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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. This 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 or process oily waste, or both, 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 or processes, or both, are out of scope of this specification.

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

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

2. Referenced Documents

2.1 *ASTM Standards:*[2]

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
F1337 Practice for Human Systems Integration Program

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

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

Requirements for Ships and Marine Systems, Equipment, and Facilities
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
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[4]
IEEE 1580 Recommended Practice for Marine Cable for Use on Shipboard and Fixed or Floating Marine Platforms[7]
NFPA 70 National Electrical Code[8]
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)[4]
UL 913 Standard for Intrinsically Safe Apparatus and Associated Apparatus for Use in Class I, II, III, Division 1, Hazardous (Classified) Locations[9]
UL 1309 Standard for Safety Marine Shipboard Cable[9]
UL 1203 Explosion-Proof and Dust-Ignition Electrical Equipment for Use in Hazardous (Classified) Locations[9]
ISO 9377–2:2000 Water Quality—Determination of Hydrocarbon Oil Index—Part 2: Method Using Solvent Extraction and Gas Chromatography[10]

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 specification as Oil Content Monitor (OCM).

[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, Washington, DC 20401-0001, 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, 1st Floor, P.O. Box 131, CH-1211, Geneva 20, Switzerland, http://www.iec.ch.
[7] Available from Institute of Electrical and Electronics Engineers, Inc. (IEEE), 445 Hoes Ln., Piscataway, NJ 08854-4141, http://www.ieee.org.
[8] Available from National Fire Protection Association (NFPA), 1 Batterymarch Park, Quincy, MA 02169-7471, http://www.nfpa.org.
[9] Available from Underwriters Laboratories (UL), 2600 N.W. Lake Rd., Camas, WA 98607-8542, http://www.ul.com.
[10] Available from International Organization for Standardization (ISO), ISO Central Secretariat, BIBC II, Chemin de Blandonnet 8, CP 401, 1214 Vernier, Geneva, Switzerland, http://www.iso.org.

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.

3.1.4 *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 or components, or both.

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 specification 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.

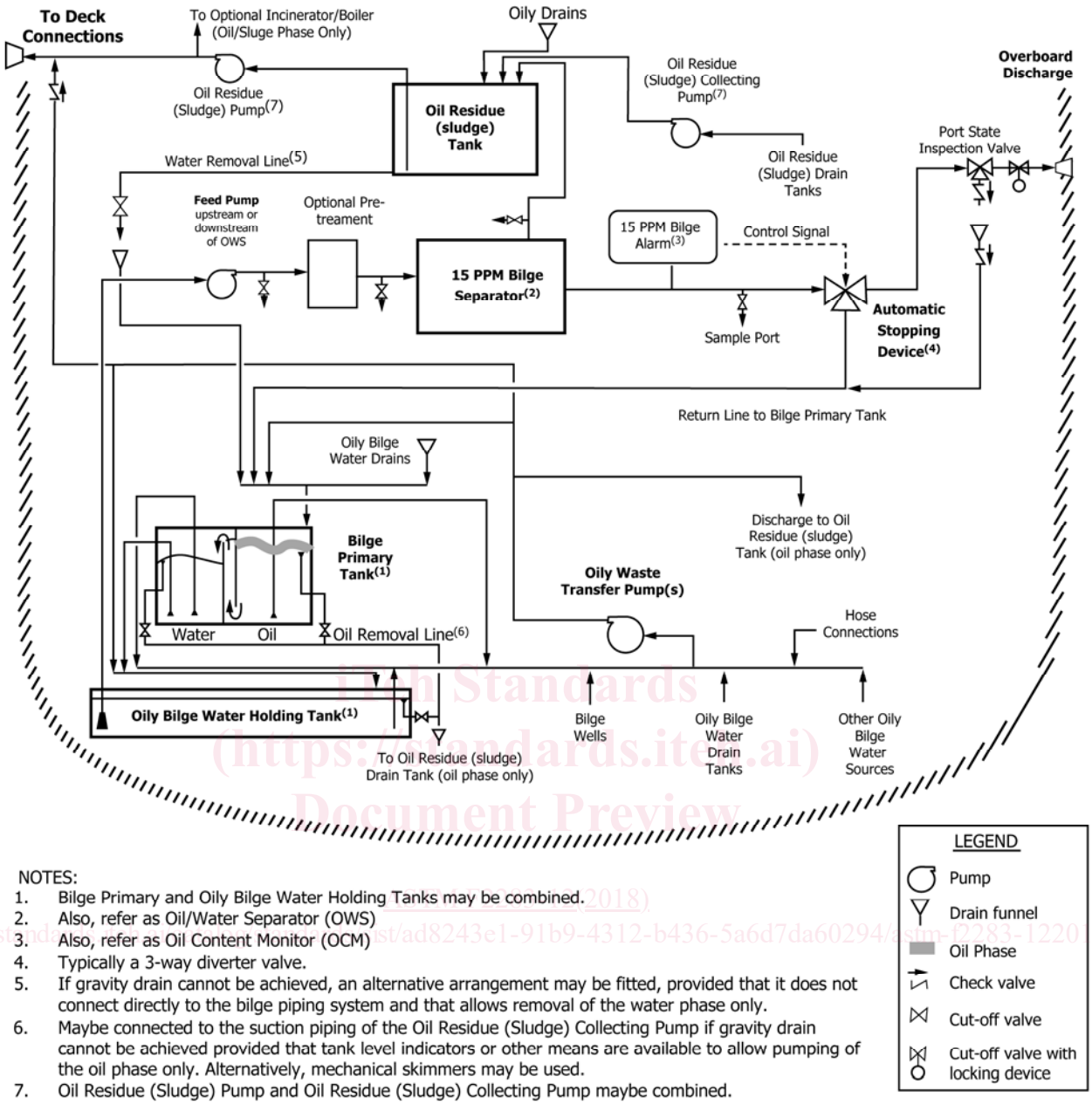
(3) Oil Residue (sludge) Tank—An Oil Residue (sludge) Tank is provided to hold oil residue (sludge) from which oil residue (sludge) may be directly transferred ashore through the standard discharge connection or any other approved means of disposal. Any accumulated water is drained or pumped to the Bilge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



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 *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 or reliability, or both.

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. Fig. 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.

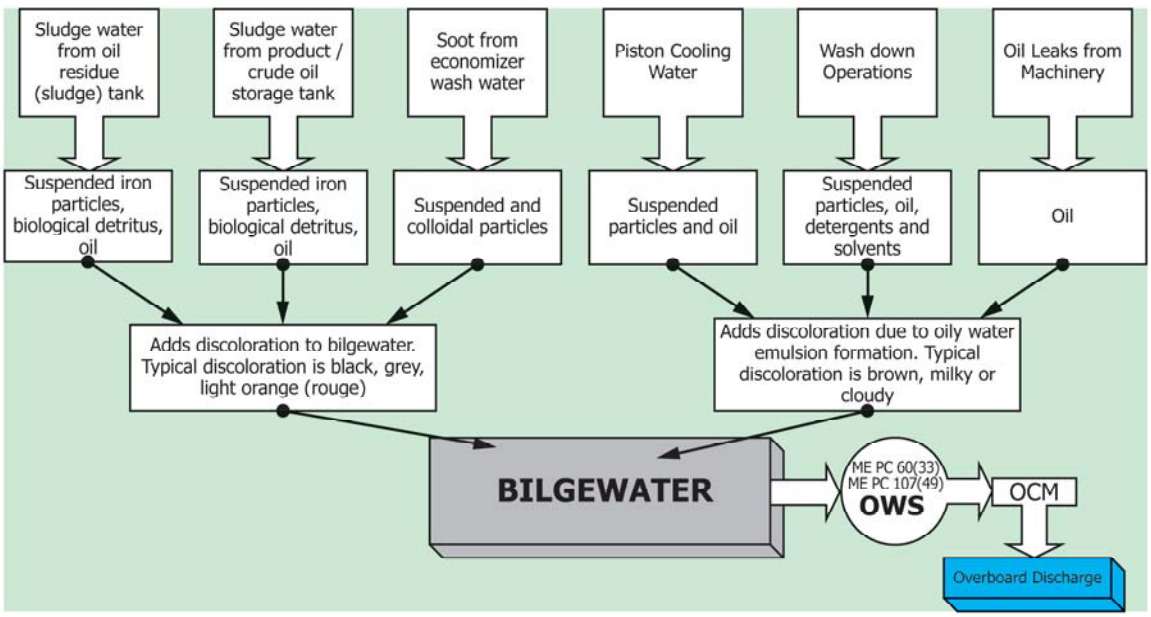


FIG. 2 Example of Shipboard Flow Diagram: Sources of Contamination in Bilge Water

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 by means of 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 Specification 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

5.3.1.2 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.

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:

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

where:

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 by means of 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 by means of 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 by means of 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 Specification 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 by means of 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 in accordance with 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 S1.1.

NOTE 3—One or more of the supplementary requirements listed in Table S1.1 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 Specification 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, the 15 ppm Bilge Alarm, or combination thereof. 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, contaminants specified by the purchaser, or combination thereof.

(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).