1.8 The MTBF shall be based upon relevant critical and relevant major failures only.

TABLE S5.1 Summary of Reliability, Availability and Maintainability (RAM) Requirements

	Transfer Pump	15 ppm Bilge Separator	15 ppm Bilge Alarm	Automatic stopping device
Service Life	15 years minimum	15 years minimum	15 years minimum	15 years minimum
Operating Life	10,000 hours	10,000 hours	10,000 hours	10,000 hours
MTBF	400 hrs, 90% confidence	400 hrs, 90% confidence	400 hrs, 90% confidence	400 hrs, 90% confidence
Maintenance Ratio	0.03	0.03	0.03	0.03
Avg. Annual Preventive Maintenance (Max)	3.5 hr/wk	3.5 hrs/wk	1 hr/wk	1 hr/wk
Max Time for Preventive Maintenance	2 man-hour	16 man-hours	1 man-hour	1 man-hour
Mean Time To Repair (MTTR) (geometric)	3 hour	3 hours	1 hour	1 hour
Maximum Time To Repair (Max TTR)	6 hours	8 hours	4 hours	4 hours
Operational Availability (A_o) for entire OPAS		95%		

TABLE S5.2 Environmental Requirements for OPA Equipment

Factor	Requirement	Standard	Demonstration Method
Shock	Grade B, Class I, Type A	MIL-S-901D	Independent Test Facility Test
Environmental Vibration	Type I	MIL-STD-167-1	Independent Test Facility Test
Internally Excited Vibration (for rotating machinery)	Type II	MIL-STD-167-1	Independent Test Facility Test
Airborne Noise	Grade E	MIL-STD-740-1	Independent Test Facility Test
Structure-borne Noise	Type II	MIL-STD-740-2	Independent Test Facility Test
Electromagnetic Interference	Emissions and susceptibility requirements for auxiliary equipment operating in a machinery space	MIL-STD-461	Independent test Independent Test Facility Test
Operational Temperatures	Operate as designed in ambient temperatures ranging from 50-122°F	MIL-STD 810 method 501.4, procedure I and II for high temperature and method 502.4, procedure I and II for low temperature. Operating period for each test is 1 hour.	Engineering Analysis by Manufacturer
Storage (non-operational) Temperatures	Not be damaged or degraded as a result of being subjected to ambient air temperatures ranging from -40 to 158°F		Engineering Analysis by Manufacturer
Humidity	No damaged or degraded performance when subjected to humidity profiles in the standard	MIL-STD-810 method 507.4	Engineering Analysis by Manufacturer
Inclination	Operate as designed with no loss of fluid when inclined at a rate of 5 to 7 cycles per minute in one phase to angles of 15 degrees on both sides of the vertical for a period of not less than 30 minutes. Repeat with the system rotated 90 degrees through the vertical to the plane in which it was originally rotated.	None	Independent Test Facility Test or Manufacturer Test
Salt Fog	Operate as designed after a 48 hour exposure followed by a 48 hour drying time	MIL-STD-810 method 509.2	Independent Test Facility Test
Hydrostatic Pressure	Subject to 135% system design pressure and hold with no leaks for 30 minutes.	None	Test by Manufacturer

S5.8.1.9 If failures (relevant critical or relevant major) occur during the 922 hour test that prevents the attainment of 400 hours MTBF, a waiver may be requested from the corresponding government authority. A waiver shall only be granted if the failure(s) occurred after 461 hours of operation (to demonstrate a MTBF of 200 hours at 90 % confidence) and if an engineering analysis is performed by the manufacturer to show that the failure will not result in an undue burden to the government for shipboard installed systems. The completion of the full 922 hour reliability test shall be at the discretion of the applicable government authority. The failure(s) shall be counted in the other maintainability metrics discussed in this section.

S5.8.1.10 The OPAS shall have a maintenance ratio of not greater than 0.03. The maintenance ratio is the ratio of total active maintenance man-hours (scheduled and unscheduled) to the total operating time. The scheduled and unscheduled maintenance shall be timed, accumulated and converted to a maintenance ratio during first article testing. Only scheduled maintenance in the manufacturer's recommended maintenance schedule shall be permitted.

S5.8.1.11 The average time for preventative maintenance (calculated on an annual calendar-year basis) shall not exceed 3.5 hours per week for 15 ppm Bilge Separator equipment and transfer pumps and 1 hour per week for 15 ppm Bilge Alarm and diverter valves. The time required to perform any preventive maintenance action shall not be greater than 16 man-hours for 15 ppm Bilge Separator equipment, 2 man-hours for transfer pumps, or 1 man-hour for 15 ppm Bilge Alarm and diverter valves by an Engineman third class or Electrician's Mate third class.

S5.8.1.12 All major OPAS assemblies and installed attachments shall be accessible for maintenance, repair, and replacement without the removal of other major assemblies and attachments. The components shall be arranged so all maintenance can be performed with access from only the front of the system and one adjacent side. In addition, the 15 ppm Bilge Separator shall be designed for a maximum time to repair (Max TTR) of 8 hours. The mean time to repair (MTTR) shall not exceed 3 hours. The transfer pump shall be designed for a Max TTR of 6 hours. The MTTR shall not exceed 3 hours. The 15 ppm Bilge Alarm and diverter valve shall be designed for a Max TTR of 4 hours with a MTTR of 1 hour.

S5.8.1.13 The availability characteristics for the OPAS are based upon operational testing and evaluation. The operational availability (A_o) shall be 95% for the entire OPAS. The value (A_o) is determined by the following formula:

S5.8.1.13.1 A_o = Uptime/ (Uptime + Downtime).

S5.8.1.14 Uptime is the total calendar time that the system is in a condition to perform its required functions (that is, it will operate if needed). Downtime is calendar time that the system is not in a condition to perform its required functions due to preventive or corrective maintenance. Downtime includes delays due to logistics.

S5.8.1.15 **Environmental Requirements**

S5.8.1.15.1 All OPAS equipment, including 15 ppm Bilge Separator, 15 ppm Bilge Alarm, automatic stopping device, and transfer pumps shall comply with the requirements in Table S5.2. Compliance shall be demonstrated by testing at an independent test facility, engineering analysis by the equipment manufacturer, or testing by the equipment manufacturer.

Results from all tests or engineering analysis shall be submitted to the corresponding government authority. Deviations from the requirements listed in Table S5.2 shall be documented in a letter from the corresponding government authority that identifies the nature of the deviation and the risks to that program.