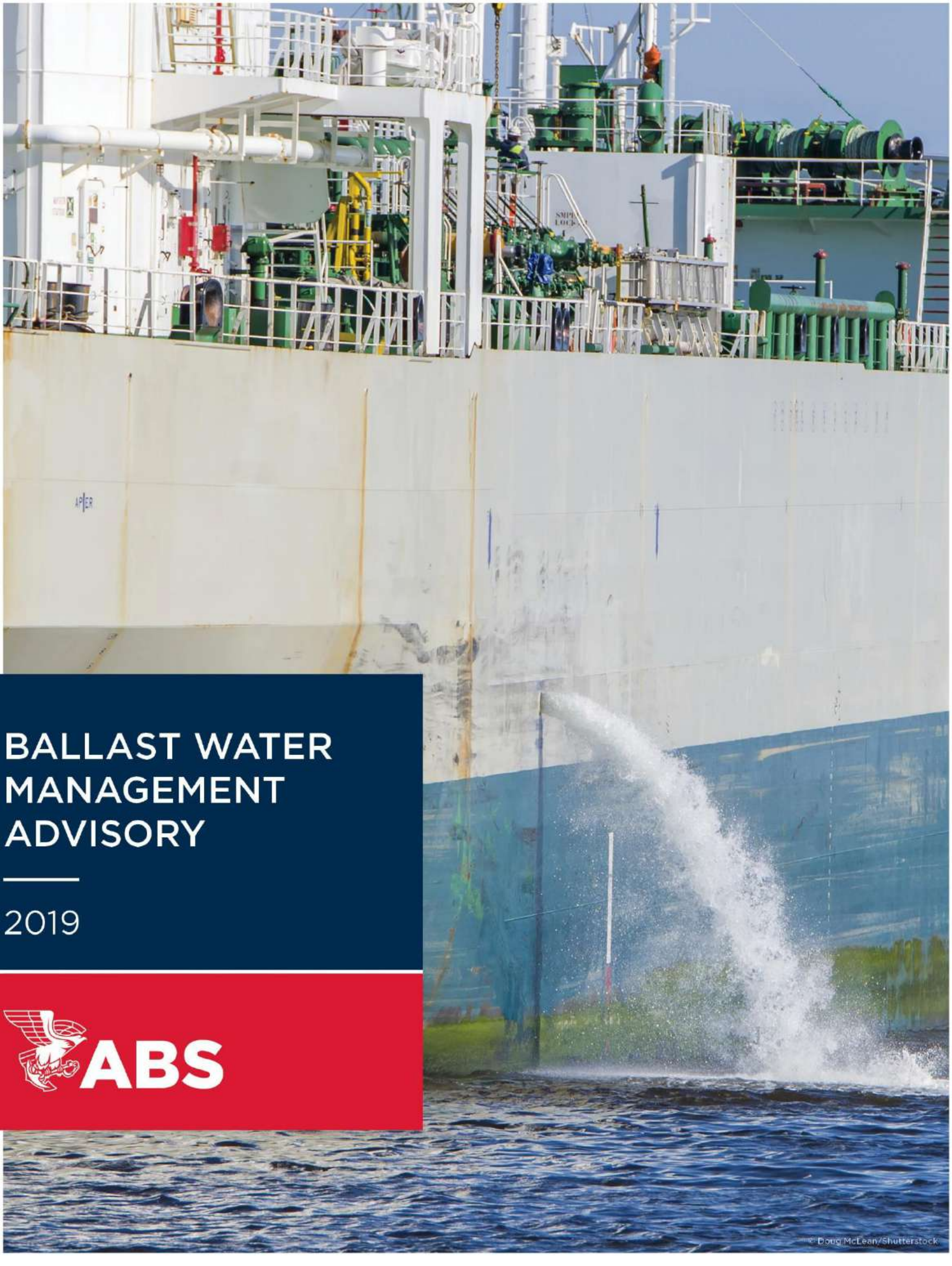

BALLAST WATER MANAGEMENT ADVISORY

2019

ABS

OUR MISSION

The mission of ABS is to serve the public interest as well as the needs of our members and clients by promoting the security of life and property and preserving the natural environment.

HEALTH, SAFETY, QUALITY AND ENVIRONMENTAL POLICY

We will respond to the needs of our members, clients and the public by delivering quality products and services in support of our Mission that provides for the safety of life and property and the protection of the natural environment.

With the input and the participation of our workers, we are committed to continually improving the effectiveness of our HSQE performance and management system by identifying risks and opportunities that help to eliminate hazards and reduce risks and by providing safe and healthy working conditions for the prevention of work-related injury, ill health and pollution.

We will comply with all applicable legal requirements as well as any additional requirements ABS subscribes to which relate to ABS and our HSQE aspects, objectives and targets.

Ballast Water Management Advisory 2019

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Introduction

The uncontrolled spread of nonindigenous species continues to be an important concern for the marine industry. Studies of the impacts of the spread of nonindigenous invasive species are frequently published. In response regulations mandating the treatment of ship's ballast water have been promulgated. The ballast water treatment market and regulatory framework for compliance continues to expand with new ballast water management systems being developed and approved and Administrations continue to refine BWM requirements and enforcement regimes.

ABS has published three Ballast Water Management Advisories that provide useful information on ballast water regulations and treatment technologies to the marine industry. This Ballast Water Management Advisory 2019 contains updated regulatory requirements, developments in technology, and important information for compliance.

ABS is an accepted subcontractor to the Independent Laboratory (IL) led by NSF International and Control Union Certifications BV for the evaluation and testing of ballast water management systems (BWMS) for US Coast Guard (USCG) Type Approval (approval series 162.060). Importantly, USCG Type Approval of BWMS is required for vessels entering and discharging treated ballast water in US waters to prevent the spread of non-native aquatic species in lakes, rivers and coastal waters. ABS performs design, construction and documentation reviews as part of the Type Approval process.

Section 1 I International Ballast Water Management Requirements

In the 1980s, Australia and Canada experienced problems caused by invasive species and brought their concerns to the International Maritime Organization's (IMO's) Marine Environment Protection Committee (MEPC). These actions resulted in the development of the 2004 International Convention for the Control and Management of Ships' Ballast Water and Sediments (i.e., the Ballast Water Management (BWM) Convention).

Continued concerns regarding the spread of nonindigenous species have resulted in various regional regulations worldwide. These regulations require shipowners and ship operators to meet a myriad of ballast water requirements based upon their current and possible future operations.

International Maritime Organization

The BWM Convention established requirements and standards for ballast water management on vessels of any type designed or constructed to carry ballast water with some exceptions, including submersibles, floating craft, floating platforms, floating storage units (FSUs) and floating production, storage and offloading units (FPSOs).

On 08 September 2016, twelve years after the adoption of IMO BWM Convention, the entry into force prerequisite of at least 30 member States representing 35 percent of the world's merchant shipping gross tonnage was met. This led to the BWM Convention entering into force on 08 September 2017 (12 months after the ratification by the contracting parties). As of April 2019, 81 countries representing approximately 80.76% of the world's merchant fleet tonnage have ratified the BWM Convention (based on 2018 tonnage figures).

The latest status of the BWM Convention and Parties to the Convention are listed in the IMO website, (*http://www.imo.org/en/About/Conventions/StatusOfConventions/Pages/Default.aspx*), by selecting the "Status of Conventions-ratifications by State" link.

IMO BWM Convention – BWM Standards

The IMO BWM Convention includes two regulations for ballast water management standards to reduce the spread of aquatic organisms and pathogens: Regulation D-1 addresses the ballast water exchange (BWE) standard; and Regulation D-2 provides the ballast water performance standard for the discharge of organisms from ships.

Some ships are required to initially comply with BWE standards. BWE is founded on the principle that organisms and pathogens contained in ballast water taken on board in coastal waters will not survive when discharged into deep oceans or open seas, as these waters have different temperatures, salinities and chemical compositions. Similarly, the deep ocean waters or open seas contain fewer organisms, and pathogens and are less likely to adapt to the new coastal or fresh water environment. Therefore, BWE significantly reduces the probability of organism and pathogen transfer through ballast water.

Ships performing BWE are required to do so with an efficiency of at least 95 percent volumetric exchange. Acceptable methods for ballast water exchange are the sequential method, the flow-through method and the dilution method. The flow-through method and the dilution method are often referred to as "pump-through" methods. Table 1 provides a description of the acceptable BWE methods.

Table 1. Acceptable Methods for BWE

Type of BWE	Description
Sequential Method	A process by which a ballast tank is first emptied and then refilled with replacement ballast water.
Flow-through Method	A process by which replacement ballast water is pumped into a ballast tank, allowing water to flow through the overflow or other arrangements. A water volume of at least three times the tank volume is to be pumped through the tank.
Dilution Method	A process by which replacement ballast water is filled through the top of the ballast tank with simultaneous discharge from the bottom at the same flow rate and maintaining a constant level in the tank throughout the ballast exchange operation. A volume of water at least three times the tank volume is to be pumped through the tank.

BWE is not completely effective at reducing the spread of unwanted aquatic organisms and pathogens. It is a temporary measure to reduce the spread of nonindigenous species through ship's ballast.

All vessels constructed after the entry into force of the BWM Convention (08 September 2017) are required to meet the D-2 standard upon the vessel's delivery date. For existing vessels, the regulation D-2 compliance dates are determined based on the completion of the vessel's renewal surveys associated with the International Oil Pollution Prevention (IOPP) certificates pursuant to Annex I of the International Convention for the Prevention of Pollution from Ships, 1973, as modified by the Protocol of 1978 (MARPOL). These vessels are required to install a ballast water management system that can meet the ballast water performance standard (i.e., Regulation D-2) as shown in Table 2. The ballast water performance standard identifies numbers of organisms for various sizes and concentrations of indicator microbes in ballast water that BWMS are required to achieve prior to discharge. Vessels constructed prior to 8 September 2017 to which the IOPP renewal survey does not apply shall conduct BWM that at least meets regulation D-2 from the date decided by the Administration, but not later than 8 September 2024.

All BWMS must undergo land-based and shipboard testing and be type approved by an Administration under a structured protocol that demonstrates the ability of the BWMS to achieve the discharge standard under full scale operations. In any port or offshore terminal, an officer authorized by a Party to the Convention may board a vessel to which the convention applies, inspect the documentation on board and take samples for compliance. Detailed inspection through sampling of the ballast water discharge is expected to be performed if documentation is found not to be in good order.

Table 2. BWM Convention Performance Standards

Constituent	Discharge Limitation
Organisms ≥ 50 µm	< 10 viable organisms per m^3 of ballast water
50 µm > Organisms ≥ 10 µm	< 10 viable organisms per ml of ballast water
Indicator Microbes	
Toxicogenic Vibrio cholera (serotypes O1 and O139)	< 1 colony-forming unit (cfu) per 100 ml
Escherichia coli	< 250 cfu per 100 ml
Intestinal Enterococci	< 100 cfu per 100 ml

In addition to the ballast water management performance standards, all ships are required to implement a Ballast Water and Sediments Management Plan, carry a Ballast Water Record Book, and follow specific ballast water management practices.

Applicability of the IMO BWM Convention

The BWM Convention applies to all vessel types which are designed or constructed to carry ballast water and are entitled to fly the flag of a Party to the Convention or operate under the authority of a Party. This includes submersibles, floating craft and platforms including FSUs and FPSOs, although the applicable requirements vary.

Under IMO Regulation E-1 – Surveys, ships of 400 gross tonnage and above excluding floating platforms, FSUs and FPSOs are subject to an initial survey before the ship is put into service or before the Certificate is issued for the first time.

Mobile offshore units should comply with the provisions of the Convention and should be surveyed and issued with an International Ballast Water Management Certificate, according to IMO regulations E-1 and E-2 of the Convention, as applicable. Circular BWM.2/Circ.46 was issued to cover the application of the BWM Convention to mobile offshore units.

The BWM Convention 2004 does not apply to the following conditions:

- Ships not designed or constructed to carry Ballast Water;
- Ships of a Party which only operate in waters under the jurisdiction of that Party,
- Ships of a Party which only operate in waters under the jurisdiction of another Party, subject to the authorization of the latter Party for such exclusion
- Any warship, naval auxiliary or other ship owned or operated by a State and used, for the time being, only for government non-commercial service
- Permanent Ballast Water in sealed tanks on ships that is not discharged.

For more detailed information, refer to Article 3 of the 2004 IMO BWM Convention.

Exceptions and Exemptions under the BWM Convention

Under Regulation A-4 (Exemptions) of the IMO BWM Convention, flag administrations may grant exemptions to ships operating in their jurisdiction from compliance to the D-1 and/or D-2 standards or from the additional measures it may have established to prevent, reduce, or eliminate the transfer of unwanted organisms under Regulation C-1 (Additional Measures), provided that a risk assessment has been carried out in accordance with the latest IMO 2017 Guidelines for risk assessment under regulation A-4 of the BWM Convention (G7) (Resolution MEPC .289(71)) and are subjected to the consultation and agreement between the States. The amendments to the Guidelines G7 with the purpose of introducing the Same risk area (SRA concept) were officially adopted in MEPC 71.

The main objective of the 2017 Guidelines for Risk Assessment under Regulation A-4 of the BWM Convention (G7) is to provide detailed procedures, requirements, and risk assessment methods for flag administration when granting exemptions to ships under the provisions of Regulation A-4. G7 Guidelines are also applicable for Shipowners and vessel operators seeking exemption under the Same Risk Area (SRA) concept.

To be classified under the SRA, IMO G7 Guidelines require a robust risk assessment to be conducted based on the best available scientific methods. The assessment must be sufficiently robust to distinguish between unacceptable, high risk scenarios and acceptable low risk scenarios where the discharge of ballast water is unlikely to impair or damage the environment, human health, property or resources of the granting Party and of adjacent or other States.

Based on the outcome of the risk assessment, if it is proven that the risk of transfer of the invasive species between the specific ports or locations is acceptable, exemptions could be issued for no more than five years from the dates granted.

All agreed exemptions are to be recorded in the Ballast water record book.

IMO Guidelines Available

Developed and adopted by the BWM Convention,16 guidelines clarify the requirements and ensure uniform implementation of the regulations. The guidelines supporting the convention are listed in Table 3. Copies of the BWM guidelines, Circulars and a full list of IMO Resolutions are also available on the IMO website.

Table 3. BWM Convention Guidelines

Guideline	Title
G1	Guidelines for Sediment Reception Facilities (MEPC.152(55))
G2	Guidelines for Ballast Water Sampling (MEPC.173(58))
G3	Guidelines for BWM Equivalent Compliance (MEPC.123(53))
G4	Guidelines for BWM and the Development of BWM Plans (MEPC.127(53))
G5	Guidelines for BW Reception Facilities (MEPC.153(55))
G6	2017 Guidelines for BWE MEPC.288 (71)), superseding MEPC.124(53)
G7	2017 Guidelines for Risk Assessment under Regulation A-4 of the BWM Convention (MEPC .289 (71)), superseding (MEPC.162(56))
G8 (New)	2016 Guidelines for Approval of BWM Systems (MEPC.279 (70), superseding MEPC.174(58) (Note: Resolution MEPC.279(70) will be superseded by the BWMS Code (resolution.300(72)) in October 2019)
G9	Procedure for Approval of BWM Systems that make use of Active Substances MEPC.169(57), superseding MEPC.126(53)
G10	Guidelines for Approval and Oversight of Prototype BW Treatment Technology Programs (MEPC.140(54))
G11	Guidelines for BWE Design and Construction Standards (MEPC.149(55))
G12	2012 Guidelines for Design and Construction to Facilitate Sediment Control on Ships (MEPC.209(63), superseding MEPC.150(55)
G13	Guidelines for Additional Measures Regarding BWM Including Emergency Situations (MEPC161(56))
G14	Guidelines on Designation of Areas for BWE (MEPC.151(55))
–	Guidelines for BWE in the Antarctic Treaty Area (MEPC.163(56))
–	Guidelines for Port State Control under the BWM Convention (MEPC.252(67))

Ballast Water Sampling for Compliance

Understanding the requirements and procedures for ballast water sampling is important for shipowners and operators, as well as for shipbuilders to ensure that systems are properly configured, and crews are properly trained. The G2 guideline (MEPC.173(58)), adopted in 2008, addresses general sampling procedures for all parties, including Port State Control officers, to determine compliance with the BWM Convention. It is important to note that the G2 guideline does not address specific legal requirements, as the legislative procedures and requirements for enforcement action vary from country to country.

Testing for compliance is proposed to be performed in two steps: indicative analysis (i.e., quick assessment of compliance potential); and detailed analysis (i.e., thorough analysis for compliance). In May 2013, the MEPC approved Circular BWM.2/Circ 42 (“Guidance on ballast water sampling and analysis for trial use in accordance with the BWM Convention and Guidelines (G2)”) to provide general recommendations on methodologies and approaches to sampling and analysis for compliance testing for the D-1 and D-2 standards.

The guidance includes information on the sampling and analysis approaches and methods for compliance testing. The methods and approaches are dependent of the type of analysis (i.e., indicative or detailed analyses). A comparison of the differences between indicative and detailed analysis is provided in Table 4.

Table 4. Comparison of Indicative and Detailed Analyses

	Indicative Analysis	**Detailed Analysis**
Purpose	To provide a quick, rough estimate of the number of viable organisms	To provide a robust, direct measurement of the number of viable organism
Sampling		
Volume	Small or large depending on specific analysis	Small or large depending on specific analysis
Representative Sampling	Yes, representative of volume of interest	Yes, representative of volume of interest
Analysis Method		
Analysis Parameters	Operational (chemical, physical) and/or performance indicators (biological)	Direct Counts (i.e. Biological Organisms)
Time-Consuming	Lower	Higher
Required Skill	Lower	Higher
Accuracy of Numeric Organism Counts	Poorer	Better
Confidence with respect to D-2	Lower	Higher

Source: BWM.2/Circ.42

The guidance was revised and approved in MEPC 68 to include the pulse counting fluorescein diacetate (FDA) as an indicative analysis method for viable organisms sizes of ≥ 50 μm, ≥ 10 μm and < 50 μm) when testing for compliance with the D-2 (biological standard for treatment systems) of the Convention.

The revised guidance BWM.2/Circ.42/Rev.1 dated 28 May 2015, contains specific information on analysis methods and approaches for sampling that should be reviewed. MEPC recommends that BWM.2/Circ.42/Rev.1 should be read along with the BWM Convention, Port State Control guidelines, MEPC.252(67), and the G2 guidelines MEPC.173(58)

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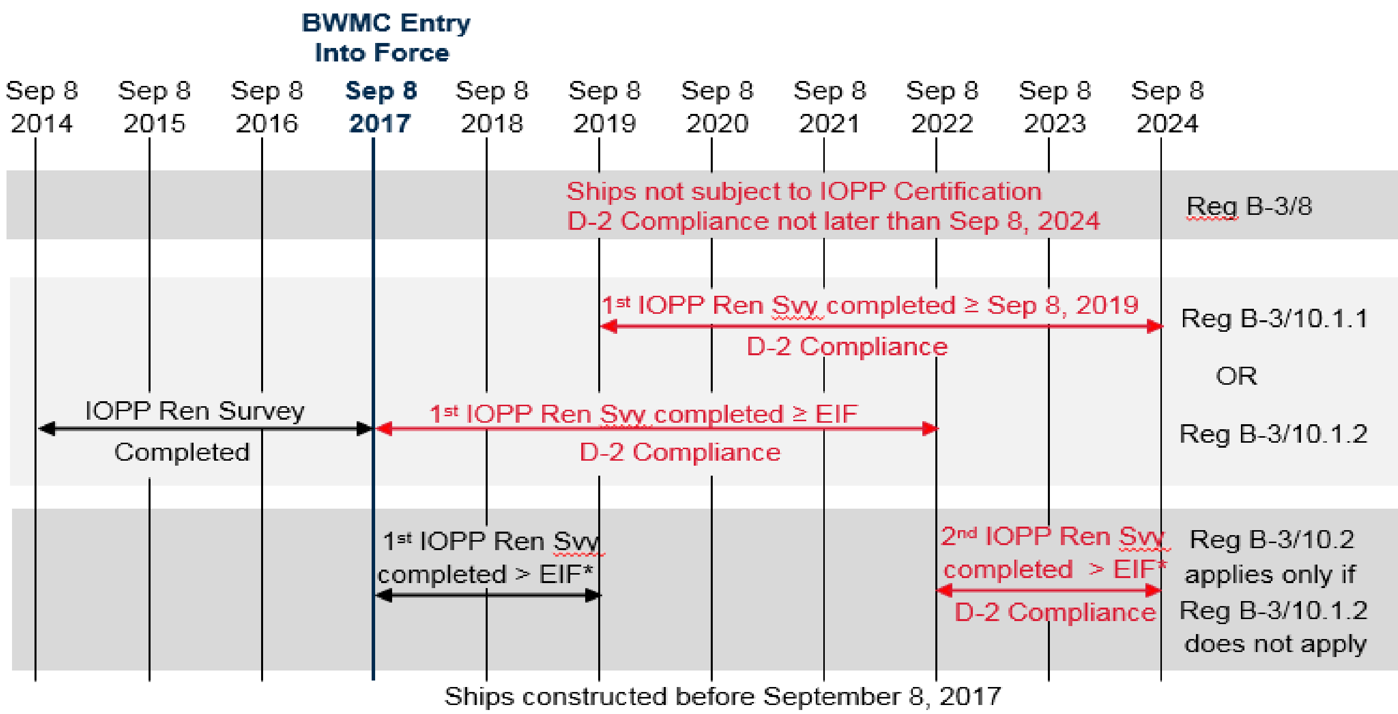
BWM Convention Compliance Timeframe

The discussion with respect to the amendments to the implementation schedule (regulation B-3 of the BWM Convention) of ballast water management for ships required to comply with the D-2 biological standard (Ballast Water Performance Standards) under the BW Management Convention concluded with the adoption of the proposed amendments by the IMO Committee with Resolution MEPC.298(72) during MEPC 72.

The amendments to regulation B-3 of the BWM Convention, which enters into force on October 13, 2019, require ships constructed on or after 08 September 2017 to comply with the D-2 biological standard upon their delivery. Referring to Table 5 below, ships constructed before 08 September 2017 are to comply with the D-2 standard at the first MARPOL IOPP renewal survey completed on or after:

- 08 September 2019 (reg B-3/10.1.1); or
- 08 September 2017, in the event a MARPOL IOPP renewal survey is completed during the period on or after 08 September 2014 and prior to 08 September 2017 (reg B-3/10.1.2).

Table 5 Adopted D-2 Implementation Schedule



If the IOPP Renewal survey was not completed during the period on or after 08 September 2014 and prior to 08 September 2017 (per reg B-3/10.1.2), then compliance with the D-2 standard is required at the second MARPOL IOPP renewal survey after September 8, 2017. This is allowed only if the first MARPOL IOPP renewal survey after 08 September 2017 is completed prior to 08 September 2019 and a MARPOL IOPP renewal survey was not completed during the period on or after 08 September 2014 and prior to 08 September 2017 (reg B-3/10.2).

However, regardless of the vessel's D-2 implementation date, the ship is to comply with at least the D-1 (Ballast Water Exchange) standard on/after 08 September 2017 until the D-2 compliance date. Further, the ships are required to maintain a ballast water record book on board and manage their ballast water in accordance with an approved ballast water management plan.

For ships constructed before 08 September 2017 which are not subjected to the MARPOL IOPP renewal survey (Oil tanker of less than 150 GRT and every ship other than Oil tankers of less than 400 GRT), are to be D-2 compliance no later than 08 September 2024 (reg B-3/8).

The full information of the amendments to regulation B-3 of the BWM Convention and associated MEPC resolution can be found in MEPC.297 (72), MEPC 72/17 and MEPC 72/17/Add.1.

Owners and operators are encouraged to consult with representatives from the local ABS Technical Offices for additional clarification and assistance.

Overview of Some Regional, National and Local Regulations

As previously stated, 81 Contracting States have ratified the BWM Convention. Various foreign countries have established ballast water management requirements as part of the vehicle for incorporation of the convention or for standalone requirements.

Contracting States/Territories that have ratified the BWM Convention (as of April 2019)

Albania, Antigua and Barbuda, Argentina, Australia, Bahamas, Bangladesh, Barbados, Belgium, Brazil, Bulgaria, Canada, China (Macao, China), Republic of the Congo, Cook Islands, Croatia, Cyprus, Denmark (Faroes, Denmark), Egypt, Estonia, Fiji, Finland, France, Gabon, Georgia, Germany, Ghana, Greece, Grenada, The Co-operative Republic of Guyana, Honduras, Indonesia, Islamic Republic of Iran, Jamaica, Japan, Jordan, Kenya, Kiribati, Latvia, Lebanon, Liberia, Lithuania, Madagascar, Malaysia, Maldives, Malta, Marshall Islands, Mexico, Mongolia, Republic of Montenegro, Morocco, Netherlands (Bonaire, Sint Eustatius and Saba), New Zealand, Nigeria, Niue, Norway, Palau, Panama, Peru, Philippines, Portugal, Qatar, Republic of Korea, Russian Federation, Saint Kitts and Nevis, Saint Lucia, Saudi Arabia, Republic of Serbia, Seychelles, Sierra Leone, Singapore, South Africa, Spain, Sweden, Switzerland, Syrian Arab Republic, Togo, Tonga, Trinidad and Tobago, Turkey, Tuvalu, and the United Arab Emirates.

Locations with BWM local and regional regulations

Antarctic Treaty Area, Argentina, Bermuda, Chile, Colombia, Hong Kong, Israel, Mediterranean (Voluntary Arrangements 2012), New Caledonia, Northeast Atlantic and the Baltic Sea (OSPAR and Helsinki Convention Contracting parties), North Sea Ballast Water Exchange Areas (OSPAR), North West Europe, ROPME Sea Area (RSA), Turks and Caicos Islands, Ukraine, United Kingdom, United States of America, St. Lawrence Seaway System, Black Sea, Orkney Islands, Vanuatu, and Wider Caribbean Region Areas.

Recent IMO Activities Related on BWM Convention

The following are a summary of noteworthy updates and important decisions made to the IMO BWM Convention in some of the recent IMO MEPC sessions.

Ballast Water Exchange

A new circular (BWM.2/Circ.63) was approved providing guidance on the application of the BWM Convention to ships operating in sea areas where Ballast Water Exchange in accordance with regulations B-4.1 and D-1 is not possible. Ships engaged in geographically constrained voyages must record the reason in the Ballast Water record book as to why exchange was not conducted but will not be expected to meet the D-2 performance standard prior to its implementation schedule as per regulation B-3.

Additionally, the Committee adopted the revised Guidelines for ballast water exchange (G6), Resolution MEPC.288(71), which includes an updated example of ballast water reporting form.

Adopted D-2 Implementation Schedule (regulation B-3)

In MEPC 71, the revised D-2 implementation schedule under the BW Management Convention was approved. The amended implementation schedule was a compromise proposal between:

1) Maintaining the decision as agreed upon in MEPC 69 in relation to the approved draft amendments to regulation B-3, which reflects the recommended implementation schedule per Resolution A.1088(28) wherein existing vessels which are constructed before 08 September 2017 are required to have a BWMS onboard in compliance with the D-2 performance standard by the first IOPP renewal survey on/after 08 September 2017, and

2) To consider an additional 2-year period, following the entry into force of the Convention, to be made to the implementation schedule in B-3 of the BWM Convention, which would allow existing vessels to have an additional two year period for the installation of an approved D-2 compliance BWMS.

There were draft amendments to the Implementation schedule of ballast water management for ships:

1) Regulation B-3 of the BWM Convention with MEPC Resolution 297 (72) and

2) The associated draft MEPC Resolution (MEPC.298(72)) on the determination of the date referred to in regulation B-3, in which the "renewal survey" is the renewal survey for the ship associated with the International Oil Pollution Prevention (IOPP) Certificate pursuant to Annex 1 of the International Convention for the Prevention of Pollution from Ships, 1973, as modified by the Protocol of 1978 (MARPOL). These draft Amendments were adopted in MEPC 72.

The amendments to regulation B-3 of the BWM Convention shall enter into force on 13 October 2019.

For a clear and detailed explanation on the adopted D-2 Implementation schedule timeline, refer to Table 5, under the section of "BWM Convention Compliance Timeframe" of this Advisory.

Code for approval of Ballast Water Management Systems (BWMS Code)

Concerns were raised by the Shipowners and operators with respect to the efficacy of the installed BWMS, approved under the existing G8 (MEPC 174(58)) Guidelines, to treat water to meet the D-2 standard during normal operation of the ship; particularly in light of the more detailed type approval test protocols in which the U.S. Coast Guard has adopted.

The USCG adopted protocols based on the US Environmental Protection Agency (EPA) Environmental Technology Verification (ETV) Generic protocol for the Verification of Ballast Water Treatment Technology, after raising concerns over the existing G8 type approval procedure.

After discussion in several MEPC meetings with respect to the specific issues being addressed in the G8 Guidelines in order to make them more robust, the revised G8 Guidelines were finalized and adopted as Resolution MEPC 279(70), superseding Resolution MEPC.174(58), in MEPC 70.

The draft Code for approval of Ballast Water Management systems, BWMS Code, as well as amendments to the BWM Convention (Regulation A-1 and D-3) which mandate that systems be approved under the Code, was approved and adopted in MEPC 71 and MEPC 72 respectively.

The BWMS Code (Resolution MEPC.300 (72)) which is technically consistent with the 2016 G8 guidelines (Resolution MEPC.279(70)), specifies that BWMS be approved in accordance with:

- The revised G8 Guidelines (MEPC.279(70)) are deemed to be in accordance with the Code;

- The earlier versions of the G8 Guidelines (MEPC.125 (53) and MEPC.174(58)) as of 28 October 2018, may continue to be installed* on board ships until 28 October 2020.
- Through a new Unified Interpretation, the word "installed" means the contractual date of delivery of the BWMS to the ship or, in the absence of such a date, it refers to the actual date of delivery of the BWMS to the ship.

Beginning October 2019, the BWMS Code (resolution MEPC.300(72)) goes into effect and supersedes the 2016 Guidelines for approval of ballast water management systems (G8).

To provide proper guidance on the Scaling of the BWMS, the Committee has approved the revised Guidance on scaling of ballast water management systems, BWM.2/Circ.33/Rev.1.This revision provides guidance for extrapolating test results for higher/lower treatment rated capacities validated by mathematical model and/or calculations. The most vulnerable models of a series are to be tested using land-based and/or shipboard testing. Numerical validation can used to predict that the key performance parameters (e.g. dosage concentration, UV intensity, filter flux density, etc.) required to achieve the system's efficacy will be achieved in the scaled unit design and that the fundamental mechanism of operation is not changed. The reference to the revised Guidance on scaling of ballast water management systems, BWM.2/Circ.33/Rev.1 has been made to the BWMS Code.

Roadmap for the Implementation of the BWM Convention (EBP)

At MEPC 68, a "Roadmap for the implementation of the BWM Convention" was agreed to be used in the development of the BWM Convention. The Roadmap emphasized that the early adopters should not be penalized after the completion of the Revised G8 Guidelines. The early adopters include Shipowners who have installed BWMS that meet the existing G8 guidelines (MEPC.174 (58)), manufacturers that produce such systems, and those who have maintained and operated the BWMS correctly in accordance with the existing G8 type approval guidelines.

Some of the key considerations from the MEPC 68 meeting include:

- A proposal for non-penalization of ships fitted with ballast water treatment systems, type approved under the current G8 Guidelines (MEPC.174(58)), and of early adopters for vessels that occasionally exceed the D-2 standard with current G8 type approved systems operated and maintained properly;
- To expand the trial period (about 2 to 3 years following entry into force of the BWM Convention) for the ballast water sampling and analysis (BWM.2/Circ.42) into an experience-building phase.

A structured plan of the experience-building phase associated with the BWM Convention was proposed in MEPC 70. It includes carrying out the experience-building phase in three stages: data gathering, data analysis, and Convention review stage. The proposal also suggested extending non-penalization to all ships, and that the ships should not be penalized throughout the three stages of the experience-building phase. The Committee instructed the correspondence team to carry out further development on the experience-building phase associated with the BWM Convention. This includes developing a plan for data gathering and analysis during the experience-building phase, a proposed timeline for the three stages (data gathering, analysis and review stages); and a draft document of the structure of the experience-building phase.

In MEPC 71, the Committee adopted resolution MEPC.290(71) which provides information on the non-penalization measures and the experience building phase (EBP) stages associated with the BWM Convention, with the objective of monitoring and improving the IMO BWM Convention.

The resolution outlines a detailed explanation of activities expected leading up to and following entry into force of the BWM Convention. The activities being considered include:

- Non-penalization of BWMS early adopters who experience non-compliance events, despite the proper use of BWMS;

- A data gathering stage (Part of EBP) where information related to BWMS implementation and operational experience are collected;
- A data analysis stage (Part of EBP) to provide useful information and an insight into the implementation of the Convention. This information includes but is not limited to pace and progress of implementing the Convention; degree to which the standards of the Convention and its requirements are achieved, and any unforeseen safety or environmental concerns;
- A convention review stage with the objective of introducing amendments to address priority issues to the current Convention based on the gathered information and experience gained.

In MEPC 72, the Committee approved the BWM.2/Circ 67 circular on the Data Gathering and Analysis Plan (DGAP) for the experience-building phase (EBP) associated with the BWM Convention.

The DGAP provides specific arrangements for gathering of data during the EBP. It also includes principles and organizational arrangements for analyzing the data collected, and sets out the timeline for the EBP.

Validation of Compliant BWMS at Commissioning

In MEPC 72, the Committee considered two new provisions in the 2017 Survey Guidelines under the Harmonized System of Survey and Certification (HSSC), adopted in December 2017 as Resolution A.1120(30).

These provisions recommend that sampling and analysis of treated water be carried out during commissioning to confirm compliance with the D-2 standard.

The Committee invited interested Parties to submit proposals for an amendment to regulation E-1.1.1 of the BWM Convention regarding validation of the compliance of BWMS with regulation D-2 during commissioning.

During MEPC 73, the Committee issued new guidance for the commissioning testing of BWMS (Circ.2/BWM.70).

Contingency measures under the BWM Convention

The MEPC Committee approved the Guidelines on the guidance on contingency measures for vessels adopting BWT under the BWM convention (BWM.2/Circ.62) in MEPC 71. The importance of contingency planning as a result of operational problems associated with an inoperable BWMS has been further emphasized.

This high-level guideline aims at providing guidance to shipowners, vessel operators and ports as to the preparation of a contingency plan and the importance of working closely with the port state in the event of non-compliant ballast water.

The possible contingency measures may include but are not limited to:

- Practical measures if a ship is unable to manage ballast water in accordance with its approved ballast water management plan
- Discharging of ballast water to another vessel or shipboard or shore reception facility,
- Managing all or part of the ballast water in a method acceptable to the port state,
- Carrying out BWE as agreed by the ship and port State, or
- Other operational actions (e.g. modifying sailing, internal transfer or the retention of ballast water on board the ship)

However, the requirement of documenting contingency measures as part of the ship's BWMP is not indicated in the current IMO G4 Guidelines for Ballast Water Management and the development of Ballast Water Management Plans, MEPC.127 (53).

During MEPC 72 the Committee considered the need to update and obtain approval of BWM Plans to reflect contingency measures in determining the most appropriate manner to allow for the discharge of non-compliant ballast water under the recommendations of BWM.2/Circ.62 while applying sound and practical measures under resolution MEPC.290(71) to ensure the protection of the marine environment and ship safety, and minimizing any impacts on the continuity of port and ship operations.

The Committee also invited Member Governments and international organizations to submit proposals to clarify when elements introduced by the Guidance on contingency measures under the BWM Convention should be included into ballast water management plans.

After MEPC 73, the Committee published Resolution 306(73) amending G4 guidelines adding that the BWMP may contain contingency measures developed taking into account guidelines developed by the Organization.

Exceptions and Exemptions under the BWM Convention

With regards to the development of the guidance for the Same Risk Area (SRA) concept in relation to regulation A-4 (Exemptions) of the BWM Convention, it was agreed that no further guidance would be required since the SRA concept is in line with the G7 Guidelines; also exemptions may be granted by the Administrations in accordance with Regulation A-4 based on the SRA concept, subject to the consultation and agreement between the States, which may be affected as a result of the exemptions.

To gain better understanding of the relationship between the SRA concept and the Guidelines for risk assessment under Regulation A-4 of the BWM Convention (G7), amendments were introduced to the G7 Guidelines with the purpose of introducing the Same Risk Area (SRA) concept which were officially adopted in MEPC 71.

It was also agreed upon that no amendments are required to Regulation A-3 of the BWM Convention, to include discharge of additional ballast from the cargo tank of oil tankers as an exceptional case, since the same has been already covered under MARPOL Annex 1.

IMO Activity Related to the BWM Convention for Offshore Vessels

The previous MEPC sessions also addressed various issues regarding the BWM Convention –Testing for offshore support vessels.

Circular BWM.2/Circ.44 (“Options for ballast water management for Offshore Support Vessels in accordance with the BWM Convention”) addresses methods of compliance for offshore support vessels (OSVs) and clarifies that drill water taken on board for the purpose of protecting low flash point liquid tanks, which is not discharged into the environment, is not subject to the requirements of the BWM Convention.

Circular BWM.2/Circ.46 (“Application of the BWM Convention to Mobile Offshore Units”) states that mobile offshore units should comply with the provisions of the BWM Convention and should be surveyed and certified according to the BWM Convention.

For mobile offshore units, ballast water loaded in preload tanks on self-elevating units and ballast tanks on column-stabilized units is subject to treatment under the convention – unless it is discharged to the same location from which it was taken on board and that no mixing with unmanaged seawater and sediments from other areas has occurred.

BWM.2/Circ. 46 also recognizes that residual water remaining on board, after a field move, could be treated by means of an approved internal circulation method and transferred to another tank and mixed with seawater taken on board from that new location.

The committee acknowledged that seawater in preload tanks in the leg foundation of self-elevating units (SEU) is handled differently and agreed only that the method of handling such seawater should be indicated in the BWM plan.

The issue of entry and exit of ships from the national policies, strategies or programs for ballast water management was discussed and resulted in development of Circular BWM.2/Circ.52 (“Guidance on entry or re-entry of ships into exclusive operation within waters under the jurisdiction of a single Party”). This issue may apply in circumstances such as:

- When bringing a vessel or platform into exclusive operation within the waters of a single Party for an extended period; and
- The need for a domestic vessel or platform of a Party to visit a foreign drydock and then to return to exclusive operation within the Party’s waters.

BWM.2/Circ. 52 provides guidance on entry or re-entry into exclusive operations and when application of the BWM Convention ceases. The circular also provides guidance on the verification required for ceasing application to the convention.

In MEPC 71, the Committee approved a revision (BWM.2/Circ.52/Rev.1) on Guidance on entry or re-entry of ships into exclusive operation within waters under the jurisdiction of a single Party, in which the amendments include a reference to the exemption’s requirements under regulation A-4 of the BWM Convention.

Section 2 I US Ballast Water Regulations

Ballast water management requirements in the United States are a result of USCG regulations, US Environmental Protection Agency (EPA) permits, and individual state laws. In March 2012, the USCG published the final ballast water rule. The EPA followed suit with revising ballast water requirements in the final National Pollutant Discharge Elimination System (NPDES) General Permit for Discharges Incidental to the Normal Operation of a Vessel (2013 Vessel General Permit) issued in March 2013. In general, US federal requirements align with the BWM Convention, while including additional requirements to enhance the control of introduction and spread of nonindigenous species from ships' ballast water in waters of the United States.

In December 2018, the Frank LoBiondo Coast Guard Authorization Act of 2018 was signed into law. Title IX of that act is the Vessel Incidental Discharge Act (VIDA). VIDA is intended to provide for uniform standards and requirements for management of discharges incidental to the operation of a vessel,

VIDA requires that the 2013 VGP, 33 CFR 151 Subparts C and D (BWM regulations), and 46 CFR 162.060 (Engineering Equipment – BWMS) continue in effect until repealed by the new regulations. VIDA requires the Administrator, in concurrence with the Secretary and in consultation with interested Governors, to promulgate new Federal standards of performance for marine pollution control devices for each type of discharge incidental to the normal operation of a vessel subject to the regulations.

VIDA implementation will have the EPA as primarily responsible for establishing standards for vessel discharges and the USCG will be responsible for prescribing, administering, and enforcing regulations based on the EPA's discharge standards. VIDA aims to preserve the flexibility of individual US States and regions for development and enforcement of these standards.

Additional information and schedule for the regulatory development of VIDA will be available in the near future.

US Coast Guard

The USCG "Standards for Living Organisms in Ships' Ballast Water Discharged in US Waters" final rule established new US requirements for BWM, ballast water reporting, ballast water recordkeeping, and established an approval process for BWMS.

The USCG amended existing BWM requirements to include ballast water discharge standards equivalent to the BWM Convention. The implementation schedule for USCG discharge standards, shown in Table 6, is similar to the BWM Convention but is not dependent upon ratification of the convention. The USCG rule established a firm timeline for ships to be required to treat ballast water if entering US waters.

The USCG ballast water regulation became effective on 21 June 2012 and applies to all vessels, US flag and non-US flag, equipped with ballast tanks operating in waters of the US unless specifically exempt (i.e., crude oil tankers engaged in coastwise service, vessels that operate exclusively within one Captain of the Port (COTP) Zone).

The USCG defines scheduled drydocking as "hauling out a vessel or placing a vessel in a drydock or slipway for an examination of all accessible parts of the vessel's underwater body and all through-hull fittings and does not include emergency drydocking and emergency hull repairs." The USCG also defines a ballast tank as any tank or hold on a vessel used for carrying ballast water, whether or not the tank or hold was designed for that purpose (33 CFR 151.1504). US navigable waters include the territorial sea extending 12 nautical miles (nm) from the US shoreline or outer shoreline of barrier islands.

Table 6. USCG Ballast Water Discharge Standards Implementation Schedule

	Ballast Water Capacity	Compliance Date
New Vessels (Constructed on or after 1 December 2013)	All	On Delivery
Existing Vessels (Constructed prior to 1 December 2013)	< 1,500 m^3	1st Scheduled Drydocking after 1 January 2016
	1,500 – 5,000 m^3	1st Scheduled Drydocking after 1 January 2014
	> 5,000 m^3	1st Scheduled Drydocking after 1 January 2016

In the USCG published a Marine Safety Information Bulletin on 22 October 2015 clearly indicating that an underwater inspection in lieu of dry docking (UWILD) would not be considered the "first scheduled dry docking". In this regard, the first scheduled drydocking, or the USCG compliance date, would be:

- For vessels that undergo one UWILD and one dry docking for statutory purposes every five years, the first scheduled dry docking is the first dry docking conducted for statutory purposes after the date specified in either Table of 33 CFR 151.1512(b) or 151.2035(b), as applicable;
- For vessels that do not routinely undergo dry docking, their original compliance date is 1 January 2014 or 1 January 2016, depending on the vessel's ballast water capacity.

Before the vessel's USCG BWDS compliance date, the vessel would be able to perform a complete ballast water exchange (BWE) in an area 200 nm from any shore prior to discharging ballast water, until the vessel compliance date is reached.

Overview of USCG Ballast Water Management Program

The USCG ballast water management program includes requirements for:

- Ballast Water Management (BWM)
- Ballast Water Reporting
- Ballast Water Recordkeeping

Prior to the dates for implementation of the ballast water discharge standards, all vessels with ballast tanks, unless specifically exempt, as identified below, must be in compliance with all aspects of the regulation – BWM, reporting and recordkeeping.

As previously stated, the USCG exempts crude oil tankers engaged in coastwise trade and vessels that operate exclusively within one COTP Zone from BWM, ballast water reporting, and ballast water recordkeeping requirements of the ballast water regulation.

BWM Options

Upon the vessel's USCG BWDS compliance date, all vessels equipped with ballast tanks with plans to trade or operate in the waters of the U.S. are required to meet the Ballast Water Discharge Standard by using one of the following BWM options:

- Install and operate a BWMS that has been type approved by the USCG under 46 CFR Part 162
- Use only water from a US public water system
- Use an alternate management system (AMS) limited for 5 years from the vessel USCG BWDS compliance date, provided that no USCG approved system is suitable for the vessel when the AMS is installed (Refer to Section 4 for more information on the applicability of USCG acceptance AMS)
- Do not discharge ballast water into waters of the United States
- Discharge to a facility onshore or another vessel for treatment.

Additional information on the USCG Type Approval process and USCG accepted AMS is provided in Section 4. The USCG also specifies additional requirements related to the operation and maintenance of the vessel, development of a ship-specific BWM plan, and management of sediment. Many requirements in the USCG ballast water regulation are not included in the BWM Convention or related guidelines. Shipowners and operators need to understand the additional requirements of the USCG ballast water regulation.

The USCG has published further guidance regarding the requirements as well as responses to Frequently Asked Questions on the USCG Ballast Water Management website.

USCG: Additional Requirements

- *Minimizing or avoiding uptake of ballast water in areas or under conditions where marine organisms are likely to be abundant*
- *Cleaning the ballast tanks regularly to remove sediments and ensuring that sediment disposal is in accordance with local, State and Federal regulations*
- *Discharging only the minimal amount of ballast water essential for vessel operations*
- *Rinsing anchors and anchor chains when the anchor is retrieved to remove organisms and sediments at their places of origin*
- *Removing fouling organisms from the vessel's hull, piping and tanks on a regular basis and disposing of any removed substances in accordance with local, State and Federal regulations*
- *Maintenance of a BWM Plan developed specifically for the vessel*
- *Training the master, operator, person in charge and crew on the application of ballast water and sediment management and treatment procedures; and*
- *Discharging only to reception facilities that have an NPDES permit to discharge ballast water, when discharging ballast water in the United States*

USCG BWM Plan Requirements

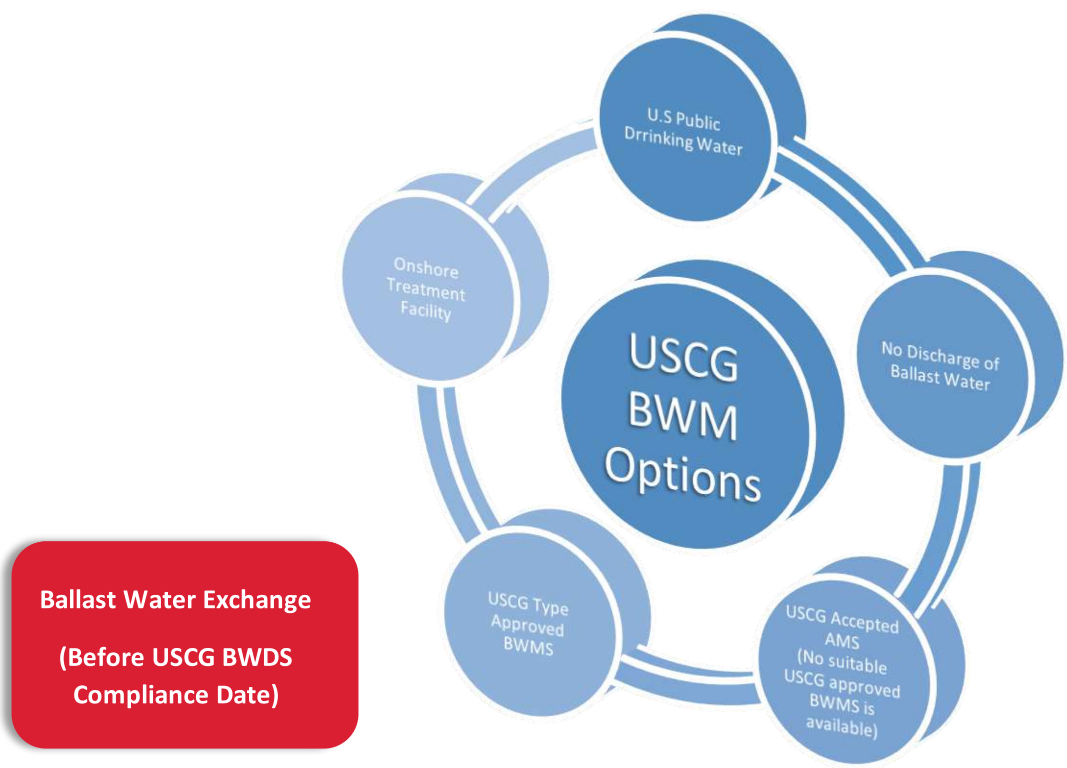
- *Detailed safety procedures*
- *Actions for implementing the mandatory BWM requirements and practices*
- *Detailed fouling maintenance and sediment removal procedures*
- *Fouling maintenance procedures may be documented in a standalone document*

- *Procedures for coordinating the shipboard BWM strategy with USCG authorities*
- *Identification of the designated officer(s) in charge of ensuring that the plan is properly implemented*
- *Detailed reporting requirements and procedures for ports and places in the US where the vessel may visit, and*
- *A translation of the plan into English, French or Spanish if the vessel's working language is another language*

USCG Sediment Management Requirements

- *Sediment from ballast water tanks or holds is to be disposed*
- *Clean ballast tanks regularly to remove sediment*
- *Dispose of sediment in accordance with applicable regulations*
- *Document practices, removal and disposal in BWM Plan*

Figure 1. USCG Ballast Water Management Compliance Options



Ballast Water Reporting and Recordkeeping

Vessels are to record information on the vessel, voyage, total ballast water, BWM practices (including BWM methods and BWM plans on board), ballast water tanks to be discharged into US waters or at a reception facility, and sediment disposal practices. The BWM activities are to be recorded on the Ballast Water Reporting Form (OMB Control No. 1625 0069) and submitted in accordance with the specified instructions.). The signed reporting form is to be retained on board the vessel for two years.

In October 2012, the USCG and National Ballast Information Clearinghouse established the Equivalent Reporting Program – an alternative single monthly batch reporting instead of the port-to-port pre-arrival notification.

To participate, vessels must meet the following criteria:

- The applicant vessel must operate exclusively within the US Exclusive Economic Zone (EEZ) or Canadian equivalent
- The applicant vessel must not have ever been listed on a USCG Lookout List for failing to submit a ballast water report or for submitting incomplete or inaccurate reports
- The person submitting the form must have suitable capability for e-mailing the form as an attachment and either
- The applicant vessel makes ten or more ballast water reports per calendar month, or
- The fleet of applicant vessels, owned by the same company, makes 50 or more ballast water reports per calendar month

Details on the Equivalent Reporting Program are located at http://invasions.si.edu/nbic/equivalentprogram.html.

On 24 November 2015 and 19 September 2018, the USCG published final rules to amend the ballast water management reporting and record keeping requirements, effective 22nd February 2016 and 1 October 2018 respectively. Now, vessels operating exclusively on voyages between ports or places within a single COTP zone are exempt from management (151.2025), reporting (151.2060), and recordkeeping requirements (151.2070).

The amended ballast water management reporting and record keeping requirements reduce the administrative burden on vessels equipped with ballast tanks.

A copy of the current Ballast Water Management Reporting form is attached in Appendix D of the Advisory.

On 10th December 2018, in the announcement section of the NBIC website, it clearly states that

"On January 1, 2019, the current ballast water management reporting form will expire. However, after January 1, 2019, and until such time as the Coast Guard provides notice of a new form, vessel owner/operators should continue to use the existing form (dated Dec 31, 2018). Updates regarding the reporting form will be made available on the Coast Guard's Maritime Commons public information portal, http://mariners.coastguard.dodlive.mil/."

For more detailed instructions, refer to the National Ballast Information Clearinghouse (NBIC) website:
https://nbic.si.edu/guidelines-regarding-current-ballast-water-management-form-form-expires-january-1-2019/.

USCG BWM Regulatory Updates (NVIC 01-18 and CVC 18-02 policy letter)

On 14th February 2018, the USCG published the Policy Letter CVC 18-02 "Guidelines for Evaluating Potential Courses of Action when a Vessel Bound for a Port in the United States has an Inoperable Ballast Water Management (BWM) System" and a Navigation and Vessel Inspection Circular, NVIC 01-18 "Ballast Water Management for Control of Non-Indigenous Species in Waters of the United States" on 1st March 2018.

Both the NVIC and CVC policy letters were issued by the USCG to assist the marine industry in developing a comprehensive understanding of the USCG's latest BWM Guidance and to move the marine industry from implementation of BWM requirements to their enforcement. The policy letter and NVIC provide detailed explanations and guidance for BWMS inspection, compliance verification and available courses of action for vessels with inoperable BWMS bound for U.S. ports to help shipowners and operators who are required to use BWMS for BWM compliance. Additionally, these documents provide guidance for the USCG port state control officers when inspecting vessels for BWM compliance.

NVIC 01-18 replaced NVIC 07-04 "Ballast Water Management for the Control of Aquatic Nuisance Species in the Waters of the United States" published in 2004. NVIC 01-18 establishes new enforcement criteria and provides the USCG's updated BWM extension policy. The updated extension policy indicates that extensions may be granted for no longer than the minimum time needed for the vessel to comply with the requirements and will generally not be longer than 12 months from the vessel's compliance date and may not coincide with the vessel's next scheduled drydock date.

The revised extension policy indicates the USCG considers that the USCG approved BWMS are sufficiently available and cover nearly all classes of vessels and are compatible with a broad range of operational requirements. The USCG policy still allows a shipowner to select a different BWMS from those approved by the USCG. However, additional documentation of when the proposed BWMS is expected to receive USCG approval is to be provided.

It is important to maintain an updated BWMP to provide guidance in the event where the BWMS experiences unexpected loss of operation. There is an increased emphasis on the importance of crew training and understanding of the BWMS operations and requirements.

Planning for BWM contingencies in advance encourages the crew to discuss, coordinate, and implement the BWM strategy to mitigate extraordinary circumstances. The crew should understand the employed BWM methods and have sufficient training to operate and maintain the BWMS. The BWMP provides additional guidance to include contingency measures.

Another important topic in the NVIC is detailed explanation of inspections and enforcement options for vessels using a BWMS for compliance. The inspection and compliance verification methods listed in the NVIC are helpful for the vessel's crew to prepare for PSC inspections and examinations. Training and preparedness targeted on these inspections and examinations could allow the crew to have suitable evidence of compliance ready at hand to avoid unnecessary operational delays. The crew could then focus on proper BWMS operations and be prepared to support inspections that showcase proper operations, recordkeeping and reporting.

The other important development for the US Ballast water regulatory guidance is the Commercial Vessel Compliance (CVC) policy letter 18-02, "Guidelines for Evaluating Potential Courses of Action when a Vessel Bound for a Port in the Unites States has an Inoperable Ballast Water Management (BWM) System", published on 14th February 2018.

This CVC policy letter outlines new guidelines for contingency measures in the event of an inoperable BWMS. The guidelines are applicable for vessels past the U.S. BWDS compliance dates (original or extended) where the vessel has a BWMS installed (either a USCG approved or AMS acceptance). The policy letter aims to establish uniform responses from the Captains of the Port/District Commanders when shipowners report an out of service BWMS and request appropriate courses of action.

Shipowners and vessel operators should understand both the NVIC and CVC Policy Letter guidance to gain better understanding of the possible USCG COTP or District Commander's responses and directions when an inoperable BWMS is being reported.

The USCG expects to be notified in advance, and if BWE is acceptable to the COTP, the USCG may allow the vessel to use the BWE 200 nm from any shore criteria in lieu of using the BWMS. For vessels with more than one documented report of an inoperable BWMS, additional information such as the date of the most recent BWMS repair, the date and location when the BWMS was last operable, and crew training records demonstrating competency in the operation and maintenance of the BWMS will be requested. The USCG should consider the totality of the vessel's record. The COTP may allow the vessel to use an alternative method, including BWE 200 nm from any shore.

Owners are reminded that bankruptcy of a BWMS manufacturer should not provide special consideration for an inoperable BWMS.

The USCG policy letter and NVIC emphasizes the importance of crew training and understanding of the BWMS operations and requirements to effectively plan ahead for BWM contingencies. Using the guidance provided in these documents could better prepare the vessel for USCG inspections and examinations to minimize operational interruptions, possible voyage deviations and delays or USCG COTP/OCMI enforcement actions.

The full information on the CVC Policy Letter "Guidelines for Evaluating Potential Courses of Action when a Vessel Bound for a Port in the Unites States has an Inoperable Ballast Water Management (BWM) System" and a Navigation and Vessel Inspection Circulars, NVIC 01-18 "Ballast Water Management for Control of Non-Indigenous Species in Waters of the United States" could be downloaded through the following links:

- *https://www.dco.uscg.mil/Portals/9/DCO%20Documents/5p/CG-5PC/CG-CVC/Policy%20Letters/2018/CG-CVC_pol18-02.pdf*
- *http://www.dco.uscg.mil/Portals/9/DCO%20Documents/5p/5ps/NVIC/2018/NVIC-01_18.pdf*

US EPA Vessel General Permit

The 2013 Vessel General Permit (VGP) issued on 28 March 2013 covers discharges incidental to the normal operation of a vessel, including ballast water, into waters of the US. Effluent limits and requirements are established for ballast water that aligns with USCG requirements. The 2013 VGP became effective 19 December 2013 and was due to expire 18 December 2018. The 2013 VGP remains in effect until superseded by revised regulations based on the new VIDA requirements.

In general, the 2013 VGP works in conjunction with the USCG ballast water regulations in the US and includes additional definitions, exclusions and management requirements for vessels. Table 7 lists some of the additional features in the 2013 VGP. One important difference with the USCG ballast water regulations is lack of an exemption for crude oil tankers in coastwise trade (33 CFR 151.2015(b)(1)).

EPA VGP Monitoring and Reporting Requirements

The EPA has included detailed monitoring requirements for vessels with installed and operating BWMS. The 2013 VGP requires three areas of monitoring for BWMS:

- Functionality
- Biological Organism Monitoring
- Residual Biocide and Derivative Monitoring

Functionality monitoring is included to verify the BWMS is operating according to the manufacturer's specifications and includes monitoring for specific metrics depending upon the components of the BWMS as well as sensor calibration. EPA has identified metrics for 18 different technology types that are to be recorded monthly. The number of metrics requiring monitoring depends on the treatment technology in the BWMS. For example, a system with filtration, chlorination and neutralization requires that eight specific metrics to be measured and recorded monthly. In addition to the metrics monitoring, sensors and control equipment in a BWMS are to be calibrated as specified by the manufacturer or, at a minimum, annually.

The 2013 VGP requires biological organism monitoring. Due to current constraints in monitoring live organisms, the 2013 VGP only includes biological organism monitoring for three listed indicator organisms: total heterotrophic bacteria, *E. coli* and enterococci.

Residual biocide and derivative monitoring are related to the active ingredients that may be used in the BWMS. EPA provided a list of common biocides and residuals (i.e., chlorine dioxide, chlorine, ozone, peracetic acid, and hydrogen peroxide) to be monitored and referenced the *EPA 2009 National Recommended Water Quality Criteria* (*http://water.epa.gov/scitech/swguidance/standards/criteria/current/upload/nrwqc-2009.pdf*) for identification of other biocides.

The frequency of monitoring biological organisms and residual biocides and derivatives is related to the specific BWMS installed. BWMS that were approved with high quality data require less frequent monitoring because EPA believes systems with high quality data may be more reliable. BWMS with high quality data are defined as systems that obtained USCG Type Approval or were accepted by the USCG as an AMS.

Detailed self-inspection and reporting requirements are specified in the VGP. Appendix H provides the form for the Annual Report and the Supplemental Addendum (Supplemental Ballast Water DMR) for monitoring. EPA is also developing the electronic reporting form. More information regarding the 2013 VGP is available at *https://www3.epa.gov/npdes/pubs/vgp_permit2013.pdf.*

Table 7. Additional Ballast Water Requirements for 2013 VGP

Exclusions from VGP Requirements and Reporting
Vessels that do not travel more than 10 nm and cross no physical barriers or obstructions (e.g., locks), whether or not they operate within one US Coast Guard COTP zone
Unmanned, unpowered barges
Vessels with a ballast water capacity of less than 8 m^3
"Lakers" Built Before 1 Jan. 2009
Additional Ballast Water Requirements
When using a BWMS, vessels must also conduct BWE or saltwater flushing (as applicable) in addition to ballast water treatment if: • Vessel operates outside of the EEZ and more than 200 nm from shore and then enters the Great Lakes from the St. Lawrence Seaway System; and • Vessel has taken on ballast water that has a salinity of less than 18 ppt from a coastal, estuarine, or fresh water ecosystem within the previous 30 days
Specific requirements for "Lakers" including annual inspections of sea screens and ballast tanks for sediment accumulation and minimizing the uptake at ballast dockside.
Use of public water as a BWM option was expanded to include water from the Canadian drinking water system
Specific discharge limitations for biocides or residuals from BWMS that use active ingredients,
Specific training requirements for all vessels equipped with ballast water tanks
Extensive monitoring and testing requirements for installed BWMS

Table 8. 2013 VGP Functionality Monitoring Metrics

Technology Type	Required Metrics to be Reported
Alkylamines	Alkylamines sample concentration Alkylamines dosage and usage pH readings
Biological agents	Treatment chemical sample concentration Treatment chemical dosage and usage
Cavitation	Pressure readings
Chlorination: (e.g., sodium chlorite and sodium hypochlorite)	Chlorine readings from both on-line sensor and sample analysis Chlorine dosage on treatment (if chlorine addition) Oxidation reduction potential (ORP) readings Total Residual Oxidizers (TRO) readings Conductivity/salinity and temperature readings
Chlorine Dioxide	Chlorine dioxide readings from both on-line sensor and sample analysis Chlorine dioxide dosage and usage (if chlorine addition)
Coagulation (flocculent)	Treatment flocculent concentration Treatment chemical dosage and usage Coagulant effluent turbidities
Deoxygenation	Deoxygenation gas dosage and usage pH readings Dissolved oxygen concentrations
Electric Pulse	Electric pulse module power consumption, voltage and current readings
Filtration	Flow readings Filter pressures (before and after) Filter backwash frequencies
Heat	Temperature readings
Hydrocyclone	Hydrocyclone back flush frequencies Hydrocyclone power consumption, voltage and current
Menadione/Vitamin K	Menadione/Vitamin K concentration at injection Menadione/Vitamin K dosage and usage
Ozone	TRO readings Ozone readings from both on-line sensor (if used) and sample analysis Bromate measurements Conductivity/salinity and temperature readings
Peracetic acid	Hydrogen peroxide readings from both on-line sensor and sample analysis Hydrogen peroxide dosage and usage Peracetic acid readings from both on-line sensor and sample analysis Peracetic acid dosage and usage pH readings
Plasma pulse	Plasma pulse module power consumption, voltage and current readings Temperature readings

Technology Type	Required Metrics to be Reported
Shear	Pressure readings
Ultrasound	Ultrasound module power consumption, voltage and current readings
Ultraviolet (UV) and UV plus TiO_2	UV module power consumption, voltage and current readings UV dosage, intensity and transmittance Flow readings

Table 9. 2013 VGP Monitoring Frequency

Type of Monitoring	BWMS with High Quality Data	BWMS without High Quality Data
Biological Organism Monitoring	2 times per year for the first year If sampling results are below effluent limits, monitoring can be reduced to 1 time per year Monitoring will remain at 2 times per year, if samples exceed effluent limits	4 times per year
Residual Biocide and Derivative Monitoring		
Initial Monitoring	3 times in the first 10 discharge events (not to exceed a 180 day period)	5 times in the first 10 discharge events (not to exceed a 180-day period)
Maintenance monitoring	2 times per year	4 times per year

Individual State Requirements

To date, 16 states in the US have specific BWM requirements. States have imposed these requirements either through specific state regulations or Clean Water Act (CWA) Section 401 Certifications for the 2013 VGP. Information on California and New York requirements are presented below, and a summary of state requirements is provided in Appendix A.

California

California has established the most stringent ballast water requirements. The California State Lands Commission Marine Invasive Species Program has been developed to prevent and minimize the introduction of nonindigenous species in California waters through requirements for ballast water management on ships of 300 gross registered tons or more.

At present, vessels discharging ballast water in California waters are required to conduct ballast water exchange. The ballast water exchange requirements depend on the vessel’s port of origin. California developed interim and final performance standards that treatment systems are to achieve. Table 10 contains the California interim performance standards.

Table 10. California Interim Ballast Water Treatment Performance Standards.

Organism Size Class	Discharge Limitation
Larger than 50 µm (micrometer or one millionth of a meter) in minimum dimension	No detectable living organisms
10 – 50 µm in minimum dimension	Less than (<) 0.01 living organisms per ml (milliliter)
Less than 10 µm in minimum dimension	Less than 10^3 (1,000) bacteria per 100 ml Less than 10^4 living viruses per 100 ml
Escherichia coli	Less than 126 cfu (colony forming units) per 100 ml
Intestinal enterococci	Less than 33 cfu per 100 ml
Toxicogenic Vibrio cholera (Human cholera)	Less than 1 cfu per 100 ml or Less than 1 cfu per gram of wet weight biological material

The California legislature passed amendments of the Marine Invasive Species Act, AB 1312 and signed by the Governor which was effective from 1 January 2016. The specific statutes amended are for different Public Resources Code sections and will do the following:

- Delayed implementation of California's interim ballast water discharge performance standards. The new implementation dates are as follows:
    - Newbuilt vessels – First arrival on or after 1 January 2020
    - Existing vessels – First dry docking on or after 1 January 2020
- Delayed implementation of California's final ballast water discharge performance standards until 1 January 2030
- Extended until 1 January 2020, the deadline for vessels to apply for use of an experimental ballast water treatment system
- Authorized the California State Lands Commission to enforce vessel biofouling management requirements and assess vessel compliance with biofouling management requirements. This includes the authority to inspect vessels for compliance with biofouling management regulations
- Changed the deadline for submitting Ballast Water Reporting Forms to 24 hours in advance of arrival at a California port
- Required all vessels that arrive at a California port or place with an installed ballast water treatment system to follow relevant reporting requirements
- Requires taking samples of ballast water, sediment, and biofouling from and inspect at least 25% of the arriving vessels
- The final discharge standards are zero detectable living organisms for all organism size classes listed in Table 10 and are to be effective 1 January 2030

Recordkeeping and Reporting Form Submission Requirements

The amended regulation requires to provide specified information in electronic or written form to California State Lands Commission at least 24 hours before the vessel arrives at a California port or, if vessel's voyage is less than 24 hours in total duration, prior to departing the port of departure. The Ballast Water Management Report (OMB number 1625-0069) submission form contains detailed information regarding submission requirements. As of 1 July 2016, the California State Lands Commission's Marine Invasive Species Program will no longer accept the old U.S. Coast Guard (USCG) Ballast Water Reporting Form. All vessels arriving at California ports should submit the USCG Ballast Water Management Report (BWMR) to the Commission to fulfill reporting requirements.

The sample of Ballast Water Management Report form is attached as Appendix D of this document.

New York

New York initially established discharge standards similar to California but revised their requirements to align with USCG and EPA 2013 VGP requirements. New York has deferred more stringent water quality based effluent limitations until the next VGP. However, New York continues to require ballast water exchange regardless of whether the vessel is equipped with a BWMS.

New York also includes additional management practices for ballast water taken aboard in Viral Hemorrhagic Septicemia (VHS) affected waters that include: annual inspection (and documentation) and replacement, as necessary, of ballast sea chest screens; lightening the ship as much as practical to elevate water intakes before ballasting to minimize sediment uptake and increase water flow; and a requirement for ballast water to be taken aboard or discharged via the pumps and prohibiting "gravity fed or drained" ballast.

In addition to the 2013 VGP biological indicator compliance monitoring, all vessels covered under the VGP and operating in New York waters, after a BWMS is installed, must sample and analyze the ballast water discharge for live organisms (i.e., organisms > 50 μm and organisms from 10-50 μm) at least once a year using acceptable sampling and testing protocol. The monitoring results are to be submitted to the EPA and the New York State Department of Environment Conversation on an annual basis.

Section 3 | Ballast Water Management Options

Various ballast water management options have been developed for compliance with regulations. While the installation of a BWMS may be the most predominant solution, other options have been identified. In the US, shipowners may also be in compliance with requirements through the following methods:

- Transfer to onshore treatment facility or another vessel for purposes of treatment
- Use of public water supply (PWS)
- Retention of ballast water
- No discharge of ballast water in US waters

Several regulations permit the onshore treatment of ballast water or discharge to another vessel for purposes of treatment. Onshore treatment facilities and vessels used for treatment must have the appropriate discharge permits. Piping and connections to onshore treatment facilities or other vessels must prevent the discharge of untreated ballast water. The State of California has also included the same provision but noted that no treatment facilities or treatment vessels have been identified.

The USCG regulation was the first to permit the use of public water as ballast water. According to the USCG regulation, ships intending to use public water as ballast may use only water from a US public water system (PWS), as defined in 40 CFR 141.2, and meeting the requirements of 40 CFR Parts 141 and 143, as ballast water. The US EPA incorporated the same requirements but expanded the definition of public water to include water from a Canadian water system, as defined in Health Canada's "Guidelines on Canadian Drinking Water Quality."

Vessels using PWS water as ballast must have either: (i) previously cleaned the ballast tanks (including removing all residual sediments) and not subsequently introduced ambient water or (ii) never introduced ambient water to those tanks and supply lines. MEPC 65 included a discussion on the use of drinking water as ballast water and encouraged Administrations to provide additional information to the Bulk Liquid and Gases Sub-Committee (BLG) regarding the option.

An important part of compliance with all regulations is determining if ballast water can be retained on board or if no ballast water will be discharged in US waters. Shipowners and operators need to initially evaluate their ballasting operations to determine if retention or use of one of the previously mentioned alternatives is an option, prior to installing a ballast water treatment technology.

Ballast Water Treatment Technologies and Practical Consideration

In general, ballast water treatment technologies fall into two groups: separation technologies or disinfection technologies. Separation technologies remove organisms from ballast water upon intake or prior to discharge. Disinfection technologies kill or render organism's incapable of reproducing. BWMS have been developed using various combinations of the technologies.

Separation Technologies

Equipment is available that separates organisms from ballast water through natural physical differences in organisms (i.e., size of organism) or is induced through the introduction of chemicals to coagulate and flocculate organisms such that separation more easily occurs. The most predominant type of separation technology in BWMS is filtration systems, which is typically used in conjunction with other disinfection methods, to increase the overall efficiency of the BWMS in the elimination of the aquatic organisms. Eliminating larger organisms from the ballast water reduces the follow-on disinfection technology burden (i.e., reduces power demand for UV-based BWMS and active substance dosing, etc.).

Filtration is the passage of a fluid through a porous medium to remove suspended matter, such as sediment, organisms, and silt. BWMS vendors use many different types of filters – disk, drum, mesh, screen, stacked disk (some older technologies). Each of the filter types identified have different arrangements, technical specifications and means for backflushing. BWMS filters are reported to remove organisms from 10 µm to 200 µm in diameter.

The filter, in which their flow rate depends on the ballast water treatment rated capacity (TRC), are installed at the uptake of the ballast water to eliminate particles or larger microorganisms, hence aids in the reduction of the total organisms/biomass to kill and reduces the maximum sediment size by allowing improved active substance effectiveness and therefore reducing the total energy consumption.

However, in areas where water conditions contains presence of significant amount of total suspended solid (TSS) particles and especially for high ballast dependent vessels (i.e., tankers and bulk carriers), where the ballasting/deballasting operation requires large volumes of water and high pumping rates to facilitate rapid port turnaround time, this could led to the heavy buildup of silt in the ballast water tanks which causes the problem of sediment control issues, and also the clogging of the filters in the long run.

Although, most of the filter technologies used in the BWMS today, are capable of cleaning the filter mesh by automatically backflushing using the differential pressure from the filter outlet to the backflush outlet (i.e., filtered water is used to clean the filter), depending on the elevation of the placement of the filters on the ballast water system line, it might be difficult to achieve effective backflushing operation of filters without affecting the overall throughput of the ballast water operation. Ballast water filters using filter output for backflushing require significant outlet pressure for proper self-cleaning. The filtered water used for backflushing could cause a further reduction in the ballast water throughput.

Some filters are installed in deck houses located at the high points in the ballast system. This could result in inadequate filter outlet pressure for effective backflushing of the filters. Due to the high elevation of the location of the filter in the ballast system, the filter outlet will cascade vertically back to the fore-aft ballast header installed below tank top possibly creating an increased static head in that part of the ballast piping. This could result in re-evaluation and re-certification (and possible replacement) of the ballast system piping for the potentially higher hydrostatic conditions. Also, the dynamic velocity of ballast water at the bottom of the vertical drop could require additional piping support components to reduce and accommodate the increased hydrodynamic forces.

The flow control valves at the outlets of the filters could be required to automatically increase filter outlet pressure to properly backflush the filters. These valves, if used during backflushing could also reduce the filter throughput during the filter backflush operations thus extending the ballasting operation.

A key point to note would be clogged filters that results in continuous backflushing operations which could affect the overall effectiveness of ballast water pumping flow rates. This could result in extended ballast water operations and result in the interruption of cargo operations causing prolonged port turnaround times.

Other than filtration, various separation technologies such as hydrocyclones are also being used for BWMS. A hydrocyclone uses centripetal force to separate materials and organisms of different densities aiding in removal of organisms. At least one BWMS removes organisms by using flocculating agents and then separates the larger “flocs” by magnetic separation technology.

Disinfection Technologies

The destruction or inactivation of organisms is an important part of ballast water management. Disinfection can kill organisms or alter organisms such that they cannot reproduce or are no longer viable. According to the BWMS Code, Resolution MEPC.300(72), which will come into effect 13 October 2019 and supersedes the 2016 Guidelines for Approval of Ballast Water Management Systems (G8) adopted by resolution MEPC.279(70), “viable organisms” are now defined as “organisms that have the ability to successfully generate new individuals in order to reproduce the species.”

Several disinfection technologies are used in BWMS, including chlorination, ozone treatment, deoxygenation, and ultraviolet (UV) treatment. The ability for technologies to be effective disinfectants may be affected by the salinity, temperature, turbidity, and possibly other physical/chemical parameters of the water being treated. The following describes each of these disinfection treatment technologies together with their pros and cons in more detail.

Full flow In-line /Side stream Electro-chlorination Injection

Chlorination is a traditional technique for waste water disinfection and can be accomplished through conversion of naturally occurring chlorides (Cl–) in seawater or direct injection of chlorine-containing compounds. In electrolytic chlorination (i.e., electrolysis), an electrical current is applied directly to seawater generating free chlorine (Cl2), sodium hypochlorite (NaOCl), hypobromous acid (HOBr), and other hydroxyl radicals. Electrochlorination (EC) requires minimum salinity levels in the ballast water or additional salt would be required. In seawater, depending on chlorination levels applied by the treatment technology, the formation of disinfection byproducts (chemical substances) such as trihalomethanes (THMs), haloacetic acids (HAAs), bromate, chlorite, and other relevant chemicals can complicate the use of this technology.

Electrolytic chlorination may be either in-line where the entire ballast water flow is treated or side-stream where approximately 1 to 2 percent of the ballast water flow is directed through the electrolytic cells and re-injected to the ballast water flow. At least one EC-based BWMS circulates ballast water in the ballast tanks while adding a small side-stream from the EC-based BWMS.

Electrochlorination systems are attractive and provide cost-effective solutions, particularly on existing vessels (i.e., high ballast dependent vessels) when high ballast water capacity, limited space available onboard the vessel, and limited power availability limits other choices. Electrochlorination systems have disadvantages.

Electrochlorination systems co-generate hydrogen (H2) gas as a waste byproduct. Depending on the BWMS technology, the hydrogen gas can be flushed to the ballast tanks to be naturally ventilated out of the tank vents or separated from the side-stream, diluted with air using small fans, and ventilated out of the ship.

The salinity and temperature of the ballast water being treated becomes a major factor when determining the efficiency of electrochlorination systems since generating the disinfectants depends on these water quality parameters. Generally, when salinity and temperature are low, additional DC voltage is required to achieve the required DC amperage to generate the disinfectants which results in higher power demand for this technology.

The electrochlorination systems work acceptably for vessels operating in warmer marine salinity waters where sufficient dissolved salts are available. However, for vessels operating in fresh or brackish waters, particularly in colder climates, electrochlorination technologies present some additional challenges.

To compensate for the low salinity problems, vessels operating in these water conditions, could carry reserved marine salinity seawater or brine tanks onboard the vessel in order for the electrochlorination systems to work acceptably. Some examples of added salt include using reserved seawater by filing the aft peak tank with marine salinity seawater before entering the fresh or brackish water ports and mix the reserved seawater into the ballast water being treated or installation of a brine system onboard the ship to pre-mix commercial salt with water for salinity enhancement of the electrochlorination feedwater.

Additionally, consideration of heating the side stream should be considered to improve the efficiency and effectiveness of the side-stream EC-based BWMS.

However, adding additional equipment for salinity enhancement and side-stream heating could be challenging for some vessel types possibly leading to not being able to use this type of technology.

The suitability of reserving marine salinity seawater in the APT is challenging. If the APT is continuously de-ballasted to feed the side-stream EC cells during cargo operations, trim control on the vessel while conducting cargo operations could be compromised. Reserving marine salinity displaces cargo capacity making some charter guarantees harder to fulfill.

Before the ballast water is discharged, chemical agents such as sodium thiosulfate, sodium bisulfite or sodium metabisulfite are prepared and injected to neutralize the remaining total residual oxidants (TRO) in the ballast water being discharged. This is mandatory to avoid unauthorized excessive TRO discharges.

The amount of neutralization agent required depends on the initial TRO dosing, temperature and organics content of the treated ballast water, and length of ballast voyages. The active substances (i.e., TRO) decay over time therefore it may be that vessels with longer ballast voyages would result in lower neutralization agent consumption with reduced chemical consumption costs. However, for shorter ballast voyage vessels, if variable TRO dosing is provided with the BWMS automation, similar reduced neutralization chemical consumption could be achieved.

Usually, neutralization is conducted by automatic dosing of a neutralization agent controlled by the use of a colorimetric DPD (N, N-diethyl-p-phenylenediamine) analysis-based TRO analyzers and monitors.

However, these TRO monitors are known to create problems with in-service BWMS operations.
The use of TRO analyzers and monitors typically requires regular maintenance and chemical refills (e.g., pH buffers and DPD chemicals). The DPD analyzer chemicals have shelf-life limits and are required to be replaced at least semi-annually (even if not used), and often expire prematurely due to shipboard conditions.

Since seawater is used as an electrolyte in the electrochlorination systems, hard scale deposits accumulate on the surfaces of the electrochlorination cell cathodes (i.e., half of the EC generator electrodes) and magnesium hydroxide (low solubility precipitate) begins to clog the narrow gaps in the electrolytic cell assemblies. To prevent service life reductions of the electrolyzers, regular cleaning of the electrolyzers is important. This may require additional cleaning chemicals costs and maintenance for the BWMS.

Throughout the lifecycle of the BWMS, all the neutralizing and cleaning chemical costs can be substantial and contribute significantly to the operational costs of the BWMS.

Chlorine Dioxide (ClO_2) Injection

ClO_2 is generated from stored precursor chemicals onboard and is injected into the ballast water during ballasting operations. The generation of chlorine dioxide has been deemed one of the more effective chemical treatment methods to eliminate microorganisms.

The advantage of this active substance is that, unlike chlorine that reacts with organic compounds producing undesired disinfection byproducts (DBPs), chlorine dioxide only reacts with living cells and does not produce DBPs. Additionally, this technology does not require secondary treatment with neutralization agents during the de-ballasting operations. The side stream chemical injection configuration also provides installation flexibility. The side-stream arrangement could be used for treating both port and starboard forward and the APT ballast systems with a single ClO_2 generator providing additional ballast treatment flexibility.

Since no secondary treatment or neutralization is required during de-ballasting operations, this treatment technology is compatible with bulk carriers with TST configurations requiring direct gravity discharge overboard.

Chlorine dioxide treatment is an attractive system for vessels with limited power availability and water ballast system configurations that challenge other technologies.

However, the ClO_2 treatment method has disadvantages.

Depending on the vessel trade routes, the vessel might experience a possibility of high ambient temperature conditions which could result in the accelerated degradation of the stored precursor chemicals (i.e., sensitive to high temperatures). To prolong or maintain the shelf life of the chemicals, proper storage spaces may need to be provided. In order to minimize chemical refill operations, larger storage tanks can be provided. The larger storage tanks require more footprint and have increased full tank weights. Storing additional chemicals onboard the vessel require proper handling where additional crew training and safety personal protection equipment (PPE) are to be provided. The BWMS vendor offers full-support for vessel owners that avoids shipboard personnel handling the chemicals during refilling.

Another issue would be availability of the treatment chemicals at the vessel’s trade route destination. To complicate the issues, the handling and refilling of the ClO_2 precursor chemicals might not be allowed at some cargo terminals requiring extended in-port periods at lay berths for chemical replenishment.

Some of the BWMS utilizing the ClO_2 treatment technology requires a minimum holding time period for the process to be dissipate relevant chemical concentrations. This could be a disadvantage to vessels with ballast voyages shorter than the minimum holding time period thus impacting the vessel’s turn-around time.

Ozone generation

Ozone treatment is an effective disinfectant in seawater. In freshwater, ozone quickly decomposes limiting the generation of oxidants for destruction of organisms. In seawater, ozone treatment initiates chemical reactions similar to chlorination that results in the formation of the effective biocides such as hypobromous acid. For successful freshwater treatment, some reserved marine salinity should be provided to mix in a small amount with the ozone injection.

Though highly effective, ozone produces similar disinfection by-products (DBPs) to those encountered with chlorine and electrochlorination technologies. Any excess TRO requires neutralizing chemicals and often, DPD-based (i.e., wet chemistry) TRO monitors are used to control the neutralization chemical injection during de-ballasting to ensure that the total residual oxidant (TRO) is within limits for overboard ballast water discharge. Similar to chlorine and electrochlorination technologies, the TRO monitors can create problems with in-service BWMS operation and the use of the neutralization chemicals increases the total operating costs.

Special safety considerations (i.e., ozone leak detectors, low and high oxygen concentration sensors) are provided for the ozone generator and associated distribution piping.

The use of ozone could increase ballast water tank corrosion. Appropriate piping materials are to be considered which could increase the capital expenses of the BWMS retrofit.

Based on the vessel characteristics, the economic and operational impacts for ozone BWM technology should be properly assessed before deciding if the ozone generation treatment systems are ideal for the vessel.

Ultraviolet Radiation

UV treatment uses either low pressure (LPUV) or medium pressure (MPUV) ultraviolet lamps to break down cell membranes or damage cellular DNA to kill organisms or causing inability to reproduce. UV lamps are required to be maintained and variable power demand needs to be considered when considering this technology. BWMS systems use different numbers of UV lamps.

During ballasting and de-ballasting operations, UV treatment is conducted. After filtration, the ballast water is routed through the UV chambers and then to the ballast tanks. To counteract potential regrowth of the micro-organisms, the ballast water is re-treated during de-ballasting operations bypassing the filters and using the UV chambers before ballast water is discharged overboard.

The effectiveness of UV treatment depends on the UV transmission (UVT) of the treated ballast water. UVT is affected by organic chemicals and inorganics (i.e., turbidity and nitrates, etc.) of the ballast water to be treated. High concentrations of silt, sediments and organic chemicals in the ballast water could reduce UVT thus limiting the treatment effectiveness.

One challenge for UV-based BWMS is the current differences between USCG and IMO in terms of the testing methods to determine the efficacy of a BWMS. The USCG evaluates the performance of the BWMS based on the a live/dead challenge with limited approved test methods (i.e., FDA/CMFDA based on the US EPA's ETV incorporated by reference into the CFR's). The IMO requirements allow assessment based on the determination that the treated organisms are viable/non-viable (i.e., to include the most probable number – or MPN method).

The current lack of harmonization between USCG and IMO over the use of the MPN enumeration method would imply that in order to achieve USCG type approval, the UV-based BWMS manufacturers have to increase the UV intensity (UVI) levels high enough to achieve efficacy results required by the US EPA Environmental Technology Verification (ETV) protocol (i.e., FDA/CMFDA). This creates additional design challenges for UV-based BWMS. The UV chambers have maximum power/UV intensity design limits and these BWMS must accommodate the existing vessel's power availability to avoid required additional auxiliary engines/power generators. To achieve USCG efficacy, treatment rated capacity may have to be reduced while using maximum power settings for the UV-based BWMS. In the next few years with implementation of VIDA that requires the USCG to evaluate alternate testing methods including the viable/non-viable tests, may allow these BWMS to operate at full TRC and once again with automatic adjustable power settings to achieve protection against invasive species.

For current USCG requirements, depending on the required UVI that depends on the water conditions in which the vessel operates, UV-based BWMS might require excessive power making use of this technology problematic.

However, for IMO applications, the UV technology seems achievable. Hopefully, future USCG requirements will allow more ships to adopt this technology.

Current USCG applications also require minimum hold times to provide adequate organism kill (i.e., dead) performance. Depending on the vessel's operational schedules, this could further challenge UV-based BWMS technology selection. IMO mode operations do not currently impose minimum hold times.

To provide efficient operation of the UV systems, the UV lamp quartz sleeves should be free from scale and as clean as necessary to provide high UVT. High UVT quartz sleeves are used to keep the UV lamps dry during operation and protected from minor entrained debris in the ballast water being treated. Elevated operating temperatures in the UV chambers, particularly at the quartz sleeve surfaces from high UV intensity, causes fouling of the sleeves (due to chemical hardness in the ballast water). If the quartz sleeves are not periodically cleaned, the efficacy of the BWMS could be compromised. Therefore, regular cleaning of the UV sleeves is required to maintain the optimum performance of the UV-based BWMS.

To support regular cleaning maintenance, increased chemical cleaning costs and possible replacement of the lamps or sleeves for could require higher operating expenses.

Additional challenges for UV-based BWMS is caused when treating ballast water during tank stripping. Various BWMS vendors provide different solutions, some more attractive than others. One option is to reserve treated ballast water in one ballast tank and using that as eductor motive water. With this scheme, the motive water does not require the use of the filter during de-ballasting. The motive water is combined with the stripped water to be re-treated by the UV equipment. Another scheme is to use native water as motive water. In this method, ambient water is filtered and routed through the eductor as motive water. Pretreated ballast stripped by the eductor is combined with the filtered ambient water and the combined stream is routed through the UV chamber for treatment. At least one BWM vendor uses a pump to strip the ballast tanks in lieu of the eductor. The stripped water is routed through the UV chamber for re-treatment.

During stripping operations, air entrainment in the stripped water (mixed with motive water or not) routed through the UV chamber may cause additional problems for this BWMS technology. Using high UVI creates substantial heat that is removed by the water flow through the UV chamber. When air is entrained and routed through the chamber, the air could blanket UV quartz sleeves allowing the surface temperature of the sleeve to create local hot spots. When the water flow flushes the air from the sleeve surface, the rapid quenching of the sleeve could cause thermal stresses on the quartz sleeve to cause cracks leading to possible water leaks that could blow out UV lamps. Some considerations to adding air vents on the stripped line before it is routed through the UV chambers might counteract the possibility of air entrainment damage to the UV chamber sleeves and lamps.

De-oxygenation

In BWMS using de-oxygenation technologies, dissolved oxygen in the ballast water is removed and replaced with inert gases (i.e., carbon dioxide or nitrogen). Removing the oxygen not only kills the aerobic organisms in ballast water but can also have positive side effect for corrosion prevention - provided that the oxygen content is maintained at the correct levels. De-oxygenation technologies may require ballast water to be held for a significant amount of time (i.e., 96 hours or more) for living organism counts to meet the discharge levels (i.e., IMO D-2 or USCG standards). Inert gas-based de-oxygenation BWMS are often combined with a cavitation or ultrasonic technology.

The in-voyage inert gas/de-oxygenation BWMS provide several advantages, especially for long ballast voyages. These systems support gravity ballasting/de-ballasting and TST direct gravity discharge operations since there are no connections to the water ballast system and no re-treatment or neutralization is required during de-ballasting. Also, for some BWMS using this technology, no treatment is required during ballasting or de-ballasting operations.

Since chemicals (i.e., chlorine or other disinfectants) are not required for neutralization in this treatment technology, no retreatment is required during de-ballasting operations (however, possibly re-aeration of treated ballast water might be required). Corrosion issues and chemical handling hazards can be eliminated, and ballast tank coatings life span can increase.

Re-growth of organisms in the treated ballast water can be avoided during extended ballast voyages. Since the efficacy of the inert gas/de-oxygenation BWMS is not dependent on ballast water salinity, temperature, turbidity or suspended solids, it can be a reliable treatment system. However, de-oxygenation technologies require additional fuel consumption (i.e., typically MGO due to potential impurities that could be added to the treated ballast water) during ballast voyages for treatment.

Other possible implications include safety considerations for tank entry for personnel making sure adequate ventilation is achieved for safe oxygen and carbon dioxide levels, oil and chemical carriers with hazardous areas might require the use of a large Deck Water Seal (DWS) to isolate the hazardous cargo area from the engine room, and required holding time to effectively achieve IMO or USCG discharge standards requirements which could affect the vessel voyage turnaround time and for smaller size vessels or vessels with ballast voyages shorter than the minimum holding time, such treatment methods might not be a practical option.

Other Technologies

Other technologies are sometimes used for ballast water treatment. For example, pasteurization, ultrasonic vibration, cavitation, and vacuum are sometimes used alone or combined with other treatment technologies for some BWMS designs.

IMO Basic and Final Approval

BWMS that uses active substances for treatment are required to undergo the Basic and Final IMO approval in accordance with the IMO G9 Guidelines - Procedure for Approval of BWM Systems that make use of Active Substances, MEPC.169 (57) to ensure that the BWMS pose no threats to the environment, human health, property or resources.

Appendix C contains a list of BWMS that received the IMO Basic Approval and Final Approval.

Section 4 | Approval of BWMS

Before engaging in a contract with BWMS manufacturers or when choosing a BWMS, shipowners and operators should verify that the system has achieved the appropriate Type Approval(s). IMO has developed a regime for BWMS Type Approval and requirements which are contained in IMO guidelines G8 - MEPC.174(58) and MEPC.279(70)), which will be superseded by Resolution.300(72) (BWMS Code) in October 2019, and G9 Guidelines. In 2012, the USCG developed an independent BWMS Type Approval regime that BWMS installed on vessels flagged or trade in the US waters must undergo.

Shipowners and operators should verify that any systems considered for installation on board their ships should have a valid Type Approval certificate. This certificate should:

- Identify the type and model of the system, related equipment assembly drawings and model specification numbers
- Include a reference to the full performance test protocol on which the approval is based and be accompanied by a copy of the original test results
- State the specific application for which the treatment system is approved, e.g. for specific ballast water capacities, flow rates, salinity or temperature ranges, or other limiting conditions or circumstances as appropriate

Type Approval of a ballast water management system should not be considered as an indication that the system will work for all vessels in all water conditions. Even after installing a type approved system, the owner or operator is still responsible for compliance to the discharge standards on a continual basis.

Shipowners should perform due diligence when selecting a BWMS suitable for their ships and trade routes. When selecting a BWMS, shipowners are cautioned to take note of limiting conditions of the BWMS and the tests and test results that the BWMS has undergone and results achieved.

In January 2019, the Organization updated the list of BWMS that have received Type Approval Certification by their respective Administrations. The list is available on the IMO website under Ballast Water Management. The updated list has 76 Type Approvals listed. However, some BWMS are cited multiple times on the list and some Administrations have not yet reported some BWMS Type Approval Certificates. Please refer to Appendix B of this Advisory for an updated list of BWMS Type Approval Certificates issued based on the updated IMO list and others known to ABS at the time of the Advisory update not yet provided to the Organization.

Revisions made to the Guidance for Administrations on the Type Approval process for ballast water management systems in accordance with the BWMS Code were approved and published as BWM.2/Circ.43/Rev.1 (10 May 2018). The Circular provides additional guidance for Administrations when determining the acceptability of system manufacturers, the use of third party's quality assurance programs during the approval process, and when verifying that a manufacturer is fully prepared to carry out the testing needed for type approval but is not intended, in any way, interfere with the authority of an Administration. The Circular also provides guidance on the details of the type approval to be reported to the Committee.

Approval Regime

IMO has prepared several guidelines to achieve consistency in the approval process:

- G8 – 2016 Guidelines for Approval of Ballast Water Management Systems (Resolution MEPC.279(70), which will be superseded by the BWMS Code (resolution.300(72)) in October 2019)
- G9 – Procedure for Approval of Ballast Water Management Systems that Make Use of Active Substances (Resolution MEPC.169(57))

- G10 – Guidelines for Approval and Oversight of Prototype Ballast Water Treatment Technology Programs (Resolution MEPC.140(54))

These guidelines outline the approval framework to provide uniform testing, analysis of samples and evaluation of test results. The G8 addresses the suitability and efficacy of the BWMS. The G9 is provided as a safeguard for the sustainable use of active substances and preparations and addresses the acceptability of any active substances and preparations for use in BWMS concerning ship safety, human health and the aquatic environment.

For BWMS that do not make use of active substances, the G8 guideline is applicable. For BWMS that makes use of active substances, G8 and G9 guidelines both are applicable.

The 2016 G8 Guidelines for Approval of Ballast Water Management Systems (G8), MEPC.279 (70), which supersede MEPC 174 (58) were approved during MEPC 71 and later on, adopted by means of a mandatory BWMS Code - MEPC.300 (72) during MEPC 72.

The BWMS Code specifies that BWMS, approved in accordance with:

- BWMS approved taking into account the 2016 Guidelines (G8) adopted by resolution MEPC.279(70) shall be deemed to be in accordance with the BWMS Code,
- that ballast water management systems approved not later than 28 October 2018, taking into account the Guidelines (G8) adopted by resolution MEPC.174(58), may be installed on board ships before 28 October 2020, and
- that, for the purpose of operative paragraph 4 of this resolution, the word "installed" means the contractual date of delivery of the ballast water management system to the ship. In the absence of such a date, the word "installed" means the actual date of delivery of the ballast water management system to the ship

The BWMS Code addresses aspects of the approval process, including the detailed requirements of land-based and ship-board testing of systems, and the approval and certification procedures.

A brief summary of the process for type approval from the BWMS Code is provided to inform the reader of this Advisory on the general process for BWMS testing.

- **Pre-test evaluation:** Documentation shall be submitted to the Administration and test organization in order to allow evaluation of the readiness of the BWMS for testing and to evaluate the manufacturer's proposed system design limitations (SDL).
- **Test and performance specifications:** Procedures for quality assurance and quality control procedures, shipboard and land-based testing procedures and requirements, BWMS scaling methods, evaluation of (organism) regrowth, and reporting of test results are provided in Part 2 of the Annex of the BWMS Code.
- **Environmental Testing:** Procedures for environmental testing of the BWMS are provide in Part 3 of the Annex of the BWMS Code.
- **Sample analysis methods (biological constituents).** Part 4 of the Annex of the BWMS Code provides procedures for biological test methods for ballast water during the BWMS testing.
- **Self-monitoring.** Part 5 of the Annex to the BWMS Code provides procedures for self-monitoring and software control of parameters of the BWMS and provides requirements for data recording and retrieval.
- **Validation of System Design Limitations (SDL).** Part 6 of the Annex to the BWMS Code provides requirements for validation of SDL's.
- **Type Approval Certificate and Type Approval Report.** Part 7 of the Annex to the BWMS Code provides requirements of the Type Approval Certificate and reporting to the Organization.

The following comparison Table 11 helps to summarize the requirements that was newly added in the new G8 Guidelines and identifies the similarities and differences between the old, new G8 Guidelines and USCG Final Rule/ETV Protocol.

Table 11. Comparison Table between MEPC.174(58), MEPC.279(70), and USCG/ETV Protocol

Items	MEPC.174(58)	MEPC.279(70), superseded by MEPC.300(72) by October 2019	USCG Final Rule/ETV Protocol
General Requirements			
Viable Organisms (Definition)	▪ Organisms and any life stages thereof that are living ▪ IMO uses the viable/unviable organism approach to measure the efficacy of the BWMS	▪ Organisms that have the ability to successfully generate new individuals in order to reproduce the species	▪ Refers to the old G8 Guidelines ▪ Final Rule uses the number of living organisms approach to measure the performance or efficacy of the BWMS
Report of Test Results for Shipboard Testing & Land-Based Testing (Specific Tests)	▪ Lack of detailed information and transparency that entail the methods of validation and the results of each treatment test cycle	▪ Reporting of the test results section has been updated ▪ Report requirements includes information from Resolution MEPC.228 (65), the USCG Final Rule and (ETV) protocol.	▪ Covered in the Final Rule and ETV Protocol
Type Approval Certificate	▪ Limited required information provided	▪ Inserted in a new Part 7 in the new G8 Guidelines ▪ More transparency to the Type Approval Certificate and Type Approval Report ▪ Additional Requirements: o System design limitations o Limiting operational conditions (Temperatures, Salinities) o Restrictions due to minimum holding time o Shipboard and Land-based test results.	▪ Conditions of approval applicable to the BWMS to be listed in the Type approval Certificate
System Design Limitations (SDL)	▪ No requirements	▪ Incorporated in Part 6 of the new G8 Guidelines ▪ Known as Critical Parameters ▪ To be identified by the manufacturer ▪ Validated minimum and maximum to be indicated in the Type Approval Certificate	▪ Similar to the new G8 Guidelines ▪ Conditions of approval applicable to the BWMS to be listed in the USCG Type approval certificate
Test Facilities	▪ Required to meet the International Recognized standard (ISO/IEC 17025) requirements ▪ A quality control/quality assurance program to be implemented ▪ Quality management plan (QAP)	▪ To be conducted by an independent facility accepted to the satisfaction of the Administration ▪ Requires a Test/Quality Assurance Plan (TQAP)) in addition to the QMP and QAPP	▪ Similar requirements to the new G8 Guidelines ▪ To be conducted by an independent laboratory (IL) designated by the USCG ▪ To be independent of the BWTS

	▪ Quality Assurance Project Plan (QAPP)		vendors/manufacturers
Control & Monitoring Equipment	▪ Limited to the monitoring of the treatment dosage or other aspect with regards to the operation of the BWMS	▪ Design requirements scope expanded ▪ Requires additional documentation (i.e., software change handling logbook, detailed functional description) ▪ Self-monitoring parameters to be recorded automatically for the performance and safe operation of the BWMS ▪ More emphasis placed on the storage and protection of the recorded data	▪ Design requirements covered in the ETV Protocol and Final Rule
Environmental Testing (Electronics Equipment and Components of BWMS)	▪ Specific requirements listed in Part 3	▪ Requires compliance with IACS UR E10, Rev.6, October 2014- Test Specification for Type Approval	▪ Requirements covered in 46 CFR 162.060-30 of the Final Rule
Installation Survey and Commissioning Procedures	▪ Provides Installation Survey and Commissioning Procedures	▪ Enhanced specification for required documentation ▪ Helps to assist the ship operators and Administration	▪ Covered in the Final Rule and ETV protocol
Bypass Arrangement	▪ Requires bypass alarms to be recorded in the Control Equipment	▪ Bypass events to be recorded in the Ballast water record book ▪ Requirements are in addition to the Control Equipment in the old G8	▪ Similar to the old G8 Guidelines
Land-Based Testing			
Challenge Water Types and its Salinity Range (PSU)	▪ < 3 PSU; 2 – 32 PSU; > 32 PSU	▪ Fresh (< 1 PSU; Brackish (10-20 PSU; Marine (28-36 PSU) ▪ Amended water salinity ranges to reflect different challenge natural water type conditions (i.e., shipboard environment) ▪ In line with ETV Protocol	▪ Fresh (< 1 PSU); Brackish (10-20 PSU); Marine (28-36 PSU)
Minimum Challenge Water Quality Characteristics • **Dissolved Organic Carbon (DOC)** • **Particulate Organic Carbon (POC)** • **Total Suspended Solid (TSS)**	• No augmentation requirements	▪ Varies with Salinities ▪ Requires validation for augmenting the test water with DOC/POC/TSS effects (i.e. UV absorption, oxidation demand, TRO decay, particle size distribution of suspended solids) ▪ Allows assessment of the impact of TSS and the DOC source on the BWMS	▪ Allows the augmentation of the challenge water using the DOC/TSS/POM ▪ Source of augmentation to be validated by the Test Facility (TF)
Standard Test Organism (STO)	▪ Naturally occurring in the challenge test water or cultured species added to the challenge test water	▪ Supplemental use of STO to ensure adequate robustness in Land-based testing is introduced	▪ Allows ETV recommended STOs to be replaced with other test organisms

		▪ Requires procedures and guidance, together with an assessment on the use of STO to be reported in the test report	▪ Requires sufficient experiments to be conducted, with supporting documentation to validate the use of alternative test organisms
Consecutive Testing/Test Cycles	▪ Five valid test cycles, for any two salinities (with Δ10 PSU)	▪ Five consecutive valid test cycles (D-2 compliance) for each of the three water salinity ranges (i.e., Fresh, Brackish & Marine water).	▪ Five consecutive, valid, and successful replicate test cycles for the salinity range for which the BWMS will be approved (Final Rule) ▪ Minimum of 3 valid test to be conducted for at least 2 salinity conditions (ETV Protocol)
Minimum Holding time	▪ ≥ 5 days	▪ Minimum holding time to be determined by the BWMS Manufacturer (D-2 Compliance) ▪ ≥ 5 days (Evaluation of Regrowth)	▪ ≥ 1 day ▪ Shorter or longer tank hold times may be utilized (To be justified in the TQAP)
Sample volume for organism enumeration ▪ Organisms ≥ 50 µm ▪ 50 µm > Organisms ≥ 10 µm ▪ Bacteria	▪ 3 sampling replicates to be collected for the influent, control and treated water ▪ Sample collection are to take place over a period of uptake and discharge of the tank (e.g., beginning, end, middle) for each test cycle	▪ 1 continuous time integrated sample ▪ In line with the ETV Protocol	▪ Sample collection replicates are based on Time- integrated sample volumes collected during each test cycle.
Methods for Counting	▪ No specific methods listed	▪ No specific methods listed	▪ Recommended test methods are based on organism sizes
Shipboard Testing			
Temperature Assessment of the BWMS from operating in cold and tropical conditions	▪ No requirement specified	▪ Requires testing over a range of temperatures from 0 to 40 °C (2 to 40 °C for fresh water) and a mid-range temperature of 10 to 20 °C	▪ No requirements for a specific temperature range ▪ Testing to include temperate, semi-tropical, or tropical locations with ambient organism concentrations ▪ Temperature to be measured for each test cycle
Consecutive Testing/Test Cycles	▪ 3 consecutive valid test cycles (D-2 compliant) ▪ Span over a period of no less than 6 months ▪ Invalid test cycles do not affect consecutive sequence	▪ Same requirements as per the old G8 Guidelines	▪ 5 consecutive valid test cycles ▪ Span over a period no less than 6 months ▪ Unsuccessful test cycles are to be

			recorded in the Test report.
Scaling of BWMS	▪ No specification	▪ Most vulnerable models to be identified ▪ Mathematical modelling and/or calculations to demonstrate that any scaling of the BWMS will not affect the functioning and effectiveness on board the ship ▪ Requires further validation during Shipboard testing at the upper limit of the rated capacity	▪ No requirements for shipboard scaling
Volume & Operational Testing period	▪ To be consistent with the normal ballast operations of the ship ▪ To operate at the treatment rated capacity for which the BWMS is intended to be approved	▪ Same as per the old G8 Guidelines ▪ Requires documentation to justify continuous operation of the BWMS throughout the test period (i.e. ballasting and de-ballasting)	▪ Volume and operational flow rate are representative of the upper end of the treatment rated capacity for which the BWMS is intended to be used ▪ Vessel tank size and flow rates are to be equal to or exceed those used during land-based tests
Shipboard Operation	▪ No requirement	▪ Operated and maintained by the ship's crew	▪ Operated by ship's crew
Sample Volumes	▪ 3 sampling replicates to be collected for the influent, control and treated water ▪ Sample collection over a period of uptake and discharge of the tank (e.g, beginning, end, middle) for each test cycle)	▪ Single, continuous time-integrated sample or composite ▪ Sample collection at intervals over a duration of uptake and discharge (e.g: beginning, middle, end of operation) for each test cycle ▪ Use of control tank samples or control water in shipboard testing is no longer required, except for land-based testing	▪ Specifies in-line sample port/facility for sample collection.

The BWMS Code is intended to increase the transparency to the Type Approval process, to provide more detailed and prescriptive requirements of areas such as validation of SDL's, evaluation or regrowth, control and monitoring system requirements, test facilities, and reporting of test results.

The G9 guidelines, applicable to BWMS that make use of active substances, consists of a two-tier process (i.e., Basic Approval and Final Approval). G9 guidelines are provided to ensure that the BWMS does not pose unreasonable risk to the environment, human health, property or resources. The Administration approving a BWMS makes the decision whether a BWMS makes use of active substances or not and whether the BWMS needs to make a proposal for approval to IMO in accordance with the G9 guideline.

Testing for Basic Approval is conducted in a laboratory under conditions simulating ballast water discharge. Basic Approval confirms that no unacceptable adverse effects, or potential unreasonable risks to the environment, human health, property or resources exists and screens for persistency, bioaccumulation and toxicity. Final Approval confirms the risk evaluation and addresses concerns identified during the Basic Approval process. In addition, a risk evaluation is performed to qualitatively account for the cumulative effects that may occur due to the nature of shipping and port operations.

The Basic and Final approval processes involve an Administration review and a review by the UN sponsored Joint Group of Experts on the Scientific Aspects of Marine Environmental Protection – Ballast Water Working Group (GESAMP-BWWG). The GESAMP-BWWG makes recommendations to the IMO MEPC on the approval of the BWMS.

Once the technical review and testing are completed to the satisfaction of the Administration who now holds sufficient evidence that the quality assurance program employed by the manufacturer indicates the equipment can be produced consistently to the required specification, a Type Approval certificate may be issued. When a type approved BWMS is installed on board a vessel, an installation survey is conducted to confirm that the system has been installed as designed, is ready for operation, and conforms to the Type Approval certificate. Upon successful completion of the installation survey, a BWM certificate may be issued as required by the Convention.

To encourage the development of new ballast water treatment technologies, the Convention also includes an allowance for short term approval of a BWMS for prototype testing (in accordance with G10 guidelines). For any ship that participates in a prototype testing program, the requirements of Regulation D-2 shall not apply until five years after the date the equipment was installed or five years after the date on which the ship would otherwise be required to comply with D-2, whichever is later.

USCG Approval Procedures

The USCG regulations for engineering equipment in 46 CFR Part 162 establish specific procedures and requirements for approval of BWMS to be installed on board vessels for the purpose of complying with the USCG discharge standards in 33 CFR Part151, subparts C and D. In addition to achieving the discharge standards, BWMS are to comply with specific design and construction requirements and have appropriate control and monitoring equipment, adequate arrangements for hazardous materials, active substances, preparations and/or pesticides.

BWMS has two paths to obtain USCG Type Approval: existing test data from Type Approval testing for a foreign Administration or test data from an independent laboratory (IL) accepted by the USCG. Manufacturers can seek USCG Type Approval of a BWMS on the basis of existing data and information generated for Type Approval by another Administration in accordance with the IMO BWM Convention. In this case, the manufacturer will contact an IL to evaluate and explain to what degree the existing data and information satisfy USCG requirements. The USCG has stated that many foreign-approved BWMS will require additional testing and analysis, but the process to secure USCG approval should be shorter than if the manufacturer were required to repeat all testing.

For new testing, applications for Type Approvals must be submitted under the auspices of a USCG accepted IL. USCG accepted ILs are to evaluate, inspect, and test BWMS. All test plans and land-based testing must meet the requirements of the Final Generic Protocol for the Verification of Ballast Water Treatment Technology (ETV Protocol). In general, the ETV Protocol is consistent with the BWM Convention but includes more detailed requirements and evaluates many more aspects (i.e., biological treatment performance, cost, predictability) of a treatment system than the G8 guideline.

On the 2nd December 2016, USCG issued the very first Ballast Water Management System Type Approval Certificate to the Norwegian manufacturer Optimarin AS, which has successfully met the more rigorous USCG requirements of 46 CFR 162.060.

Optimarin's BWMS, the Optimarin Ballast System (OBS), is a non-active ballast water management system which utilizes the technology of back flushing filters and UV irradiation to inactivate marine organisms, viruses and bacteria, with treatment capacities ranging from 167 m^3/h to 3,000 m^3/h.

The availability of the first USCG Type approved BWMS marks an important breakthrough for the marine industry, to finally have a BWMS that can now meet the ballast water requirements for both IMO and USCG (globally accepted) with respect to the prevention of the spreading of aquatic invasive species into non-indigenous waters.

To cater to the different needs of the shipping industry, in terms of addressing the threat of harmful aquatic invasive species, the USCG is continuously evaluating BWMS that are submitted by different manufacturers.

As of 02 May 2019, there are 18 USCG approved BWMS. Three of the approved BWMS are seeking additional modifications to their approval certificates. Eight other BWMS have submitted for USCG TA application and are now pending review by the USCG.

Table 12. List of USCG MSC BWMS Type Approvals

USCG Type Approved BWMS
OBS by Optimarin AS
PureBallast 3 by Alfa Laval AB
TeamTec OceanSaver MK II BWTS by TeamTec OceanSaver AS
SunRui BalClor BWMS by SunRui Marine Environment Engineering Co., Ltd.
Ecochlor BWTS by Ecochlor, Inc.
ERMA FIRST FIT BWTS by ERMA FIRST ESK Engineering Solutions S.A.
Electro-Cleen System by Techcross Inc.
Purimar BWMS by Samsung Heavy Industries Co., Ltd.
BIO-SEA B BWTS by BIO-UV SAS
AQUARIUS EC BWMS by Wärtsilä Water Systems Ltd.
HiBallast BWTS by Hyundai Heavy Industries Co., Ltd.
OceanGuard BWMS by Qingdao Headway Technology Co., Ltd.
BallastAce BWMS by JFE Engineering Company
GloEn-Patrol BWMS by Panasia Co., Ltd.
BALPURE BWTS by De Nora Water Technologies
inTank BWTS by Envirocleanse, LLC
CompactClean BWMS by DESMI Ocean Guard A/S
AQUARIUS UV BWMS by Wärtsilä Water Systems Ltd.

Table 13. USCG BWMS Approvals Pending Review

Application Under Review
NK-O3 BlueBallast II by NK BMS Co., Ltd.
NK-O3 BlueBallast II Plus by NK BMS Co., Ltd.
Evac Evolution by Cathelco Ltd.
Electro-Cleen System by Techcross Inc.
L-UV BWTS by Semb-Eco Pte, Ltd.
HK-S(E) BWMS by Miura Co., Ltd
PureBallast 3.2 by Alfa Laval AB
CompactClean BWMS by DESMI Ocean Guard A/S
EcoBallast BWTS by Hyundai Heavy Industries Co., Ltd.
HK-E(C) BWMS by Miura Co., Ltd
BALPURE BWTS by De Nora Water Technologies

The USCG Marine Safety Center type approval status of BWMS can be reviewed at: https://www.dco.uscg.mil/Our-Organization/Assistant-Commandant-for-Prevention-Policy-CG-5P/Commercial-Regulations-standards-CG-5PS/Marine-Safety-Center-MSC/Ballast-Water/ by selecting the "Approved BWMS and Status of Applications" link.

The copies of the USCG type-approved BWMS Certificates could be retrieved from the following link http://www.dco.uscg.mil/msc/Ballast-Water/TACs/, or by visiting the USCG Approved Equipment List at: http://cgmix.uscg.mil/Equipment/Default.aspx.

Further, as of October 2018, the USCG has already received over 50 Letters of Intent (LOI) from the ballast water equipment manufacturers indicating their intention to conduct the USCG type approval testing for their Ballast water management system.

For a full list of BWMS manufacturers who have submitted a LOI to the USCG Marine Safety Center, the information can be accessed from the USCG home port website at https://www.dco.uscg.mil/Our-Organization/Assistant-Commandant-for-Prevention-Policy-CG-5P/Commercial-Regulations-standards-CG-5PS/Office-of-Operating-and-Environmental-Standards/Environmental-Standards/ followed by Type Approval – Letters of Intent (LOI).

The USCG homeport website also allows access to other Ballast water related information which includes but are not limited to BW regulatory aspects, bulletins, policy letters, and practicability review.

Extended Compliance Date

The 2012 Ballast Water Regulations, Title 33, Code of Federal Regulations Part 151, Subparts C and D allows vessels to apply for an extension to the original compliance date (See Table 6- USCG Ballast water discharge standards implementation schedule of this Advisory), provided that they are able to present documentary evidence showing that despite exhausting all possible efforts, the vessel is still unable to implement an approved Ballast Water Management (BWM) methods by its original Compliance date.

With an approved USCG extension letter, the vessel may continue to operate using ballast water exchange when trading in U.S waters until the extended compliance date as indicated in the letter.

However, the USCG extension policy has changed over the last few years. In more recent years, particularly with the increased number of USCG approved BWMS being available, It is clear that the USCG has evolved from implementation to enforcement of compliance to the USCG BW requirements.

Due to the lack of USCG-approved BWMS being available, vessels with scheduled drydocking dates in 2016 or 2017 were able to obtain a USCG extension to defer the installation of the BWMS until the next scheduled drydocking (typically five years for many vessels less than 15 years old). As the USCG approved BWMS became available, the extension periods for vessels with drydocking dates in 2018 was reduced from 5 years to typically 30 months.

USCG has made it clear in their Navigation and Vessel Inspection Circular (NVIC 01-18, Ballast Water Management for Control of Non-Indigenous Species in Waters of the United States (March 2018)), that shipowners should not anticipate that the extension period will be granted for more than 12 months since the currently approved available USCG BWMS are now able to cover nearly all classes of vessels, and are compatible with most operational requirements.

To increase the chances of obtaining a USCG extension, the extension applications to USCG should now include strong substantial evidence and documentation supporting the acquisition of a system, a specific date of installation not more than 12 months past the vessel's compliance date (or date of extension request) and demonstrate that the selected Ballast Water Management System (BWMS) is expected to receive type approval.

Further, the USCG has also made it more difficult to obtain an extension if an AMS accepted BWMS is selected. Additionally, if an AMS accepted BWMS is to be replaced, it is not allowed to be with another AMS accepted BWMS.

Another key point to note, is the request to the USCG with respect to the extended compliance date due to slippage of next scheduled drydocking dates. Until recently, the USCG would generally edit the extension letter to provide the same type of extension by simply pushing out the dates based on the three-month drydocking delay. However, with the change of the USCG extension policy, the USCG would now revise the extended compliance date out by 30 months by issuing a new extended compliance date with fixed end date.

The end result from this policy shift is, if the vessel has a 60-month extension following the next drydocking from a previously issued extension letter, the owner is advised to carefully consider the 30-month penalty with the new policy versus the added benefits of delaying the drydocking by 3 months to complete the last charter opportunities.

With the issuance of NVIC 01-18, significant policy changes for vessels with drydocking dates in 2019 and onwards, where USCG extension may be increasingly reluctant difficult to approve the extension requests. The extensions should not be expected to align with the normal out of service periods or even the intermediate survey period. This would indicate that for vessel trading in both International water and US waters, early installation of the BWMS to meet the USCG compliance date may be required. If the USCG BWDS original or extended compliance date falls before the IMO D-2 compliance date, the shipowner will need to make an economic decision for the vessel.

More information on the latest USCG guidance and extension policy as provided in Navigation and Vessel Inspection Circular 01-18 and USCG Maritime Commons article (A closer look at NVIC 01-18 and BWMS compliance date extensions), please refer to the following link:

- *http://www.dco.uscg.mil/Portals/9/DCO%20Documents/5p/5ps/NVIC/2018/NVIC-01_18.pdf*
- *http://mariners.coastguard.dodlive.mil/2018/03/07/3-7-2018-a-closer-look-at-nvic-01-18-and-bwms-compliance-date-extensions/.*

The list of the current status of the vessels USCG BWM extension request could be downloaded through the U.S Coast Guard Homeport website: https://www.dco.uscg.mil/Our-Organization/Assistant-Commandant-for-Prevention-Policy-CG-5P/Commercial-Regulations-standards-CG-5PS/Office-of-Operating-and-Environmental-Standards/Environmental-Standards/, under the BW Regs and Policy.

Alternate Management Systems (AMS)

A BWMS accepted as an AMS is not a USCG type approved system. The AMS acceptance program was included in the USCG final rule to provide BWMS implementation as an alternate to BWE before USCG approved BWMS were available.

The USCG announced the acceptance of the first AMS in April 2013. The total number of USCG issued AMS Acceptance letters, for foreign administration approved ballast water management systems (BWMS) now stands over 60, as of January 2018.

The USCG AMS acceptance letters contain details on the acceptance and limitations of systems and are available from BWMS vendors. The USCG Ballast Water Management website (https://www.dco.uscg.mil/Our-Organization/Assistant-Commandant-for-Prevention-Policy-CG-5P/Commercial-Regulations-standards-CG-5PS/Office-of-Operating-and-Environmental-Standards/Environmental-Standards/AMS/ contains a link to the list of accepted AMS.

The AMS program was intended as a bridging strategy to allow foreign type approved BWMS to be installed and operated on vessels for a limited amount of time. An AMS must be installed prior to the vessel's original or extended compliance date and may be used for a maximum of five years after the date that the vessel is required to be in compliance with USCG ballast water discharge standards. The USCG stated that this interim measure would allow BWMS vendors or manufacturers sufficient time to obtain USCG Type Approval without penalizing vessel owners for having been early installers.

BWMS vendors (not shipowners or operators) must submit an application for AMS determination that includes the foreign Administration's Type Approval certificate and G8 test reports, testing protocols, and testing results. The USCG examines the AMS application and determines if the BWMS is accepted as an AMS. When accepted as an AMS, the USCG provides BWMS vendors with a letter of acceptance that includes conditions for use of the BWMS. For example, an AMS acceptance letter includes limitations on salinity for which the BWMS may be used in US waters.

In NVIC 01-18, the USCG indicated no extension would be granted to a vessel with an installed AMS or with plans to install one onboard.

The installed AMS must obtain a USCG Type approval in order to continue operations beyond the five years period from the vessel's compliance date. If the installed AMS does not receive USCG approval by that time, the vessel would have to install an approved USCG BWMS or us another USCG approved BWM compliant method. Otherwise, the ship would not be allowed to discharge ballast water to U.S. waters with the expired AMS accepted BWMS installation.

In the event that the AMS becomes inoperable during the five years acceptance period and that a suitable USCG approved BWMS is available, the inoperable AMS is to be replaced with either the suitable USCG approved BWMS or an AMS with the same identification number and model, but not a different AMS.

A vessel owner may choose to install an AMS instead of a USCG approved BWMS. However, documentation or evidence showing that the existing USCG approved BWMS is not suitable for the vessel at the time of the installation of the AMS is to be provided and retained onboard the vessel.

Practicability Review

Pursuant to the USCG ballast water regulations, the USCG undertook and published the results of the Practicability Review of Ballast Water Discharge Standards in May 2016.

The objective of the USCG's practicability study was to determine if technology to comply with a performance standard more stringent than that required by 33 CFR 151 Subparts C and D could be practicably implemented.

The review studied the availability of testing protocols that could assure accurate measurement of compliance with a more stringent performance standard; and could be practicably implemented.

The results from the USCG's Practicability review, concluded that, at the time it was published, technology to achieve a significant improvement in ballast water treatment efficacy onboard vessels could not be practicably implemented.

The reason for drawing this conclusion, was that, there was no availability of data demonstrating that ballast water management systems (BWMS) could meet a discharge standard more stringent than the existing performance standards, as of the date of the Practicability Review.

Full information on the USCG Practicability Review- Standards for living organisms in ships' ballast water discharged in U.S. waters can be found in the U.S Coast Guard Homeport website, under the BW Regulations and Policy Documents:
https://www.dco.uscg.mil/Portals/9/DCO%20Documents/5p/5ps/Operating%20and%20Environmental%20Standards/OES-3/Regs%20and%20Policy/BWMS%20-%20Practicability%20Review%20(Final).pdf?ver=2018-02-05-131156-040.

Most Probable Number (MPN) Method

On 14 December 2015, the USCG Marine Safety Center (MSC) declined requests from four UV BWMS manufacturers to use the Most Probable Number (MPN) based method as a testing alternative; as being equivalent to the test method as stipulated in the USCG's regulations with respect to the type approval of ballast water systems.

The four UV manufacturers went forward to appeal the USCG MSC's decision, requesting the reconsideration of the MPN-based method, which was widely accepted as an appropriate test method for all BWMS, as being equivalent to the test method as stipulated in the ETV Protocol. However, the Most Probable Number (MPN) based method was determined not be equivalent to the testing method described in the USCG's regulations (the provisions of 46 C.F.R. § 162.060-10(b)(1) with respect to the type approval of ballast water systems.

their appeals were officially rejected on 12 July 2016 with the USCG issuance of the final Agency action.

As required by the USCG regulations for BWMS type-approval, the efficacy of the BWMS is to be evaluated based on the standard of live/dead organism enumeration which is the ability of the BWMS to kill certain organisms, instead of the viable/unviable approach allowed by the IMO BWM Convention and the Convention Guidelines.

The manufacturer's proposed MPN-based test method, instead, evaluated the viability of an organism to colonize after the treatment process. The USCG did not recognize this as a similar approach to measure the efficacy of the BWMS to the performance standard required by the USCG's regulations pertaining to the type approval of ballast water systems.

The denial of the Most Probable Number (MPN) based method to be used as a form of an alternative testing method by the USCG caused UV-based BWMS vendors to add power and reduce TRC of their BWT equipment.

Shipowners whose vessels have already been fitted with low power consumption UV-based BWMS having been issued an IMO Type Approval Certificate should be covered for a period of time by the AMS acceptance period. However, recent developments (i.e., VIDA) may allow the BWMS vendor to retest their equipment to meet revised USCG compliance standards if the USCG accepts the MPN method in the future.

For UV-based BWMS, to meet the current USCG requirements, requires more treatment dosage to killing the organisms within the minimum hold time assigned by the USCG in the approval certificate. The increased UV dose requires higher UVI – thus increases the BWMS power demand.

Key affected factors include considerable financial costs involved for removing the UV-based BWMS system if the existing system is deemed not approved; exceeding existing auxiliary engine/generator excess power available to meet the increased power demand; higher operational cost as a result of higher energy consumption; limited cost-effective and chemical free options, and a possible increased footprint for larger BWMS.

Section 5 | Selection of Most Appropriate BWM System for Retrofit Vessels

After shipowners or operators have determined that a BWMS is needed for their vessels for compliance with ballast water regulations, identifying the “best” BWMS to install on a vessel is an important decision. The shipowner or operator must evaluate various factors and determine which system best meets the demands of the ship by balancing costs and the impact to the ship operations.

A shipowner or operator needs to evaluate the following factors:

- Ports of call and operational areas
- Necessary approvals
- Vessel-specific information
- Materials, equipment protection (IP rating) and hazardous spaces
- Technology preferences
- Installation considerations
- Life cycle costs
- Vendor qualifications and reputation

Ports of Call and Operational Areas

A vessel owner needs to assess where the vessel will need to operate and load ballast to identify potentially suitable BWMS for at least two reasons:

- Some ports have specific requirements for BWMS
- Characteristics of the ambient water determine BWMS suitable technology options

The vessel’s service or trade rout requirements are critical for BWMS selection. Some ports have established specific requirements. For example, vessels discharging ballast water in US waters will be required to have a USCG type approved BWMS (or AMS accepted during the vessel’s as well as follow additional local discharge limits (some States), and follow additional US-specific recordkeeping and reporting, as well as US EPA VGP monitoring. Section 1 and Section 2 provide information on areas where specific requirements may need to be achieved for a vessel.

In addition to regulatory requirements, ambient water quality varies between ports. Turbidity, salinity and temperature impacts the operation and performance of the BWMS. Shipowners and managers need to verify the water quality under which a BWMS was tested. If regular port calls will be made (or are planned) to areas with water quality that would challenge the performance of the BWMS (i.e., fresh or cold water, high total suspended solids, etc.), the treatment technology should have been tested in similar conditions.

The list of ports developed by the owners and managers should include as many potential areas as possible to best estimate the number of annual ballast water operations that may not be possible due to water quality challenges. If contingency measures required because of challenges from planned BWM operating ports is too expensive or not an acceptable operating option, then the owners or managers should select a different BWMS.

Necessary Approvals (Administration Approvals)

First and foremost, a vessel must confirm any BWMS considered has received a Type Approval from an appropriate authority (i.e., flag Administration). In general, most Type Approval certificates state the BWMS is found to comply with the G8 Guidelines. Ships with type approved BWMS may be issued an International BWM certificate upon a successful onboard functional test (or, if the Administration requires, commissioning testing). Some flag Administrations may develop their own Type Approval procedures resulting in additional Type Approval certificates required for some ships. For example, ships discharging ballast water to US waters will be required to possess a USCG approved BWMS.

A certificate of Type Approval from a flag Administration indicates that, under proscribed test conditions, the system achieved the discharge standards. The only systems lacking Type Approval certificates are prototype systems or systems being tested for Type Approval.

When evaluating a BWMS, shipowners and shipyards need to request a copy of the BWMS Type Approval certificate and data from testing of the system.

The Type Approval certificate that includes the latest amendments introduced in the revised BWMS Code per resolution MEPC.300(72) – including all references to the 2016 G8 Guidelines per resolution MEPC.279(70) should clearly indicate:

- Name of BWMS
- Manufacturer of BWMS
- Type and model designation of BWMS
- Equipment/assembly drawings
- Manufacturer of additional equipment (if any)
- Treated Rated Capacity (TRC) Limiting conditions (temperature/salinity)
- Limiting operating conditions imposed on the BWMS
- Other restrictions imposed
- System design operating conditions – system design limitations (SDL) per BWM.2/Circ 69.
- Reference made to the full performance test protocol
- Reference made to the previous Type approval (If the current Type Approval Certificate is issued based on that approval)
- Test results of each land-based and shipboard test cycle

Shipowners should review the SDLs in the Type Approval certificate to determine if the limiting conditions would excessively impact the ship's use of the BWMS. The BWMS is considered in compliance when limiting conditions are not exceeded.

A copy of the original test results should be included with the Type Approval certificate. The shipowner and shipyard should review the data for the test conditions (i.e., salinity, water temperature, UV intensity, etc.) to ensure the BWMS was tested in conditions important to the ship's planned operations. For example, ships that ballast and de-ballast freshwater should verify that the BWMS was tested in freshwater and that the BWMS is approved for operation in freshwater.

Vessel-specific Information

To effectively identify the most appropriate system for a specific ship, several important operating and design factors should be considered. Shipowners and operators should evaluate the type of ship, ballast water capacity, power available, available installation spaces and other post-installation operating details.

Ship Type and Capacity

The ship ballasting characteristics are an important factor in selecting a suitable treatment system. Some ships are high ballast dependent, such as tankers and bulkers, and some are low ballast dependent ships, such as containerships, general cargo ships and cruise ships. The determination of whether a ship has a high or low ballast dependency is based upon the ballast demands, such as the maximum amount of discharge at any one port, pump capacities, and maximum ballast flow rates. Table 14 lists the representative ballast water capacity and ballast pump rates for a variety of vessel types.

Table 14. Ballast Water Capacity and Ballast Pump Rates by Vessel Type

Vessel Category	Vessel Type	Representative Ballast Capacity (m^3)	Representative Pump Rate (m^3/hr)
High Ballast Dependent Vessels	**Bulk Carriers**		
	Handy	18,000	1,300
	Panamax	35,000	1,800
	Capesize	65,000	3,000
	Tankers		
	Handy	6,500	1,100
	Handymax-Aframax	31,000	2,500
	Suezmax	54,000	3,125
	VLCC	90,000	5,000
	ULCC	95,000	5,800
Low Ballast Dependent Vessels	**Containerships**		
	Feeder	3,000	250
	Feedermax	3,500	400
	Handy	8,000	400
	Subpanamax	14,000	500

	Panamax	17,000	500
	Postpanamax	20,000	750
	Other Vessels		
	Chemical Carriers	11,000	600
	Passenger Ships	3,000	250
	General Cargo	4,500	400
	Ro/Ro	8,000	400
	Combination Vessels	7,000	400

As illustrated in Table 14, a wide range of ballast capacities and pumping rates exist for commercial vessels. High ballast dependent vessels need to ballast in a fixed time period to facilitate rapid port turnaround times – typically 12, 18 or 24 hours for ballast operations. The low ballast dependent vessels generally have smaller ballast capacities, and their pumps do not typically have to handle the full ballast capacity on a regular basis. Ballast is often shifted from one tank to another to adjust trim or heel, rather than a full ballasting operation when offloading vessel cargo.

Ballast Water Management Practices

Selection of the proper BWMS depends on the treatment rated capacity (TRC) of the BWMS and the total volume of ballast water to be managed. Vessels may be required to treat additional ballast water for the heavy ballast condition. If ballast water discharges can be reduced or eliminated by the vessel in-port operations, then the TRC of the BWMS might be reduced. For example, many containerships rarely need to discharge large volumes of ballast water during typical operations. Another case of ballast management practices to reduce BWMS TRC's is a bulk carrier.

Some bulk carriers have high rates of cargo loading and significantly lower rates of cargo off-loading. During cargo off-loading the vessel might only need to use one ballast pump but require multiple pumps for loading of cargo. Some BWMS, especially those with one treatment technology for ballasting and a different treatment technology for de-ballasting, can provide higher de-ballasting TRC and reduced ballasting TRC. For example, if an EC-based BWMS is selected, the de-ballasting neutralization-only treatment can be provided with a larger neutralization sub-assembly (sized for multiple pumps) and the EC system, used only for ballasting, can be sized for a single pump and in some cases, other ballast pumps. This ballast water management strategy can provide a BWMS solution with reduced cost impacts to the owners.

Another ballast factor influencing choice of BWMS is accumulated mud and silt in the ballast tanks. Sediment can harbor invasive species even when the tank is empty (i.e., NOBOB – no ballast on board condition). Even if loaded locally, when mixed with remaining silt and sediments in the tanks, ballast can lead to contamination leading to out of compliance ballast water. This may require re-treatment of ballast water, or specialized contingency measures to allow compliant discharge. If mud accumulation is properly managed and the tanks are cleaned regularly, noncompliance problems may be reduced. For those ships constructed in or after 2009, compliance with G12 guidelines is to be applied.

Turbidity, salinity and temperature can impact the operability and efficacy of a BWMS. Other major causes of poor performance are improper or insufficient maintenance and calibration of the BWMS. If operations at ports with challenging water are planned, the owner/operator should consider other technologies to resolve this issue.

Ballast System Configuration

Besides ballast capacity, other vessel particulars (especially for some specific ship types) also influence the selection of BWMS. These features include the number of separate ballast systems (e.g., oil tankers often have two: one for the forward segregated ballast and one for the after peak tank (APT), use of stripping eductors to remove un-pumpable ballast water during de-ballasting, and gravity-only dumping of some topside ballast tanks (TSTs).

The BWMS needs to be evaluated to determine if all aspects of the vessel's ballast system configuration are capable of being properly treated by the technologies used by the BWMS. For some complex operational scenarios the shipowner or operator may need to contact the flag State.

Power Demand and Energy Consumption

Electrical power demand and energy consumption by a BWMS may be a significant issue for some ships, most often for retrofits. Power demand and energy consumption are often misunderstood and communication from vendors to prospective BWMS owners is often imprecise. Power is required by the BWMS (i.e., operating power demand). The prospective owner of a BWMS must understand the differences between typical operating demand and maximum power demand of the BWMS being considered. For newbuild vessels, the designer will accommodate the power demand management of the BWMS.

However, for retrofits, in order to gain class approval for the BWMS installation, the vessel must have enough available power to meet the maximum power demand of the BWMS. This may result in running all three auxiliary engines/generators in order to operate the BWMS under its maximum power demand conditions. This could result in a BWM challenge for the vessel if any single auxiliary engine is out of commission or not available. Some BWMS can operate at reduced power, but only in some water conditions.

The reduced "typical" operating power demand can be used to estimate energy costs for the BWMS operations, but the owner should understand that the BWMS may not always operate at the reduced power demand, and energy costs could be ignorantly more than estimated. Estimating the operating expenses (OPEX) of a BWMS requires a calculation based on understanding typical power demand, water conditions, rated TRC and probable or actual flow rates, and total ballast water treated (or re-treated for some technologies).

Electrical power is often the primary OPEX for BWMS. In contrast, treatment systems that use chemical dosing of active substances (i.e., chemicals purchased ready for use or stored precursor chemicals) that are mixed *in situ* and dosed during ballasting may have reduced electrical power demands and energy costs but these systems might require larger storage tanks, additional chemical handling, and mixing. For these systems, chemical costs are typically the predominant OPEX.

Installation Space Required and BWMS Weight

BWMS are available in configurations conducive for retrofits. For newbuild vessels, the vessel designer must accommodate the BWMS size and weights. The space requirements can vary from a few to more than 25 m^2 for a small BWMS (i.e., TRC of 200 m^3/h) and more than 50 m^2 for larger systems (i.e., TRC of 4,000 m^3/h). Most BWMS models increase in size as ballast capacity increases but the increased size may not be linear.

Another important space consideration is the changes to the vessel's ballast piping. When the BWMS requires new branch lines or bypasses to be installed, greater impacts on the space requirements should be understood. Large diameter piping with large elbows and tee fittings can require much additional installation space. In some ships, ballast piping retrofits can complicate retrofit installations because of the added space required for the large piping revisions. This is typically caused by selecting full flow treatment systems (i.e., full-flow EC or UV-based BWMS especially those using ballast water filtration). In addition to large retrofit piping pieces, additional piping supports will be required. Some BWMS are available that can reduce piping revisions (i.e., side-stream EC or chemical dosing BWMS).

In addition to the size of the BW Treatment Equipment (BWTE), the BWMS with modular sub-assemblies can reduce the installation challenges. Larger skid-mounted assemblies may not fit into existing spaces typically required for retrofit installations. Lifting and setting smaller BWTE sub-assemblies can reduce installation costs and reduce time required for the retrofit. The systems that can be provided as smaller modules that can be located in multiple spaces can provide more options to the installation designer. Some BWMS provide the BWTE that requires complete on-site assembly. While this might require additional time to assemble the system, the assembly typically requires fewer personnel. This method can help further alleviate additional hull or deck cutting for BWTE installation access.

In addition to the BWTE, the space required for installation should be carefully checked for maintenance space requirements. Improper review can result in interference when opening BWMS components for removal/replacement of internal components (i.e., ladders, supports, or piping in the way). Some BWMS require significant chemical storage space. Chemical restocking routes (i.e., pier to the ship's deck and from the deck to the storage locker, etc.) as well as from the storage locker to the chemical mixing or point of application should be carefully reviewed. Chemical storage locations may require additional safeguards, such as a specific firefighting system or enhanced ventilation.

Materials, Equipment Protection (IP Rating) and Hazardous Spaces

A BWMS must meet all requirements for shipboard materials, equipment protection and hazardous space safety. The materials used in the system components and the level of equipment protection (IP rating) provided should be reviewed during the Type Approval and certified in compliance with the class requirements. One important aspect of this review is when the BWTE is considered an "essential" system. In those cases, some materials such as plastic piping may not be allowed.

Additionally, specific remotely operated valves and other components may be required. These challenges do not normally cause problems for shipowners unless higher performance specifications are required. BWTE components are normally reviewed and specified by shipowners during BWMS selection.

An understanding of rules and regulations is important to specifying the BWTE components of a BWMS. Most often, electrical equipment installed in hazardous spaces is more challenging to prospective BWMS owners. Not all BWMS vendors Explosion proof (i.e., Ex) models and some Flag-specific limitations imposed on electrical components can lead to some owners being forced to select an alternate BWMS.

For installations in the engine room, the electrical components can have more flexible certifications. Class and statutory requirements limit the electrical equipment that can be installed in a cargo pump room and other hazardous spaces.

The application of the International Standard International Electrotechnical Commission (IEC) 60092-502 *Electrical Installations in Ships – Part 502: Tankers – Special Features* referenced by SOLAS Regulation II-1/45.11 for ships constructed on or after 1 January 2007, is generally less restrictive on the certification of electrical equipment than traditional classification society rules.

The installation of a BMWS in a pump room may be possible on tankers constructed on or after 1 January 2007 provided the tanker is operated and maintained in accordance with the IEC standard. Such an installation would be contingent on compliance with the requirements contained in IEC 60092-502; the submission of a detailed risk assessment addressing those aspects not covered in the IEC standard; and the approval of the designated approving authority.

Tanker owners and operators are reminded that ballast water from tanks adjacent to cargo oil tanks cannot pass through or be treated by a ballast water system located in the engine room.

Technology Preferences

Shipowners and operators may also have preferences relating to the treatment technology or treatment sequences. Many owners prefer not to use specific technologies that use filters or chemicals due to impacts on the ship's operation. Other shipowners and operators may want to evaluate the treatment sequences used by the BWMS. Most BWMS require treatment upon ballasting and de-ballasting. However, some BWMS only require treatment upon ballasting, or during the ballast voyage (i.e., in tank – during the ballast retention period).

A number of BWMS are available and most use similar technologies, but some are available that use specific technologies or treatment sequences that might be advantageous to shipowners for some ships. A study of the BWM Technologies may be necessary to better understand the advantages/disadvantages for some BWMS.

Installation Considerations

The ship's remaining service life and charter opportunities after the BWMS retrofit should be examined. This is often a major factor when selecting a BWMS because the total cost of ownership (i.e., CAPEX and operating expenses – OPEX) for one system with lower CAPEX may be less than another with higher CAPEX, or the OPEX of one system may be more favorable than another, etc.

Shipowners may have more options when installing a BWMS during construction of the vessel because the system requirements will be incorporated into the design and original equipment layout of the vessel. Installation of a BWMS for a retrofit may have significant added costs due to piping, structural supports, electrical challenges; it is for these reasons that some BWMS retrofits are more labor intensive than others.

Total Cost of Ownership - Life Cycle Costs

Total cost of ownership (TCO) can be estimated using life cycle cost calculation methods. BWMS selection should be based on TCO and not simply initial vendor's CAPEX. Considering added costs such as installation and through-life OPEX (i.e., energy, chemicals, technical assistance, and certified replacement components, etc.) can determine if a potential BWMS selection is the best overall choice. TCO calculations combined with BWMS system design limitations that can result in vessel delays or longer ballasting times, etc., are often the best BWMS selection method.

Vendor Qualifications, Reputation, and Sustainability

For any shipboard equipment, the ability of the vendor or manufacturer to deliver the product on time even during periods of high demand is an important BWMS selection criterion. Some manufacturers may require longer lead times for BWMS delivery, especially during peak demand. Manufacturing quality and reliability can be a major factor. BWMS using existing proven technologies and marine certified components should have an advantage in equipment sustainability.

The service network and ability of the owner to get onboard technical assistance is an important criterion for BWMS selection. If replacement parts or repair service are needed, a ship might not be able to remain on the charter until the BWMS is restored to service. Shipowners and operators should request information to validate the vendor's service network locations and manpower when evaluating BWMS vendors.

Section 6 | Retrofitting Ships with BWMS

Retrofitting a BWMS is more challenging than installing a BWMS on a newbuild vessel, and the complexity of the challenges vary for different ship types and vessel operations. Poor retrofit planning or selecting a BWMS with incompatible system design limitation (SDL) could result in consequences such as:

- Noncompliant ballast discharges requiring another retrofit for replacement with a suitable BWMS,
- Possible deviations from planned routes and loss of charter opportunities due to inability to meet the discharge standards or severe vessel voyage restrictions,
- Fees or criminal penalties and Port State detentions that could damage the reputation of the vessel owners and operators,
- Delays during cargo operations and possible restrictions by some ports,
- Additional delays to conduct contingency measures to regain compliance (possibly at lay berth, loitering, or slow steaming *en route* while conducting BWE, etc.),
- Increased operating expenses (OPEX) and higher life-cycle costs,
- Off-hire periods making charter retention problematic, and
- Commercial and financial losses including early scrapping of a vessel in lieu of a second retrofit.

Careful retrofit planning including detailed BWMS integration into the existing ballast water system and attention to each key phase of the retrofit process is suggested to achieve a cost effective and compliant BWMS retrofit is achieved.

Challenges faced by the shipowners are due to evolving BWMS experience by shipyards, vendors, classification engineers, and retrofit designers. Compromises with installation planning and execution can result in operational challenges with the BWMS leading to non-compliant ballast discharges.

It is important to conduct advanced planning to provide sufficient time to complete a study of different BWMS technologies, preselect the most suitable BWMS, analyze the vendor qualifications and sustainability, determine a suitable installation location on board, and to allow for additional time in the event of unforeseen circumstances that might require rework or repairs.

A detailed timeline for the installation should be completed at least 24 months before the vessel’s compliance date (i.e., IMO Regulation B-3, as amended or USCG compliance date). Critical project phase analysis can contribute to a timely and successful BWMS retrofit.

BWMS Retrofit Challenges

To date, installation of a Ballast Water Management System (BWMS) appears to be the only feasible compliance method for most ships to meet the IMO and USCG ballast water discharge standards in the coming years.

Retrofit compliance for both regulations might be relatively simple for some ships but more challenging and difficult for many mid-life vessels close to the end of useful life. Insufficient power, inadequate installation spaces available, and overcoming compromises to the water ballast system with the addition of a BWMS cause additional problems for these older ships.

The following paragraphs outline some of the common challenges that are faced by the shipowners and operators with respect to BWMS retrofits for their vessels.

Alignment of IMO and USCG Compliance Date

Shipowners and vessel operators can plan their fleet BWMS retrofits. After several years, IMO regulation B-3 (as amended) implementation dates have been established. USCG NVIC 01-18 (dated 1 March 2018) indicates the USCG is limiting extensions to transition from implementation to enforcement of the US ballast water regulations. Shipowners are advised not to rely on extensions for vessels that must operate in US waters where de-ballasting is necessary.

The United States is not a signatory to the IMO BWM Convention. Vessels that trade in international and US waters may face an early retrofit of a BWMS if the USCG compliance date occurs before the IMO D-2 compliance date and the vessel does not have an extension.

In the first few years following the USCG BWDS compliance dates (first drydocking after 1 January 2014 and 1 January 2016 depending on the vessel's ballast capacity), due to the lack of USCG-approved BWMS availability, shipowners were granted extensions typically to the next scheduled drydocking after the vessel's initial compliance date (i.e., for many vessels using in-water hull inspections, which were up to 5-year extensions).

Later, after the USCG first approvals were granted, the USCG reduced the length of the extensions to typically 30 months (i.e., fixed extended compliance dates). Later, as more approvals were granted, the USCG reduced the duration for extensions to fixed dates (typically 12 months in duration, discussed in NVIC 01-18). Extension applications must now provide sufficient documentation supporting acquisition of a system, set a specific date of installation not more than 12 months past the vessel's compliance date (or date of extension request) and demonstrate that the BWMS selected is expected to receive type approval (if not already approved).

The increased level of challenges to obtain a USCG extension implies that the USCG-granted extensions will no longer align with the normal out of service periods or even the vessel's intermediate surveys. Shipowners and vessel operators, (with vessels trading both internationally and in US waters) trying to align the USCG compliance date with the IMO regulation B-3 (as amended) dates for commercial reasons, must make economic decisions based on the remaining service life of the vessels (i.e., to install a BWMS or to scrap the vessel).

Ability of BWMS to Meet both USCG and 2016 BWMS Code

After 28 October 2020, all BWMS installations onboard vessels are to be type approved in accordance with the requirements of the mandatory Code for Approval of Ballast Water Management Systems (BWMS Code).

Updating the Type Approval in accordance with the BWMS Code may require additional testing that could result in modification of the BWMS configuration. The modifications could require additional USCG TA testing to maintain both USCG and IMO Type Approvals.

The USCG and IMO have different testing requirements and test methods to determine the efficacy of a BWMS. The USCG evaluates the performance of the BWMS based on the live/dead organism determination (i.e., FDA/CMFDA) and the IMO allows assessment based on viable/non-viable approach (i.e., MPN method). The lack of USCG alignment in the acceptance of the MPN test method presents a challenge for operating BWMS under both USCG and IMO requirements. Due to differences between USCG and IMO test methods, manufacturers of UV-based BWMS must increase the UV intensity levels to achieve results required by the US EPA Environmental Technology Verification (ETV) protocol (i.e., FDA/CMFDA).

An obstacle for UV based BWMS to achieve the USCG efficacy is the possibility of reduced flow rates through the UV reactors to achieve higher UV dosage at maximum UV intensity levels. The reduction of ballast water flow rates is important to the vessel operators to avoid longer ballasting/de-ballasting operations.

Challenges for using one BW Treatment Technology for all Types of Vessels

Another technical challenge for retrofitting the BWMS is that there is no one BWMS treatment technology suitable for all marine vessels. An improper BWMS selection decision could severely limit the commercial operations of the vessel.

There are numerous BWMS available that have received both USCG and IMO Type Approval certificates. However, selection of an appropriate BWMS depends on a number of factors such as ship types and sizes, ballast water treatment rated capacity (TRC), high or low ballast dependency, operating profiles of the vessels, space and power available onboard the vessels, equipment installation, and design limitations. There is no single BWMS appropriate for all vessel types, sizes and operating conditions.

BWMS Challenges with Bulk Carriers/TST Gravity Discharge Configuration

Bulk carriers, one of the largest segments of the merchant shipping fleet, are highly ballast-dependent. Some of these bulk carriers, possessing Topside Water Ballast Tanks (TST) not connected to the Bottom Side Water Ballast Tanks (BSWBT) and which often de-ballast directly overboard by gravity discharge, complicate BWMS selection. For these vessels, the selection of a suitable BWMS requires additional considerations. TST gravity discharge operations are incompatible with most IMO and USCG type approved BWMS.

To date, all UV-based BWMS require re-treatment by UV during discharge and most active substance based BWMS require neutralization (mandatory for compliance with the type approval certificate requirements) before discharging overboard. Retreatment (i.e., UV re-dose or neutralization) process requires the TST to be re-routed back to the BSWBT or ballast headers to perform retreatment during de-ballasting. Other alternative measures include selecting a BWMS that does not require secondary treatment, allowing overboard discharge of the TST or to install a dedicated BWMS for the TST. However, this might increase the capital and operating expenses due to additional equipment and associated components.

Heavy weather ballast for bulk carriers remains unclear today. The IMO BWM Convention does not allow untreated heavy weather ballast (HWB) to be discharged in waters of any Administration signatory to the Convention. During MEPC 70, the Committee agreed that HWB used for crude oil carriers was a MARPOL Annex I issue and would not be addressed within the IMO BWM Convention (MEPC). However, the same has not been rectified for bulk carriers using heavy weather ballast. The USCG allows discharge of untreated HWB to waters of the U.S. outside 12 nm and many signatory Administrations to the BWM Convention might allow similar discharges at some determined distance from land.

However, the need to treat HWB ballast could result in additional footprint and weight considerations for the BWMS retrofit. For some active substance-based BWMS, treating HWB will require additional chemical storage capacities (treatment and neutralization chemicals). Total energy consumption for HWB ballasted and de-ballasted may change the BWMS selection criteria.

Other Major Difficulties and Issues

Another key concern faced by shipowners and vessel operators is the sustainability and reliability of the BWMS vendors. This can create uncertainty and unrest for shipowners, putting them at risk of investing in expensive BWMS, but not assured of sustained regulatory compliance in the event the installed BWMS manufacturer exits the market.

Other issues include:

- After sales support and availability of the technical service network of the BWMS manufacturer. Global support for shipowners in the event of component failures, inoperable BWMS, or necessary spare parts and consumables is important for continuous operability of the BWMS.
- Timely delivery of the BWMS, particularly when customs clearances can delay delivery, can affect the installation plans.
- BWMS training and global support for the crew is important. It is important that the crew onboard the vessels are familiar with the operations of different BWMS.
- Some shipyards have limited or no practical retrofit experience.

Successful Retrofit Execution

One key to achieving a successful on-time BWMS retrofit is proper planning. A detailed retrofit strategy and timeline should be created at least 24 months before the vessel's compliance date (Convention regulation B-3 as amended or USCG compliance date). The plan should allow enough time for BWMS technology reviews and pre-selection, pre-installation planning and final BWMS selection, as well anticipating delays that could affect cost for BWMS retrofits. It is important that communication and cooperation be established throughout the BWMS retrofit process, between all the key stakeholders (i.e., shipowners, shipbuilders, BWMS vendors, classification societies, and third-party installation designers) to ensure smooth retrofit operations and rectify possible issues at early stages of the retrofit process.

The following eight key phases of a retrofit process can support detailed planning to ensure successful retrofit project completion.

1. Evaluation of the Vessels Compliance Dates and Operational Profiles

During the preliminary planning stage, it is important to identify the vessel's compliance dates (IMO and/or USCG) to achieve a better understanding of the project deadlines and explore the possible restrictions and challenges for the BWMS technologies to identify the best BWMS. Recognizing the vessel's compliance dates at this early stage would also allow owners of mid-life vessels to determine the economic impacts of retrofitting the BWMS or scrapping the vessels.

Proper evaluation of the vessel's design and operational profile (i.e., water ballast system design, ports of call and future trade routes such as discharging to U.S. waters, freshwater ports, etc.) at this early stage is important to enable shipowners and operators to prepare for specific additional local BWM requirements. This can eliminate the possibility of non-compliance leading to criminal and financial penalties, or port state detention exposing the vessel to economic and commercial disadvantage.

Understanding the BWMS system design limitations (SDL) can allow the vessel to operate with minimum interruptions due to problems treating ballast water. Early IMO Type Approvals did not provide clear indications, and this led to improper operation (i.e., water quality). USCG approvals list a few operating conditions that must be met in order to discharge treated ballast water to US waters.

Later Type Approvals (i.e., 2016 G8 and BSMS Code) will provide SDLs identified by the Administration to better inform the BWMS owner on how to predict compliant treatment success. A BWMS selection that provides the best operational flexibility can be made by understanding these SDLs. System design limitations should be studied when developing contingency plans. Cost impacts involved when dealing with water quality outside the BWMS SDLs should be considered an integral part of the BWMS selection. This is particularly important for high ballast dependent vessels (i.e., tankers, bulk carriers, LNG carriers, etc.).

2. BWM Technology Evaluation and Feasibility Study

After determining the vessel's IMO or USCG compliance date and understanding the vessel or fleet operating profile, the next step is to conduct a comprehensive technology evaluation study that provides a shortlist of several potentially suitable BWMS appropriate for the vessel's operational needs and future routing. The development of the preselection list should be based on a scoring criterion used to evaluate all shortlisted BWMS. This can provide the best technical performance with the most cost-effective solution for each vessel (i.e., CAPEX, OPEX, and total cost of ownership through the remaining service life of each vessel). The output of this technology evaluation should be a BWMS preselection (primary, secondary, and possibly an alternate third option).

Performance of the feasibility study as part of the BWMS retrofit program can provide an objective assessment of the suitability of the BWMS allowing shipowners and vessel operators to gain a deeper understanding of the various types of treatment technologies available for the ship. These commercial and technical factors of the selected vessel should be made before making purchase commitments. The feasibility study can help avoid a second retrofit (i.e., replacing an improperly selected BWMS) to provide compliance ballast water treatment through the remaining life of the vessels.

When making a preliminary list of suitable BWMS for the retrofit, key driving factors such as the vessel's remaining years of service life, installation and operational feasibility, operating/maintenance costs, vendors sustainability and global support network capabilities, and ability to provide training should all be considered.

Depending on the vessel's post retrofit trade routes (e.g., operating in both International and US waters), the shipowner should consider a BWMS that has received both IMO and USCG Type approval certificates, or is capable of achieving both certificates including the BWMS Code for retrofits beyond 2020.

Feasibility studies should be ship specific, taking into account vessel operations and other key considerations including the vessel trading profile, number of round trips per year, ballast system design including total ballast tank capacities, the type and number of the ballast pumps and locations, ballast pump sizes and maximum ballasting/de-ballasting rates, gravity ballasting and de-ballasting, stripping eductor performance, ballast water operations at cargo loading and discharge ports, available space for installation of BWMS, presence of separate ballast pumps for the APTs, and available electrical power capacity onboard.

The list of pre-selected BWMS should be analyzed and compared against important parameters such as CAPEX and OPEX, equipment installation/design, the operational flexibility of the BWMS and its design and operational limitations, and other considerations such as the reliability and sustainability of the vendor, the ability of the vendor to provide technical service support network globally and, the ability of the vendor to provide BWMS training. Each of these parameters are key contributing factors in determining the suitability of the BWMS and their importance are explained in much greater detail in the following.

To yield an accurate assessment of the most cost effective and suitable BWMS, both the CAPEX and OPEX for the BWMS retrofit should be considered and evaluated.

Capital Expenses (CAPEX)

CAPEX is the total investment costs for the BWMS retrofit project, including BWMS acquisition and its component cost; other miscellaneous equipment or components/instrumentation cost, shipyard engineering and design costs, procurement and fabrication costs, costs for engaging a third party installation firm with contracts that include the cost for 3D scanning, engineering, manufacturing, installation and commissioning services for retrofitting BWMS; class engineering reviews and survey costs; and drydock fees for installation of the BWMS**.**

Operating Expenses (OPEX)

OPEX are costs that includes the energy consumed for operating the installed BWMS throughout the lifecycle, additional fuel consumption for BWMS that use fuel during the treatment process (i.e., deoxygenation treatment technologies); chemical consumption required for chlorine dosing or active based substance BWMS; neutralization chemical consumption for total residual oxidants (TRO) during ballast water discharge; and cleaning chemical costs for UV based BWMS or electrochlorination (EC) based BWMS.

For UV-based systems, regular cleaning for the UV lamp sleeves is required to avoid accumulation of sediments that could affect the performance of the system. UV-based BWMS use different cleaning methods (some have no cleaning required, some use integrated mechanical wipers, and some require added chemicals used with a clean-in-place unit).

EC-based BWMS require descaling of the electrodes. EC-based BWMS use different cleaning methods (from no cleaning required, potable water flushing, to cleaning chemicals used periodically).

Equipment installation and design includes the evaluation and assessment of the equipment footprint and weight, flexible installation arrangements, pressure drop considerations, use of filter technologies, control and automation integration, availability of redundancy.

Footprint and dryweight of the installed BWMS are key aspects for BWMS selection. Vessels with larger ballast water treatment rated capacities, such as high ballast dependent vessels, would typically result in larger BWMS. Due to limited space onboard an existing vessel, selection of a BWMS with small footprint or suitable for installation in smaller spaces on the vessel is important.

Total dryweight and operating weight of the BWMS is also an important aspect of the BWMS retrofit, particularly since additional weight onboard the vessel cause cargo displacement and affect the vessel's trim and stability and could result in structural modifications.

Flexible installation arrangement of the BWMS and associated components helps reduce challenges finding additional spaces for installing the BWMS where space is already a concern for existing vessels.

Flexible installation approaches should include potentially optional filtration equipment with the selected BWMS and orientation (horizontal or vertical), and installation locations, side stream electrochlorination, chemical storage and dosing equipment allows installation flexibility. Side-stream BWT equipment can be used for treating port, starboard and APT ballast systems adding greater flexibility.

Pressure Drop of the BWMS and the effect on the existing ballast pumps performance could result in higher power demand and reduced overall flow rates that would affect the vessels ballasting/de-ballasting times.

Use of filter during ballasting allows elimination of larger organisms as a pre-treatment method to reduce overall power demand for the secondary treatment technology.

Although most filter technologies have proven effective, the use of filters could result in operating problems leading to the reduction in ballast pump flow rates due to added differential pressures, clogging requiring backflushing operations that could affect the overall ballast water flow rate prolonging ballast operations. The use of a filter also requires additional maintenance and replacement costs through life cycle to ensure the reliability of the filter components.

Some BWMS do not require filters. These BWMS can be ideal for vessel with limited space for additional modifications that need BWMS installed on the main deck. Eliminating filters could reduce equipment, maintenance and installation costs and other operational concerns resulted from clogging and backwashing losses. However, there are disadvantages of BWMS without filters. BWMS without filters can require higher power demand and energy consumption to generate higher disinfectant chemical dosing.

Vendors offering different filter options to meet challenging retrofit demands can help avoid complications by selecting the most appropriate filter. Investigation and analysis of the vendor's approval certificates can help the shipowner select the best filter for each vessel.

Automation Integration BWMS are those with capability to integrate the BWMS controls into the vessel's exiting automation system which can provide ease of operations. Fully automated BWMS could allow more convenient adjustments and responsive actions to be taken for changing water conditions.

Level of Redundancy is a critical feature for a BWMS to provide uninterrupted ballast operations. Without establishing some level of redundancy for major BWMS components, any failure could require a cessation of cargo operations to repair the BWMS. This could result in delay in cargo delivery, failure to meet the planned charterer schedule and thus result in late penalties. Having appropriate redundancy is important for high ballast dependent vessels where rapid vessel turnaround time is important.

Different levels of redundancy for BWMS could be achieved in various arrangements or configurations. Some BWMS vendors offer redundancy by providing additional (i.e., standby installed spare) components that perform the same function (i.e., filters, electrolytic cell assemblies, chemical dosing sub-systems, auxiliary pumps, motors and multiple UV reactors). Even with the addition of redundant components, the level of redundancy could be reduced if essential major components (i.e., feed pumps for the side-stream EC or chemical dosing system, chemical injection pumps, chemical storage tanks, filter backflush pumps and flow control valves, etc.) required for the BWMS are not provided with adequate redundancy.

Understanding the levels of redundancy provided for each BWMS can help avoid interruptions in ballast operations.

Operational Flexibility (System Design and Operational Limitations)

Selecting a BWMS with suitable SDLs can allow shipowners to operate with minimum geographic limits. Understanding BWMS SDLs can allow the shipowner to select a BWMS suitable for most ports planned for the vessel's post retrofit routing. Where the BWMS SDLs prevent successful treatment, the shipowner should be able to plan suitable and effective contingency measures (such as bypassing the BWMS to exit the port and conduct BWE followed by BWT to regain compliance). For BMWS retrofits before suitable SDLs for each BWMS are published and made available by Administrations, shipowners can undertake predictive SDLs for each BWM technology before making the final BWMS selection.

The list of ballast water management systems that have received IMO Basic and Final approval for the use of active substances (G9 Guidelines) and IMO Type Approval certificate per G8 Guidelines) can be found in Appendix B and C.

The information on BW manufacturers having submitted letters of intent (LOI) for USCG testing are indicted in the USCG MSC LOI register list, which could be retrieved from the USCG Homepage, *https://www.dco.uscg.mil/Our-Organization/Assistant-Commandant-for-Prevention-Policy-CG-5P/Commercial-Regulations-standards-CG-5PS/Marine -Safety-Center-MSC/Ballast-Water/*. As of 30 October 2018, the USCG has received over 50 Letters of Intents (LOI) from BWMS vendors.

As of 13 February 2019, USCG has approved 16 BWMS. 7 other vendors have submitted approval applications to the USCG and are pending review. The list of USCG-approved BWMS can be reviewed at: *https://www.dco.uscg.mil/Our-Organization/Assistant-Commandant-for-Prevention-Policy-CG-5P/Commercial-Regulations-standards-CG-5PS/Marine-Safety-Center-MSC/Ballast-Water/* by selecting the "Approved BWMS and Status of Applications" link.

Before selecting a BWMS, it is important to understand and analyze the design and operational limitations (i.e., TRC, minimum UV intensity, maximum allowable active substance concentrations, required salinities, temperatures, minimum hold times, suitability of installation in hazardous area for US flag vessels, etc.) for the BWMS and how the limitations affect the operations of the vessel. All SDLs should eventually be listed on the IMO Type Approval certificates. USCG AMS acceptance letters and USCG Type approval certificates have some operating limitations.

Salinity limitations imposed on EC-based BWMS present a challenging problem for shipowners particularly when treating fresh or low salinity water.

Different salinity levels affect the efficacy and performance of the electrochlorination BWMS since the system uses dissolved salts in seawater (predominantly sodium chloride) for generating active substances. Vessels operating in freshwater may be unable to use this technology without additional salinity enhancement. Typical salinity enhancement includes reserving marine salinity seawater in a ballast tank, usually the APT. This operation requires additional capital and operational expenses and for high ballast dependent vessels where cargo capacity is important, reserving seawater in the APT might not be a practical solution.

Temperature limitations are also one of the key aspects for efficacy of the treatment operation. If the required minimum temperature is not achieved, the treatment of ballast water might not be compliant.

To meet USCG type approval testing requirements (live/dead organisms), some UV-based BWMS are designed to reduce ballast flow rates by as much as 50% to achieve the high UV dose (UVI multiplied by time of exposure) indicated in the Type Approval certificate required for successful treatment. The reduction of ballast water flow rates can result in prolonged ballasting/de-ballasting operations.

To provide effectiveness of the treatment process, some of the Type Approved BWMS have minimum holding time limitations imposed. Minimum holding times required could be an obstacle for vessels with shorter ballast voyages than the minimum holding time period.

Other Considerations

Other additional considerations that contribute to the decision-making for a BWMS selection include vendor reliability and sustainability, the availability of technical support provided globally after the sale, and the availability of BWMS training provided globally.

The availability of after sales and technical support services globally by the BWMS manufacturers, such as ability to send service engineers to attend the vessel in the event of malfunction of BWMS, or timely delivery of spares components and consumables are important for ongoing operation of the BWMS.

Another important factor to be considered would be the availability of the BWMS manufacturers to provide practical BWMS training and support globally to crews onboard the vessel.

Upon the completion of the preselection or feasibility study of the BWMS, a summary and comparison table of each pre-selected BWMS should be reviewed for key parameters and presented in the form of a score sheet. An overall score can reveal the most suitable BWMS. Weighting factors could be applied to adjust each set of unweighted scores to heighten key parameters that are more important for each vessel or operational routing.

3. *Contract with BWMS Manufacturers, NA/ME, Installation Contractors*

The shortlisted BWMS can be further refined for BWMS pre-selections based on the results of the feasibility study. Considering more than one BWMS in parallel, if the primary selected manufacturer is unable to deliver the BWMS on time to meet the vessel's installation requirements, can help maintain the retrofit schedule.

The proposal with the primary and secondary BWMS vendors should be analyzed to confirm that the CAPEX, OPEX, and total cost of ownership (TCO) allows the best solution decision (i.e., performance shortfalls vs. economics, etc.) to be made. Final selection of the BWMS should be based on a decision hierarchy developed by the owners and managers during the feasibility study and not created during the proposal reviews.

A ship visit to conduct a preliminary onboard survey (2D tape measurements) should also be included in the proposal. This can help determine that the pre-selected BWMS will fit in the spaces available and potentially provide some installation options. This is important for existing vessels limited installation space.

Once the 2D preliminary onboard survey is completed, the shipowners and managers should start requesting technical and installation proposals from reputable Naval Architect/Marine Engineering companies and third-party installation contractors with extensive experience in carrying out detailed 3D laser scanning, preparing engineering system drawings for class approvals, fabrication and manufacturing, installation and commissioning services.

To provide full support (i.e., urgent request to revise design that occurs during equipment installation, prompt onsite attendance to address any conflicts with the existing vessel onboard systems, etc.), it is important to engage a responsible and reliable Naval Architect or Marine Engineer and installation contractor with good knowledge and experience for the installation, operation and maintenance of BWMS. Previous experience and successful installations can be beneficial. Credibility of each potential Naval Architect or Marine Engineer and installer should be reviewed.

4. *Pre-installation Surveys, Detailed Design, and Class/Flag Approvals*

Pre-Installation

After the third-party installation contractor has been selected, a detailed onboard installation survey should then commence to identify the locations for the installation of the BWMS using the 3D laser scanning and model development, including an in-depth evaluation of power demand and power availability.

Performing a 3D laser scan may add capital cost but this offers several benefits for the retrofit project. This includes:

- Accurately capturing physical measurements of the BWMS and how it will fit in the proposed installation spaces. This helps eliminate installation conflicts that can add time during the installation stage,
- Saves time in design work and allows identification of possible conflicts with the existing machinery or piping systems onboard,
- It provides an overview of connecting pipes, fittings and supports for the BWMS and the ballast tanks. This can be helpful for pre-fabrication for other components required for the BWMS installation.

Detailed Design

The 3D model can be converted into a detailed engineering drawing to show all structural foundations, pipes and pipe fittings, controls and automation, other machinery and electrical components required for the installation of the BWMS. Final ship checks should be carried out to ensure that the drawings match the actual onboard configuration.

Class and Flag Approvals

Prior to installation, plans, drawings, and operational manuals are to be reviewed and approved by the ship's classification society. The classification society is also required to conduct an engineering review and approval of the installation design. The engineering review includes a review of hull plans showing foundation and attachments to vessel's structure for each component of the BWMS. These plans are to clearly indicate the scantlings and welding details. The specific list of required drawings and documentation required for approval might vary between different class societies.

Machinery plans are to be reviewed showing the installation of the BWMS on the vessel including location, piping and electrical details, drawings, general arrangement and layout, and installation and equipment plans. Plans are to include applicable arrangements for hazardous areas.

A safety risk assessment specific to the installed BWMS to be installed and for the specific type of vessel under consideration to address the risk to the vessel and its crew is also to be conducted before the installation of the BWMS, so that any mitigation measures identified during the assessment study could be applied before or during the BWMS installation. This safety assessment is to be reviewed by the class society to confirm the adequacy of the proposed arrangements. Relevant information resulting from the safety assessment is to be documented in the vessel's BWMP.

Shipowners and operators need to allocate enough time for review and approval of the required items. Installation is not to occur until approval has been obtained.

To avoid costly rework that affects the installation schedule, it is important to first obtain Class and Flag approvals before beginning the retrofit. It is important to start the BWMS fabrication after the completion of the design and approval phase. Retrofit project plans based on experience gained during newbuild BWMS installations tend to overlap design and BWMS manufacturing phases. This is acceptable for newbuild projects where the ship designers will accommodate the BWMS installation spaces and power demand, but it can be detrimental for retrofit projects.

5. Selecting the Installation Approach

Deciding on the best approach for the retrofit is another important phase in the BWMS retrofit process. If the retrofit is not completed in time allowing the BWMS to be commissioned by the vessel's IMO or USCG compliance date (as applicable), the vessel's ability to trade could be affected. The BW Convention does not allow extensions - the worst case for the shipowner would be to miss the IMO compliance date.

The BWMS retrofit approach can be carried out when the vessel is in a drydock during an out of service period or when the vessel is in service. Each of these retrofit approaches have pros and cons. Another method would be a combination of both – partially in drydock and completed in service. The shipowner, managers, crew, charterers, third party installation contractors and shipyard should agree to the method and planning should be detailed enough to avoid missing milestones.

A convenient time for the retrofit is during the Special Survey Hull (SSH) drydocking since the vessel is scheduled to be out of service and accessible to multiple stakeholders and with adequate crane support. Different sequences such as removal of deck plates, gas-freeing tanks to support hot work required for hull cuts and bulkhead penetrations (equipment access and installing new hull valves, etc.), new electrical panels (possibly requiring blackout for extending bus bars if insufficient breaker panel spaces are available), welding new support structures, rerouting existing piping, integrating control wiring (uses numerous remote sensors throughout the installation spaces), etc.

If the vessel can complete the drydocking soon enough (i.e., before the IOPP renewal survey is completed), the vessel could then finish the retrofit in-service (i.e., riding crews to complete some time-consuming assembles, computer-based control troubleshooting, etc.). If the vessel's IOPP renewal survey is completed concurrent with the IOPP certificate during the drydocking, the vessel may not have any additional time before the Convention regulation B-3 (as amended) date – forcing the completion of the BWMS retrofit including commissioning before leaving the shipyard for commercial work.

Retrofitting the vessel during the drydocking can present challenges. Conflicting workloads with the previously planned repairs (and possibly other retrofits) can extend the expensive drydocking time. For example, early retrofits following the 8 September 2019 IOPP renewal survey dates will occur at nearly the same time many vessels will be installing exhaust gas cleaning systems (EGCS) – particularly scrubbers for Sulfur 2020 compliance. The amount of work required to install the scrubber may be more complicated than that of the BWMS. However, if the vessel's regulation B-3 (as amended) date passes, the vessel cannot discharge unmanaged ballast water. Then, the conflicting work would be evaluated to reduce the total costs impact (complete the work requiring drydocking and do the rest of the work at a lay berth). Class support for surveys are generally more available at the shipyards.

Another installation approach for the BWMS is when the vessel is in service. The owner will have to coordinate riding crews from the BWMS vendor and shipyard (or installation contractor). Vendor and installation contractors will need to transition between specialization work (i.e., mechanical, electrical, controls, etc.). This can cause delays if some of the riding crews miss the ship (i.e., due to rerouting for cargo operations, missed air travel connections, etc.). Additionally, if the crews working on the BWMS need parts or components, their work may be interrupted – adding more delays. The spare parts might not be readily available at the ports where the vessel is trading. This retrofit approach can eliminate some problems for the vessel's out of service/off-hire but could cause some other problems if the retrofit is not completed in time for the IOPP renewal survey (marking the regulation B-3 compliance date).

Once the BWMS installation method decision is made, the shipowner should request fee quotes from several shipyards and drydocks. Considering that the BWMS retrofit activities will increase in the next few years, there could be increased bookings for drydocking facilities. It is recommended to book the drydock facilities and shipyards well in advance.

6. BWMS and Ancillary Equipment Manufacturing and Shipment

Unlike BWMS manufacturing for newbuild vessels, the vendor should not start fabrication of the BWMS until approval from the class and Flag. Subcomponents required for the BWMS can be ordered before drawing approvals but starting to assemble equipment with ship-specific arrangements subject to approval may require rework if changes are required. Auxiliary equipment (i.e., some structural support components, piping assemblies, valves, electrical switchgear and cabling) can be sourced and manufactured at the same time as the BWMS is assembled.

The retrofit schedule may be improved by preordering major subcomponents of the BWMS. However, specific details such as the locations of the piping connections for filters may require the vendor's subcontracts with the subcomponent suppliers to wait for drawings to be approved. The filter vendor can preorder major subcomponents to help reduce the manufacturing time.

Planning to accommodate small dimensional errors of the as-built equipment can help avoid installation problems. This could include pre-planned use of small piping make-up pieces to avoid rework on larger piping spool subassemblies. Reworking larger subassemblies is more expensive and time consuming if conducted on-site.

Advanced planning is recommended to complete manufacturing in time for thorough factory acceptance testing and as-built dimension verifications (allowing additional time for factory corrections to be made). Once the date for the drydock facility/installation location is confirmed, the equipment should be shipped as soon as possible to ensure on-time delivery to avoid missing shipment cutoff dates or potential international freight delays.

After overseas shipping and customs clearance, the BWMS equipment and all ancillary equipment should arrive at the shipyard facility. The shipyard should conduct thorough initial receipt inspections to allow time to correct any equipment damaged during shipment or reorder missing components lost during shipment. Additional time should be provided in the planning process to conduct repairs or reordering equipment when it is found unrepairable at delivery.

The vessel should arrive at the drydock based on drydocking schedule per the class certificate. Any BWT equipment onsite should be properly laid up and preserved until the vessel arrives. It is important to properly store the BWT equipment to prevent the BWMS vendor from having to carry out or expedite additional repair work.

7. BWMS Installation and Integration

Installation of a BWMS on existing ships can be a difficult process that requires detailed planning for proper integration into the ships existing ballast system. Installations could take place during a drydocking period, with the vessel pier side or even underway for some smaller and less complicated vessels. During the installation, coordination with other shipboard work might be necessary. Technicians should identify other ship systems that will be affected and precheck equipment necessary to perform the installation work. It is important for shipowners and operators to work closely with their classification society to identify any class or statutory issues in advance to ensure successful installation and commissioning of systems.

Planning the installation should include contingencies for missing, broken, or damaged sub-assemblies, and the need to make repairs that could delay the installation. All cut-ins and tie-in connections to the water ballast system, structural support hot work, electrical outages, and major equipment pre-installations should be prioritized with the vessel in the drydock. Minor supporting subassemblies, cabling, and controls can be completed after the vessel leaves the drydock. This approach is similar for in-service installations except the vessel may be at a lay berth when conducting the initial equipment placement and system tie-ins.

For personnel safety, access to medical facilities should be preplanned and all work sequences should be reviewed for safety hazards (during the initial planning and before the commencement of each activity). This is especially important if installation work is conducted with the vessel in-service (i.e., riding crews working in tight spaces, rigging, inclement weather, etc.).

Some shipyards might be more familiar and have the practical experience with the installation of the selected BWMS technologies. However, some shipyards may have little or no experience with the different treatment technologies. Therefore, it is important to plan early if vendor service technician's attendance on site (or prior to pre-commissioning) will be required.

Proper integration of a BWMS system is required for vessel and crew safety. The following paragraphs cover some key considerations when integrating the BWMS with the existing systems onboard. The vessel's classification society should be included in these decisions.

Location

A BWMS may be installed in multiple locations throughout a vessel (filters separate from the treatment equipment, sub-assemblies instead of single skid mounted BWMS, etc.). The acceptability of the location and arrangements depend on the type of treatment system, the installation specifications and the type of vessel involved. Each installation must be evaluated to verify that potential safety concerns and pollution hazard issues are adequately addressed.

BWMS that do not serve ballast tanks considered to be hazardous may be installed in the following locations, unless specifically prohibited due to the treatment method involved:

- Machinery space or engine room
- Void spaces with or without direct access or adjacent to the machinery room
- Dedicated enclosure

BWMS that serve ballast tanks considered to be hazardous are to be installed in a void space, weather deck enclosure, or enclosed compartment on the cargo deck, complying with the following compartment criteria:

- Determined to be suitable for the service intended
- Treated as “other machinery spaces” with respect to the fire protection
- Positioned outside of any combustible, corrosive, toxic, or hazardous areas unless specifically approved
- Arranged with no direct access to accommodation spaces, service space, machinery space, control stations or other spaces containing sources of ignition, unless specifically approved
- Maintained watertight integrity of all bulkhead openings and penetrations
- Maintained watertight integrity of all deck openings and penetrations
- Minimized the extent of bulkhead and deck openings and penetrations

Retrofitting of BWMS requires a review of the current ballast system layout and operation. Many existing vessels use ballast tanks that drain by gravity. Most BWMS require treatment prior to discharge of the ballast water. Treatment from a gravity drain ballast tank is not easily accomplished and options need to be reviewed. One additional issue with gravity drain ballast tanks is the sampling point included in the G2 guideline. The BWM Convention refers to guidelines developed by the Committee for sampling. The G2 guidelines state that “samples should be taken from the discharge line, as near to the point of discharge as practicable.” This can be a problem for vessels with tanks that discharge by way of gravity only.

A key point to note for retrofitting is ships that utilize eductors for stripping ballast tanks: While the motive water for stripping can be ambient water, the motive water is mixed with the stripped ballast water from the ballast tank, which in most cases has not completed all treatment or undergone testing for compliance. MEPC 67 concluded that no sampling should take place during tank stripping operations. However, this could be different for USCG inspections.

Additional restrictions and requirements may apply to BWMS serving ballast tanks on oil and chemical carriers. The ship’s classification society should be contacted regarding these requirements.

Ventilation

The ship’s classification society should be consulted regarding ventilation requirements. Specific requirements have been developed for hazardous areas. In general, BWMS are to be installed in well ventilated areas. If the BWMS is to be installed in a non-hazardous space, other than the machinery space, and is not to serve any ballast tanks considered to be hazardous, the space should be fitted with an independent mechanical extraction ventilation system providing at least six air changes per hour or the amount specified by the BWMS manufacturer, whichever is greater.

BWMS installed in a separate compartment that is a hazardous area requires verification that the ventilation system for the space meets the design and code. Additional ventilation may be required depending on the specific BWMS. For example, a BWMS using chemicals or generating hazardous gasses may require additional ventilation.

Structural

The BWMS equipment must be efficiently supported and the adjacent structures are to be adequately stiffened as required. Structural considerations are subject to classification society requirements. The installation of a BWMS on a new or existing vessel shall not compromise the integrity of the vessel hull, framing, decks, bulkheads, tank structures, existing equipment foundations or additional structural member. Additionally, the application of a BWMS is not to adversely affect the ballast loading conditions, loading instrumentation, intact stability, damage stability and fire safety.

Electrical Systems

The electrical components of a BWMS are to be integrated with the existing electrical system. The retrofit design needs to verify enough power is available for operation of the BWMS. Retrofitting vessels may require additional power for operation of the BWMS.

Instrumentation

The BWMS may be connected to existing instrumentation and controls. The shipowner should request information on the BWMS control system prior to purchasing the system to understand installation and integration challenges.

8. Commissioning and Operational Testing of the BWMS

An initial survey of the BWMS is to be conducted by the classification society to verify that the installation of the BWMS including any associated structure, fitting, arrangements and material are in compliance with applicable requirements, as indicated in the approved drawings and plans. The purpose of the survey is to verify proper documentation is on board and that the BWMS is installed in accordance with drawings, and workmanship is acceptable.

After installation of the BWMS, a shipboard function test is to be carried out to the attending Surveyor’s satisfaction at the sea or quay trials, as appropriate. The function test is to demonstrate the ability of the BWMS to operate consistently with the ship’s normal ballast operations at the treatment rated capacity. The function test will not evaluate the ability of the BWMS to achieve ballast water discharge standards. A shipboard function test plan is to be prepared and submitted for approval prior to the testing.

Timely completion of the BWMS commissioning and survey can present a serious challenge. Many early BWMS installations have not yet been operated and continue to suffer frequent outages because of difficulties with initial commissioning.

Owners and operators should be aware that after the vessel’s compliance date (i.e., Convention regulation B-3 as amended or the end of a USCG extension period), all ballast water discharged must be in compliance with BWMS regulations (i.e., IMO Convention or U.S. waters inside of 12 NM, US EPA Vessel General Permit, and any added local requirements).

When planning the retrofit schedule, additional time should be allocated for the shipyard and vendor to conduct necessary repairs or rework (i.e., warranty repairs, spare parts expediting, issues with electrical and control components, pipe fittings, etc.) that may have occurred during commissioning and before the vessel returns to service. This could help avoid vessel delays that could affect the vessel’s follow-on charter opportunities.

During MEPC 72 (April 2018), the Committee requested that the Ballast Water Review Group (BWRG) consider recommendations for validation of compliance with Regulation D-2 (biological analysis testing) during the BWMS initial survey.

During MEPC 73, the Committee approved BWM.2/Circ.70 containing guidance for validating the compliance of individual ballast water management systems approved under regulation D-2 of the BWM Convention in conjunction with their commissioning on board the ship. The purpose of commissioning testing is to validate the installation of a BWMS by demonstrating that its mechanical, physical, chemical and biological processes are working properly. Commissioning testing is not intended to validate the design of type-approved BWMS that are approved by the Administration.

The indicative analysis testing may result in additional time and technical assistance costs from the BWMS vendor.

Tank cleaning may be required to meet the discharge standard.

BWMP/Contingency Measures

With the installation of the BWMS, a ship-specific ballast water management plan (BWMP) should be updated to provide the latest information for operational, maintenance, safety and repair instructions. The vessel's crew, supervisor and Master should be familiar with the BWMP. The updated BWMP should be validated and verified by the crew to ensure reliable and sustainable operations of the BWMS. All stakeholders should participate in the development of the BWMP.

Clear contingency measures are recommended for the BWMP. Clear plans for action should be available to the crew in the event of a malfunction or inoperable BWMS. The Master and crew should practice contingency measures to validate the feasibility of the BWMP.

Examples of contingency measures may include conducting sequential BWE plus BWT during re-ballasting to alleviate water quality issues that may be encountered in some ports (i.e., low UVT, low salinity for electro-chlorination based BWMS, high silt and sediment that affect filters, etc.). Performing BWE in lieu of treatment may be considered the last resort in the event of failure of the BWMS. However, the acceptability of BWE only is subject to the approval by the port state and Flag administrations. BWE followed by BWT to regain compliant ballast water may be more acceptable by port state. The BWMP should provide detailed instructions for contacting port state control (i.e., COTP or District Commander for US waters, etc.).

The MEPC Committee has issued a circular for guidance on contingency measures for vessels adopting BWT under the BWM convention (BWM.2/Circ.62). The importance of contingency planning anticipating operational problems with an inoperable BWMS will be further emphasized in follow-on Committee meetings.

The high-level guidelines aim to provide guidance to shipowners, vessel operators and ports on the need to prepare contingency measures and the importance of working closely with port state control. Some contingency measures may include:

- Practical measures in the case a ship is unable to manage ballast water in accordance with its approved ballast water management plan,
- Discharge to another vessel or shore facility,
- Managing all or part of the ballast water in a method acceptable to the port,
- BWE as agreed by the ship and port state, or
- Other operational actions (e.g. modifying sailing, internal transfer or the retention of ballast water on board the ship).

Resolution MEPC.306(73) provided a change to the G4 Guidelines for Ballast Water Management and the Development of Ballast Water Management Plans, MEPC.127 (53). Contingency plans can be included in the BWMP in Part B in the non-mandatory information. Contingency planning should be included in the BWMP.

The USCG has published CVC policy letter 18-02 “Guidelines for Evaluating Potential Courses of Action when a Vessel Bound for a Port in the Unites States has an Inoperable Ballast Water Management (BWM) System”. NVIC 01-18 also contains guidance for shipowners and operators with an inoperable BWMS.

The USCG has established uniform response guidance for COTP/District Commanders when notified of an inoperable BWMS. These documents provide shipowners and vessel operators a better understanding of the possible USCG COTP or District Commander’s responses and directions when notified of an inoperable BWMS.

Other regional requirements should be understood by the crew and instructions for BWMS outage repair attempts, reporting, and requests for using contingency plans should be included in the BWMP. Training for the Master, crew, and shore support should be provided to reduce delays from determining the likelihood of restoring the BWMS to service and communicating with the PSCO.

It is important for all shipowners and operators with installed BWMS to review and understand both IMO guidance (BWM.2/Circ.62) and USCG guidance (CVC policy letter 18-02 and NVIC 18-02). This will help identify acceptable contingency measures based on the vessel type and operational needs and can limit additional delays.

Summary

Retrofitting BWMS appears to be the primary compliance method for most ships to meet both the IMO and USCG regulations in the coming years. The IMO BWM Convention has adopted a modified regulation B-3 requiring BWT for most ships at the first IOPP renewal survey after 8 Sep 2019 (and newbuild vessels constructed on and after 8 September 2017). The USCG regulations are moving from implementation to enforcement and, with additional USCG approved BWMS, extensions are harder to obtain. Proper planning for BWMS retrofits will help shipowners and shipyards avoid delays. To date, most BWMS installations have been carried out during vessel newbuild and little time remains before the high-paced retrofit installations begin in late 2019.

BWMS compliance for existing vessels present more challenges compared to a newbuild constructions with limited installation spaces, power availability and other compromises required for the installation of the BWMS. Continuing development IMO and USCG testing increases the level of challenges faced for existing vessels (i.e., BWMS Code and VIDA). Shipowners with mid-life vessels are placed in a difficult position to make economic decisions for these vessels – installing a BWMS or scrapping the vessel. Retrofit challenges for mid-life vessels, when combined with nearly concurrent implementation of Global Sulfur 2020 regulations could cause additional problems for these older ships.

There are no single BWMS options suitable for all vessels. Careful detailed retrofit planning is important for cost effective and compliant BWMS solutions. The importance of conducting a comprehensive BWMS feasibility study and selecting from the acceptable shortlisted BWMS should not be overlooked. A feasibility study allows an objective and impartial assessment to help prevent selecting an unsuitable BWMS that could result in additional BWMS retrofits.

Other important considerations that contribute to a successful BWMS retrofit operation includes establishing and maintaining communications with all key stakeholders, choosing a shipyard with practical retrofit experience for installation of the BWMS, engaging with a reliable and reputable naval architect or marine engineering firm and installation contractor, crew training, identifying and developing contingency measures, and developing the BWMP. The BWM Advisory aims to provide useful advice and guidance to achieve successful retrofit. The importance of a BWM Technology feasibility study can help with proper BWMS selection.

Section 7 | Evaluation Checklists

ABS has created a set of checklists to assist shipowners and operators in their assessment of BWMS. Some information is to be supplied by the shipowner and some by BWMS vendors.

Shipowner Supplied Information

Vessel BWMS Compliance date (IMO and/or USCG)

Keel Laying Date: ______________________________

Delivery Date: ______________________________

Total Ballast Capacity (m^3): ______________________________

UWILD Notation/Physical Features: ______________________________

Next IOPP Renewal Survey: ______________________________

Last IOPP Renewal Survey: ______________________________

Last Drydocking Date: ______________________________

Next Drydocking Date: ______________________________

IMO D-2 Compliance Date (Reg. B3 as amended): ______________________________

USCG BWDS Compliance Date: ______________________________

USCG Extension Letter (Validity Date): ______________________________

Vessel Ballast System Information

Ballast System Arrangement

Total Ballast Capacity (m^3): ______________________________

Number of Ballast Tanks: ______________________________

Minimum/Maximum Ballast Tank Size (m^3): ______________________________

Number of Separate Ballast Systems (i.e., not served by the same pump): ____________

Are ballast tanks contiguous with cargo oil or other hazardous cargo tanks? ____________

____

Does the vessel have a dedicated set of heel control tanks (FW or SW)? ____________

Ballast System Equipment

Number of Ballast Pumps and Rating (Flow rate and pressure for each pump): ____________

Overall Ballast Rate (m^3/h): ______________________________

Ballast Pump Location (i.e., engine room, pump room, main deck): _______________________

Main Ballast Line Configuration (ER, pump room, main deck, etc.): _______________________

____

Type of Stripping System, if any: ____

____

Are all ballast system valves remotely operated? ___________________________________

Are ballast pumps piped/shared with other systems (i.e., bilge, fire, cooling water)? ____________

____

Number and Location (i.e., height above bottom) of Sea Chests: _______________________

____

Diameter of Main Ballast Line to/from Pumps: _______________________________________

Number and Size of Spare Circuit Breakers on Main Switchboard: _______________________

____

Estimated Spare Electrical Capacity during Ballasting Operations: _______________________

____

Ship Service and Characteristics that Impact BWMS Selection

Ship Type

Type of Ship: ____

Ballast Water Handling Practices

On average, how much ballast is loaded or discharged at any given port? __________________

____

What are the time constraints on ballast intake (i.e., how fast must it happen)? _______________

____

Maximum Required Flow Rate for Intake of Ballast: ___________________________________

What are the time constraints on ballast discharge (i.e., how fast must it happen)? ____________

____

Maximum Required Flow Rate for Discharge of Ballast: _______________________________

Sediment Build-up in Tanks (i.e., little, moderate, significant): ____________________________

Minimum Time Ballast Held in a Tank between Port Calls: ______________________________

Ballast Water Characteristics

Does the ship encounter fresh water in ports where discharging ballast is necessary? __________

____

Minimum salinity of brackish water encountered: ______________________________________

Turbidity or silt content of port water (low, moderate, heavy): _____________________________

Vessel Service Characteristics

Any unique service constraints or trading patterns regarding ballast use? ____________________

____

Is there trade to special BWT zones: California, Great Lakes, Australia, etc.? ________________

____

Does active ballast management allow zero ballast discharge in some/all ports? ______________

____

Ballast System Characteristics

What are the gravity intake/discharge practices? ______________________________________

Can internal ballast transfer to control trim, heel, bending moment be easily accomplished?

____

Challenges for Installation Engineering

Intake/Discharge Isolation: Cross-Contamination

Can piping installation options provide adequate contamination protection? __________________

____

Can intake and discharge pumps be isolated and dedicated to that service? _________________

____

Sampling and In-service Testing

Does the ship have adequate space and facilities for sampling and testing? __________________

____

Maintaining Ballasting Flexibility

Can the treatment system options selected provide full ballast flexibility? ____________________

____

Other

Is adequate space available for all system components and ballast connections? ______________

____

What are the access openings and routes for bringing in new treatment system components?

____

What are the access needs during system operation and maintenance? ______________________

____

Are switchboard modifications required? ____

Are control system modifications required? ____

BWMS Manufacturer/Vendor Supplied Data

Treatment Technology Factors

Treatment Method

Description of Technology Treatment Sequence: ____

____

For UV System:

Lamp type, required minimum intensity and water clarity: _________________________________

____

For Chemical or Chlorination Systems:

Required minimum dosage rate and minimum holding time: ________________________________

____

Neutralizing agents – How stored, dosed? ____

____

Time required for discharge? ____

Chemicals generated on board or supplied as preparations? _______________________________

____

For De-Oxygenation:

How much inert gas required? ____

Minimum holding time: ____

Type of gas, fuel type and consumption to generate gas: _________________________________

____

Treatment System Capacity

Overall BWMS Rate (m^3/hour): ____

Overall Tank Capacity (m^3) required, if applicable: ______________________________

Treatment System Pressure Drops

Expected pressure drops to main ballast flow added by treatment system: _______________

____

Quantity of ballast redirected for cleaning or sludge discharge: ________________________

Is gravity intake/discharge possible with this system?______________________________

Equipment Size and Space Requirements

Total space required for treatment equipment: ____________________________________

Size of largest single component: ____

Weight of largest single component: ____

Space required for maintenance (element removal, etc.):___________________________

Materials, Equipment Protection (IP rating) and Hazardous Spaces

IP rating of components:____

EX rating of components: ____

Any special risk assessments performed to date for hazardous space installations?__________

____

Power Requirements

Average and maximum power requirements and operating voltage: ___________________

____

Duration of maximum power consumption as function of ballast process: ________________

____

Impacts on Ballast Tank and Pipe Corrosion

Is published R&D available regarding the impact on tank and pipe corrosion rates? __________

____

Health and Safety (Handling, Operation Maintenance)

Quantity of treatment chemicals needed (per ton of ballast water treated): _______________

____

For BWMS using Active Substances, request:

- A copy of the MEPC Final Approval Report with Recommendations
- Material Safety Data Sheets for all Chemicals

General Treatment System Considerations

Proven Efficacy and Official Approvals

Copy of Type Approval certificate issued by or on behalf of, a Government: __________________

System limitations or operating guidelines from Type Approval process: _____________________

Copy of Reports from Land-based and Shipboard Laboratories: ___________________________

Vendor Qualifications and Reputation

Annual production capacity of manufacturer:____

Which components are custom made or incorporate new/novel technology? _________________

____

How many units have been built at the factory to be used for this installation? ________________

Client referrals for previously installed systems: ____

Maintenance Requirements and System Reliability

How many units of similar capacity have been installed? _________________________________

What is average duration of operating experience per unit? _______________________________

What is standard maintenance protocol?____

- Maintenance required at each operation: ____
- Annual Maintenance:____
- Other time-based maintenance (i.e., 1,000 hour service): _______________________________
- Any condition-based maintenance:____

What is the expected service life? ____

Control and Monitoring

Type of remote control system included: ____

____

Ease of connection to primary control and monitoring system: ______________________________

____

Life Cycle Costs

Estimated power consumption for normal ballast operations: ____________________________

____

Fuel consumption expected for inert gas generation: ________________________________

____

Cost of consumables (chemicals, lamps, filter elements): ______________________________

____

Expected frequency of resupply of consumables for planned system size: _________________

____

Availability of consumables (i.e., supplied by one vendor or many): ______________________

____

What major components are most likely to need replacement within 10, 15, 20, 25 years? ______

____

What is their estimated life cycle cost? ____

Section 8 | Sampling and Monitoring Compliance

Many shipowners are concerned with the sampling and monitoring requirements for compliance with the various ballast water discharge standards. As described in Section 1, guidance has been developed to identify the type of analysis that may be required to demonstrate compliance with the BWM Convention and other regional regulations.

Information on the collection of samples and means for quick verification of BWMS performance will help shipowners
15

develop a strategy for compliance and ensure BWMS are operating as designed.

Sample Collection

The G2 Guidelines recommend that vessels install an isokinetic sampling facility to ensure that a sample contains the same proportions of the various flowing constituents as the flow stream being sampled. The USCG and Germany have reported developing isokinetic sampling ports that can be incorporated into the ballast system to collect representative samples of ballast water.

SGS recently presented information on their new prototype isokinetic sampling port. SGS designed a prototype isokinetic sampling port that can easily be incorporated into ballast systems or carried onto a vessel for collection of samples.

Portable Test Kits

Several equipment manufacturers and research institutions have developed portable test kits to quickly identify the presence of a variety of organisms, such as phytoplankton, *E. coli*, and enterococci. These portable test kits could be used by shipboard personnel to assess proper functioning of the BWMS or by Port State Control for the indicative sampling identified in BWM.2/Circ 42 ("Guidance on ballast water sampling and analysis for trial use in accordance with the BWM Convention and Guidelines (G2)").

Most portable test kits identify if the sample is in gross non-compliance with the D-2 standard. One portable test kit also tests for levels of total residual oxidants (TRO) in the ballast water that may result from using specific BWMS. A summary of portable test kits identified is listed in Table 15.

Some portable test kits use fluorescence for an estimate of the abundance and health of phytoplankton in a sample. Other portable test kits monitor biological indicators, such *E. coli* or enterococci, to assess the efficacy of the BWMS.

Regulatory agencies have suggested purchasing portable test kits to ensure the BWMS is operating correctly after installation and as a means to test operation of the BWMS during the warranty period to ensure the BWMS manufacturer corrects any problems.

For ships monitoring BWMS performance, questions have been raised regarding the legal requirement to notify Port State Control of any performance issues with the BWMS.

Table 15. Summary of Available Portable Test Kits

Product/Vendor/Website	Description
*SX-CYT Cytometer Institute of Photonic Sciences (Barcelona, Spain) www.sixsenso.com	Cytometer for measurements with at-spot identification and quantification of biological organisms in water and bio-compatible liquid samples.
10cells bbe Moldaenke GmbH (Schwentinental, Germany) https://www.10cells.com/en/	Portable modified PAM fluorescence detector.
AquaPen-C & AquaPen-P Photon Systems Instruments (Drasov, Czech Republic http://handheld.psi.cz/products/aquapen-c-and-aquapen-p/	Hand-held PAM fluorometer. Quick, reliable and easily repeatable measurements of photosynthetic parameters in both algal and cyanobacterial suspensions.
Ballast-Check 2 Turner Designs (California, USA) https://www.turnerdesigns.com/	Handheld fluorometer detector.
BallastWISE MicroWISE (Aarhus, Denmark) https://microwise.eu/ballastwise/	Portable fluorescence analyzer.
B-QUA LuminUltra (New Brunswick, Canada) https://www.luminultra.com/b-qua/	Portable intra-cellular and extra-cellular ATP detector.
bw monitor Ballast Water Monitoring A/S (Lyngby, Denmark) http://www.bw-monitor.com/	Automated fluorescence in-line analyzer.
BW680 Hach Company (Loveland, Colorado, USA) https://www.hach.com/	Handheld fluorometer uses variable fluorescence to measure the presence of active chlorophyll in living systems.

Product/Vendor/Website	Description
Colilert, Colilert-18, Enterolert, Enterolert-E IDEXX (Westbrook, Maine, USA) https://www.idexx.com/en/	Defined Substrate Technology (DST) microbial enzyme activity detection (E. coli and Enterococci) using MPN method.
ET1302 Ballast Water Checker Euro Tech (Far East) Ltd. (Hong Kong) http://www.euro-tech.com/en/	Handheld PAM fluorescence analyzer.
FastBallast Chelsea Technologies Group (Surrey, UK) https://www.chelsea.co.uk/	Portable fluorescence ballast water compliance monitor for use with discrete or flow-through samples.
P-Counter (OCEANTECH) OCEANTECH CO., LTD. (Busan, ROK) http://www.oceantech.co.kr/EOT/index.php	Portable fluorescence counter enables to obtain the number of phytoplankton instantaneously from a sample of ballast water.
RAPTOR Research International (Monroe, Washington, USA) https://www.resrchintl.com/RAPTOR_Bioassay_System.html	Portable fluorometric 4-channel assay system for monitoring toxins, viruses, bacteria, spores, fungi and other diverse targets.
SpeedyBreedy BACTEST Limited (Colchester, UK) http://speedybreedy.com/	Portable, precision respirometer that has been designed for both industrial and laboratory applications.
VOA1000K Viable Organism Analyser Satake (Hiroshima-ken, Japan) https://satake-group.com/	Fluorescein Diacetate (FDA) stain detection system.

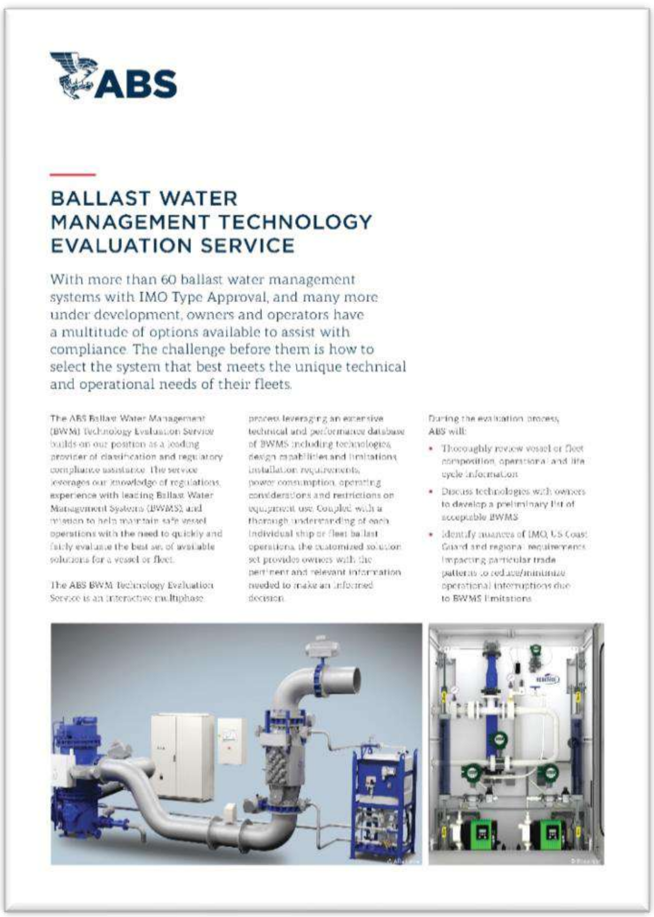
Section 9 | ABS Solutions

Numerous BWMS are available on the market to combat the spread of nonindigenous species, each with benefits and limitations. ABS can assist shipowners to identify systems that can meet their vessel's operational requirements while providing required biological efficacy under expected operating conditions.

Ballast water management is an important issue for shipowners and operators. ABS has the experience to provide assistance in understanding the requirements and identifying solutions. ABS services include:

- Providing guidance on regulatory requirements
- Review of ship survey schedules
- Provision of pertinent and relevant information allowing a vessel owner to reach an informed BWM Technology decision.

ABS provides a Ballast Water Management Technology Evaluation Service to help owners understand installation requirements, design capabilities and limitations, and performance and operating considerations of different ballast water management systems to meet their regulatory compliance needs. The evaluation provides owners with information that enables them to reach an informed decision by confidently choosing the BWMS that best fits their vessels' design and operational profiles**.**



ABS

BALLAST WATER MANAGEMENT TECHNOLOGY EVALUATION SERVICE

With more than 60 ballast water management systems with IMO Type Approval, and many more under development, owners and operators have a multitude of options available to assist with compliance. The challenge before them is how to select the system that best meets the unique technical and operational needs of their fleets.

The ABS Ballast Water Management (BWM) Technology Evaluation Service builds on our position as a leading provider of classification and regulatory compliance assistance. The service leverages our knowledge of regulations, experience with leading Ballast Water Management Systems (BWMS) and mission to help maintain safe vessel operations with the need to quickly and fairly evaluate the best set of available solutions for a vessel or fleet.

The ABS BWM Technology Evaluation Service is an interactive multiphase process leveraging an extensive technical and performance database of BWMS including technologies, design capabilities and limitations, installation requirements, power consumption, operating considerations and restrictions on equipment use. Coupled with a thorough understanding of each individual ship or fleet ballast operations, the customized solution set provides owners with the pertinent and relevant information needed to make an informed decision.

During the evaluation process, ABS will:

- Thoroughly review vessel or fleet composition, operational and life cycle information
- Discuss technologies with owners to develop a preliminary list of acceptable BWMS
- Identify nuances of IMO, US Coast Guard and regional requirements impacting particular trade patterns to reduce/minimize operational interruptions due to BWMS limitations

BWM Technology Evaluation Service Cutsheet

To demonstrate compliance with class and statutory requirements, ABS also offers the optional classification notation Ballast Water Treatment (**BWT**) and Ballast Water Treatment Plus (**BWT+**). Both the **BWT** and **BWT**+ notations require an IMO type approved BWMS installed onboard, to verify that the testing, approval, and certification processes are conducted in accordance with the IMO's "Guidelines for Approval of Ballast Water Management Systems (G8)" and the "Guidelines for Procedure for Approval of Ballast Water Management Systems that make use of Active Substances (G9)" for BWMS using active substances.

To receive the **BWT+** notation, in addition to having a IMO type-approval system, the BWMS installed onboard shall also fulfil all the applicable requirements of the ABS Guide for Ballast Water Treatment, and be surveyed by an ABS Surveyor during the manufacture of the system and components,

Vessels that are fitted with a BWMS but did not pursue the **BWT** or **BWT+** notation are to comply with the requirements as stipulated in Sections 4 and 5 of the ABS Guide for Ballast Water Treatment and be verified by an ABS Surveyor during installation.

To help support the marine industry in better understanding the BWM legislation and requirements and the challenges ahead with respect to BWMS operations, ABS has also developed the following documents in addition to this BWMS Advisory:

- ABS Guide for Ballast Water Exchange, May 2018
- ABS Guide for Ballast Water Treatment, June 2018
- Best Practices for Operations of Ballast Water Management Systems, August 2017
- 2019 Best Practices for Operations of Ballast Water Management Systems, March 2019

ABS can also provide additional assistance in many environmental areas, such as assistance in understanding and complying with US EPA VGP requirement.

For more information, please contact your local ABS representative or email environmentalperformance@eagle.org.

Appendix A I Individual US State BWM Requirements

Table 16. Summary of State Requirements

State	Regulation
Alaska	Alaska Statutes 46.03.750 on ballast water discharge provided the following: (a) Except as provided in (b) of this section, a person may not cause or permit the discharge of ballast water from a cargo tank of a tank vessel into the waters of the state. A tank vessel may not take on petroleum or a petroleum product or by-product as cargo unless it arrives in ports in the state without having discharged ballast from cargo tanks into the waters of the state and the master of the vessel certifies that fact on forms provided by the department. (b) The master of a tank vessel may discharge ballast water from a cargo tank of a tank vessel if it is necessary for the safety of the tank vessel and no alternative action is feasible to ensure the safety of the tank vessel.
Arizona	Discharge must not exceed a maximum level of 19 µg/L of total residual chlorine
California	Requirements for ballast water management apply to vessels over 300 gross registered tons, capable of carrying ballast water. Prior to the implementation of performance standards management requirements vary depending on whether the vessel arrives from inside or outside of the Pacific Coast region, and whether ballast water is from inside or outside of the Pacific Coast region. The two regulatory categories are: 1. Vessels arriving to California waters from a port or place outside the Pacific Coast region 2. Vessels arriving to California waters from a port or place within the Pacific Coast region, with ballast water from the Pacific Coast region If the ballast water receives chlorination treatment, the discharge to the ocean shall not exceed a maximum level of 60 micrograms per liter (µg/L) of total residual chlorine, and the discharge to inland waters, enclosed bays, and freshwaters shall not exceed a maximum level of 19 µg/L of total residual chlorine. Information on California discharge standards are in Section 2 of the BWT Advisory.
Connecticut	Vessels entering CT waters must maintain the ability to measure salinity levels in each ballast tank on board the vessel so that salinities between 20 and 25 ppt can be ensured for ballast water exchange (BWE) in marine waters and salinities between 0 and 5 can be ensured for BWE in fresh water.
Hawaii	Vessels that carry ballast water are to follow the state administrative rules for ballast water (HAR 13-76), have a ballast water management plan specifically for that vessel, and file a ballast water reporting form with the Department of Land and Natural Resources (DLNR) no later than 24 hours prior to arrival. HAR 13-76-18 states that any vessel that has not conducted a mid-ocean waters BWE shall not discharge BW into state marine waters. Vessels also shall provide information on ballast water treatment systems (BWTS) and management practices. The discharge to salt waters shall not exceed a maximum level of 13 micrograms per liter (µg/L) of total residual chlorine (TRC), and the discharge to freshwaters shall not exceed a maximum level of 19 µg/L of total residual chlorine (TRC). The discharge of pH to salt waters shall not deviate more than 0.5 units from a value of 8.1, except at coastal locations where and when freshwater form stream, storm drain or groundwater discharge may depress the pH to a minimum level of 7.0. The discharge of pH to fresh waters shall not deviate more than 0.5 units from ambient conditions and shall not be lower than 5.5 nor higher than 8.0. The discharge of turbidity to salt waters shall not exceed 5.0 NTU and fresh waters shall not exceed 25.0 NTU. The discharges temperature shall not vary more than one degree Celsius from ambient conditions.

State	Regulation
	The discharges of enterococcus to sea waters within 300 meters of the shoreline, including natural public bathing or wading areas shall not exceed a geometric mean of 35 CFU per 100 milliliters in not less than five samples which shall be spaced to cover a period between twenty-five and thirty days. No single sample shall exceed the single sample maximum of 104 CFU per 100 milliliters or the site-specific one-sided 75 per cent confidence limit. Marine recreational waters along sections of coastline where enterococcus content does not exceed the standard, as shown by the geometric mean test described above, shall not be lowered in quality. The discharges of enterococcus to sea waters shall not exceed a geometric mean of 33 per one hundred milliliters in not less than five samples which shall be spaced to cover a period between 25 and 30 days. No single sample shall exceed the single sample maximum of 89 CFU per 100 milliliters or the site-specific one-sided 82 per cent confidence limit.
Illinois	Any vessel employing ballast water management systems using chlorine in any of its forms, shall not exceed the acute water quality standard for Total Residual Chlorine of 0.019 mg/1 or the chronic water quality standard for Total Residual Chlorine of 0.011 mg/l. In order to demonstrate compliance with the water quality standards above, the discharge of Total Residual Chlorine shall not exceed the laboratory quantification level of 0.05 mg/1 using test methods equivalent in accuracy to amperometric titration. The usage of other biocides shall not cause a violation of applicable water quality standards and shall not be discharged in concentrations considered toxic or harmful to aquatic life.
Indiana	Oceangoing vessels that enter the Great Lakes-St. Lawrence Seaway system and are transiting from beyond the 200-nautical-mile Exclusive Economic Zone (EEZ) shall perform open ocean BWE or saltwater flushing before entering the Great Lakes St. Lawrence Seaway system. For Oceangoing Vessels, constructed prior to 1 December 2013, treatment shall be installed and operational to meet the performance standards for organisms by the vessel's first scheduled drydocking after 1 January 2016. For Oceangoing Vessels, constructed after 1 December 2013, treatment shall be installed and operational to meet the performance standards for organisms prior to commencement of vessel operation in Indiana state waters. Any vessel discharging ballast water via a BWTS using chlorine shall not exceed a maximum total residual chlorine (TRC) limit of 0.02 mg/l and shall not violate applicable water quality standards and discharged in concentrations considered to be toxic or harmful to aquatic life for other biocides used.
Maine	Vessels whose voyage originates outside the EEZ and enters Maine waters shall conduct BWE or flushing beyond the EEZ, at least 200 nautical miles from any shore, and in water at least 2,000 meters in depth, resulting in salinity levels of at least 30 ppt. These requirements remain in effect regardless of whether the vessel is equipped with a BWTS. All vessels entering Maine waters must maintain the ability to measure salinity levels in each tank on board the vessel so that salinities of at least 30 ppt can be ensured.
Michigan	Oceangoing vessels are prohibited from discharging ballast water in Michigan's waters unless the vessel has obtained a Certificate of Coverage under the Ballast Water Control General Permit (Permit No. MIG140000) or an Individual Permit from the Michigan Department of Environmental Quality (MDEQ)and is in full compliance with the discharge limitations, monitoring requirements, and other conditions set forth in that General Permit or Individual Permit. Vessels whose voyages originate from outside the EEZ and enter Michigan waters with ballast on board, shall conduct BWE at least 200 nautical miles (nm) from any shore and in waters beyond the EEZ. Such vessels that carry only residual amounts of ballast water and/or sediments shall conduct saltwater flushing of their ballast tanks, at least 200 nm from any shore and in waters beyond the EEZ. All vessels entering Michigan waters must maintain the ability to measure salinity levels in each ballast tank on board the vessel so that salinities of at least 30 ppt can be ensured.

State	Regulation
	Any vessel using a BWTS by 31 December 2014, consistent with the technologies identified in Michigan's Ballast Water Control General Permit or an alternative technology approved by the MDEQ, will not be required to meet any future numeric water quality-based effluent limits (WQBEL) for living organisms until the functional life of that BWTS has expired or the life of the vessel has expired, whichever is earlier. These vessels must continue BWE and saltwater flushing unless it is demonstrated to the MDEQ that numeric WQBELs adopted after the date of this certification for living organisms are met. Live Organism Monitoring: Any vessel, whose voyages originate from outside the EEZ that discharges ballast water to Michigan waters, shall monitor ballast water discharged from their vessel at least once each year for living organisms greater than 50 µm in minimum dimension, and living organisms equal to or less than 50 µm in minimum dimension and equal to or greater than 10 µm in minimum dimension; and submit a report summarizing the discharge monitoring results collected for the above live organism size categories to the MDEQ no later than 31 December of each year. The ballast water discharge samples shall be collected and analyzed consistent with protocols established by the MDEQ. If the MDEQ fails to establish protocols, then the requirements set forth in this condition will be waived. Any non-oceangoing vessels the ballast water management systems are prohibited from discharging ballast water in Michigan waters with total residual chlorine concentrations above 38 micrograms per liter (µg/L) when the ballast water discharge duration exceeds 160 minutes, or above 200 µg/L when the ballast water discharge duration is less than or equal to 160 minutes. The owners/operators of vessels required to utilize a ballast water management system shall allow the MDEQ reasonable entry onto the vessel for inspection, access to records, and collection of a ballast water discharge sample(s) for determining compliance.
Minnesota	Vessels must obtain any permits required by the state of Minnesota for vessel discharges and comply with all requirements in the applicable permit at the time of compliance review. Any vessel whose voyage originates outside the EEZ and enters Minnesota waters shall not discharge ballast unless the following conditions are met: the vessel has conducted BWE or flushing beyond the EEZ, at least 200 nautical miles from any shore, and in water at least 2,000 meters in depth, while in oceanic waters, resulting in a salinity level of at least 30 parts per thousand (ppt) prior to the time the vessel enters Minnesota waters. This requirement remains in effect regardless of whether the vessel is equipped with a BWTS. This requirement is in addition to treatment requirements. All vessels entering Minnesota waters must maintain the ability to measure salinity levels in each tank on board the vessel so that salinities of at least 30 ppt can be ensured prior to discharge in Minnesota waters. "High Risk" Ballast Water. If relocation of a high risk ballast discharge is required, proper authorities will identify alternative locations for the discharge of the high risk ballast water. As an alternative to discharging high-risk ballast water, the Minnesota Pollution Control Agency (MPCA) may authorize the use of BWTS identified as promising technology by EPA, USCG, neighboring states or a US ballast water testing research facility (e.g., Golden Bear, Great Ships Initiative and Maritime Environmental Resource Center). Lakers that operate exclusively in the Great Lakes. Specific Best Management Practices (BMPs) are required to be incorporated into the vessel's ballast management plan and implemented prior to discharge of ballast in Minnesota waters. Monitoring: Vessels with a BWTS must sample and analyze the ballast water discharge at least once a year (provided appropriate facilities are available) using the shipboard Environmental Technology Verification (ETV) sampling protocol, a protocol consistent with IMO G8/G9 protocols, or a compliance monitoring protocol developed by the USCG, whichever is most advanced and available. This monitoring shall include sampling, identification and enumeration of live organisms >50 µm and between 10-50 µm in size. The monitoring results shall be submitted to EPA and the MPCA on an annual basis. Live organism monitoring shall include the collection of representative discharge samples and the testing (counting) of live organisms in such samples by qualified personnel in accordance with standard and/or best available sampling and analytical methods. Beginning 24 months after final issuance of the 2013 VGP, all vessels not required to meet numeric ballast treatment limits shall complete the following ballast discharge monitoring: i. sample and analyze, a minimum of once annually, for organism density and composition. Sampling and analysis methods shall be consistent with protocols described above. Samples must be analyzed for total organisms (live or dead) greater than or equal to 10 micrometers in size. The ballast discharge subject to sampling must be taken on the ship in a Great Lakes port for discharge into Minnesota waters. You

State	Regulation
	must report the uptake locations and volumes subject to sampling, as well as the volume you plan to discharge in Minnesota's waters, best management practices employed, and other factors affecting the composition of the sample. ii. Complete a ballast discharge biological study approved by the MPCA.
New York	Vessels whose voyage originates outside the EEZ and enters New York waters shall conduct BWE or flushing beyond the EEZ, at least 200 nautical miles from any shore, and in water at least 2,000 meters in depth, resulting in a salinity level of at least 30 ppt. These requirements remain in effect regardless of whether the vessel is equipped with a BWTS. No Vessel which operates a treatment system shall bring ballast water into New York waters unless its ballast tanks have been exchanged or flushed at a location at least 200 nautical miles from shore in accordance with the above requirements, and unless any water reintroduced into the vessel's tanks is ocean water from that same general location which has been treated by the vessel's treatment system prior to entry into New York waters. All vessels entering New York waters must maintain the ability to measure salinity levels in each tank on board the vessel so that salinities of at least 30 ppt can be ensured. The following Best Management Practices (BMPs) are required to be implemented in the Great Lakes: a. Annually inspect (with documentation) and replace, as necessary, ballast sea chest screens, b. Lightening the ship as much as practical to elevate water intakes before ballasting to minimize sediment uptake and increase water flow, c. Ballast water taken aboard in Viral Hemorrhagic Septicemia (VHS) affected waters shall be the minimum needed to ensure the safety of the crew and vessel. d. Ballast water shall always be taken aboard or discharged via the pumps and never "gravity fed or drained." Recommended BMPs are also included to reduce the spread of the VHS disease. Live Organism Monitoring. All vessels with a BWTS must sample and analyze the ballast water discharge at least once a year (provided appropriate facilities are available) using the California shipboard sampling protocol, or a compliance monitoring protocol developed by the USCG, whichever is most advanced and available. This monitoring shall include sampling for >50 µm and for 10-50 µm organisms. The monitoring results shall be submitted to EPA and the Department on an annual basis. Such live organism monitoring shall include the collection of representative discharge samples and the testing (counting) of live organisms in such samples by qualified personnel in accordance with standard and/or best available sampling and analytical methods.
Ohio	Vessels that operate outside the US EEZ and more than 200 nautical miles from shore, and then enter the Great Lakes via the St. Lawrence Seaway System must conduct salt water flushing of ballast tanks. This condition applies both before and after treatment system deadlines in the VGP. Vessels are prohibited from discharging ballast water sediment in Ohio waters. Ohio EPA believes that IMO treatment standards are not "practical and possible" at this time for existing vessels operating exclusively within the Great Lakes, as defined in the VGP. It is likely that discharges of ballasted sea water will not meet the toxicity narrative water quality standard if discharged in the relatively shallow water of Ohio's Lake Erie ports, due to the dissolved solids levels in sea water. Discharges in the open waters of the Lake minimize the risk of toxicity and will allow the standard to be met. To prevent toxicity to ambient organisms or rapidly lethal conditions, discharges of ballasted sea water within the breakwalls of Ohio's Lake Erie Ports is prohibited. For BWTS using chlorine, discharges must meet a maximum chlorine limit of 38 µg/l if the discharge lasts for more than 160 minutes/day; the limit is 200 µg/l if the discharge is 160 minutes/day or less. The inside-mixing-zone maximum criterion for short-term exposures to chlorine is 200 µg/l; the otherwise applicable criterion is 38 µg/l. The water quality criteria for bromine are therefore set at1/4 of the chlorine standard. Discharges of other biocides must meet the narrative water quality standard for toxicity noted above. Other biocides used in ballast water treatment must meet Ohio's narrative toxicity water quality standard. To meet the 'no rapidly lethal conditions' narrative, discharges of all biocides must meet inside-mixing-zone water quality standards (Final Acute Values). The discharge of organic quaternary ammonium compounds is prohibited.

State	Regulation
Oregon	Oregon's ballast water management legislation prohibits discharge of ballast water into state waters, except under below specified conditions. These regulations apply to all commercial vessels greater than 300 gross tons that are equipped with ballast water tanks. A vessel may discharge ballast waters into waters of the state if: the vessel conducts an open ocean exchange (at least 200 nautical miles from shore and in waters at least 2,000 meters deep); or the discharged ballast was solely sourced within 'common waters' of the state, identified as the West Coast region of North America between 40° N and 50°N; or a coastal exchange of ballast water takes place (at least 50 nautical miles from shore and in waters at least 200 meters deep) for coastwise voyages with ballast tanks that originated from the Pacific Coastal Region south of 40° N or north of 50°N; or the discharged ballast was treated in a manner authorized by Oregon Administrative Rule 340-143-0050; or conditions are such that conducting an exchange would be unsafe or infeasible due to adverse weather, vessel design limitations or equipment failure. In these instances, the vessel must clearly declare a safety exemption on its ballast water reporting form and may be subject to operational delays and/or alternative management requirements following DEQ review. Oregon requires that vessels submit ballast water management reporting forms to DEQ at least 24 hours before entering state waters. Reports may be submitted as email attachments (.pdf or .xml formats only) to ballast.water@deq.state.or.us. In the event a vessel's actual ballast practices differ from those projected on the report, an amended report must be submitted to DEQ before the vessel's departure. Ship owners must develop a vessel-specific Ballast Water Management Plan and maintain a shipboard ballast water handling log that may be reviewed as part of compliance verification inspections. Violations of the state ballast management regulations or failure to meet the reporting or recordkeeping requirements may be subject to fines up to $25,000 per day of violation and/or civil penalties. An $88 per-arrival fee assessed on regulated commercial vessels transiting Oregon waters.
Rhode Island	Vessels whose voyage originates outside the EEZ and enters Rhode Island waters shall conduct BWE or flushing beyond the EEZ, at least 200 nautical miles from any shore, and in water at least 2,000 meters in depth. These requirements remain in effect regardless of whether the vessel is equipped with a BWTS. Vessels are urged to voluntarily install currently available technologies that go beyond the IMO D-2 standard (e.g., systems that have demonstrated the ability to meet and exceed a 10x IMO level of treatment) as a means of gaining useful experience while contributing to the advancement of treatment technology. All vessels covered under the VGP and operating in Rhode Island waters, after a BWTS is installed, must sample and analyze the ballast water discharge at least once a year (provided appropriate facilities are available), using the California shipboard sampling protocol, or a compliance monitoring protocol developed by the USCG, whichever is most advanced and available. The monitoring results shall be submitted to EPA and the department on an annual basis. Such live organism monitoring shall include the collection of representative discharge samples and the testing (counting) of live organisms in such samples by qualified personnel in accordance with standard and/or best available sampling and analytical methods. In addition to EPA submissions, the applicant must submit all sampling results to the Office of Water Resources, RI Department of Environmental Management.
Washington	Vessel are required to file a ballast water reporting form at least 24 hours prior to arrival into waters of the state. If filing twenty-four hours prior is not possible due to voyage distance or change in destination, vessel owners or operators must file at the time of first known or predictable Washington port visit. A vessel owner or operator filing a reporting form for a Columbia River visit and stating its destination as a state of Oregon port must file a new reporting form if its itinerary changes to a Washington port or for a subsequent voyage from an Oregon port to a Washington port. Discharge of ballast water into waters of the state is authorized only if there has been an open sea exchange, or if the vessel has treated its ballast water, to meet standards set by the department consistent with applicable state and federal laws. Please see detail state ballast water requirements from Chapter 220-150 WAC: Washington State Ballast Water Management Rules by using the following link: http://wdfw.wa.gov/ais/ballast/wac_220-150_ballast_water_rules_072609.pdf

State	Regulation
Wisconsin	Oceangoing vessels that enter the Great Lakes-St. Lawrence Seaway system and are transiting from beyond the 200-nautical-mile EEZ shall perform open ocean BWE or saltwater flushing before entering the Great Lakes-St. Lawrence Seaway system in order to ensure water quality standards are met that protect the general public interest. Vessels must obtain any permits required by the state of Wisconsin for vessel discharges. Vessels that operate exclusively within the Great Lakes, and which meet the EPA VGP applicability requirements, will be addressed in Wisconsin's next ballast water discharge general permit. Discharges of ballast water from vessels using BWTS using chlorine must meet a daily maximum total residual oxidants limit, measured as total residual chlorine, of 38 µg/L. Discharges of ballast water from vessels containing seawater in other than insignificant residual amounts that remain in tanks and that cannot be pumped out or drained (no ballast on board) is prohibited unless it can be demonstrated that the discharge will comply with Wisconsin chloride limits. High-risk ballast water may not be discharged into waters of the state without Wisconsin Department of Natural Resources (WDNR) review and authorization. Vessel owners or operators with unexchanged or untreated ballast must submit a request, providing sufficient additional information for WDNR to evaluate the request and determine whether an emergency ballast water management alternative is warranted. WDNR, coordinating with the USCG and the states of Illinois, Iowa, Michigan and Minnesota as needed may identify alternative locations for the discharge of unexchanged or untreated ballast water. As an alternative to discharging high-risk ballast water, WDNR may authorize the use of BWTS identified as promising technology by EPA, USCG, neighboring states or a US ballast water testing research facility. US ballast water testing research facilities include, but may not be limited to the Golden Bear, Great Ships Initiative and Maritime Environmental Resource Center. BWTS used in Wisconsin waters must be specifically tested for use in fresh water. Routine visual inspections of the BWTS are to be conducted at least on a monthly basis.

Appendix B | Type Approved BWM Systems

Note: Information presented is current as of February 2019 and is based on:

- BWM.2/Circ.34/Rev.7 (9 Jan 2019) available at IMO DOCS website (https://docs.imo.org/),
- January 2019 list of BWMS which received Type Approval Certification by their respective Administrations (http://www.imo.org/en/OurWork/Environment/BallastWaterManagement/Pages/BWMTechnologies.aspx),
- IMO Docs MEPC 74 (https://docs.imo.org/)
- USCG Marine Safety Center Ballast Water Management Switchboard (https://www.dco.uscg.mil/Our-Organization/Assistant-Commandant-for-Prevention-Policy-CG-5P/Commercial-Regulations-standards-CG-5PS/Marine-Safety-Center-MSC/ballast-water/),
- USCG OES Alternate Management Systems list (https://www.dco.uscg.mil/Our-Organization/Assistant-Commandant-for-Prevention-Policy-CG-5P/Commercial-Regulations-standards-CG-5PS/Office-of-Operating-and-Environmental-Standards/Environmental-Standards/AMS/), and
- ABS Type Approval Database (https://ww2.eagle.org/en/Products-and-Services/type-approval.html).

BWMS Manufacturer	Treatment Method	BWM Conv. Flag Admin. Approvals	USCG Type Approved	USCG IL LOI	USCG AMS	ABS PDA/ TA
AHEAD®-BWMS Ahead Ocean Technology Co., Ltd.	Ballasting: Filtration and UV treatment De-ballasting: UV re-treatment	China			YES	YES
AQUARIUS® EC Wärtsilä Water Systems Ltd.	Ballasting: Filtration and side-stream EC De-ballasting: TRO neutralization	The Netherlands	YES	YES	YES	NO
AQUARIUS® UV Wärtsilä Water Systems Ltd.	Ballasting: Filtration and UV treatment De-ballasting: UV re-treatment	The Netherlands	YES	YES	YES	NO
AquaStar™ and MACGREGOR AquaStar Co., Ltd.	Ballasting: Smart Pipe and in-line EC De-ballasting: TRO neutralization	Republic of Korea		YES	YES	YES
ARA PLASMA SAMKUN CENTURY CO., LTD	Ballasting: Filtration, plasma and UV treatment De-ballasting: Plasma and UV re-treatment	Republic of Korea		YES	YES	
ATPS-BLUE Panasonic Environmental Systems and Engineering Co., Ltd.	Ballasting: In-line EC and Stirring Device with TRO neutralized sediment removal De-Ballasting: TRO neutralization	Japan		YES	YES	
BalClor™ SunRui Marine Environment Engineering Co., Ltd	Ballasting: Filtration and side-stream EC injection De-ballasting: TRO neutralization	Norway and China	YES	YES	YES	YES

BWMS Manufacturer	Treatment Method	BWM Conv. Flag Admin. Approvals	USCG Type Approved	USCG IL LOI	USCG AMS	ABS PDA/ TA
BallastAce® JFE Engineering Corporation	Ballasting: Filtration and stored TG Ballastcleaner® dosing De-ballasting: TRO neutralization	Japan	YES	YES	YES	
BallastAce® JFE Engineering Corporation	Ballasting: Filtration and NEO-CHLOR MARINE® dosing De-ballasting: TRO neutralization	Japan	YES	YES	YES	
BallastMaster ultraV 250/v500 GEA Westfalia Separator Group GmbH	Ballasting: Filtration and UV treatment De-ballasting: UV re-treatment	Germany			YES	
BALPURE® De Nora Water Technologies	Ballasting: Filtration and side-stream EC injection De-ballasting: TRO neutralization	Germany	YES	YES	YES	YES
BALWAT Shanghai Jiazhou Environmental Mechanical and Electrical Co. Ltd.	Ballasting: Filtration and UV treatment De-ballasting: UV re-treatment	China			YES	
BAWAT™ BAWAT A/S	Ballasting: NONE In voyage: Pasteurization and N_2 deoxygenation De-ballasting: NONE	Denmark		YES	YES	YES
BIO-SEA® BIO-SEA B BIO-UV SAS	Ballasting: Filtration and UV treatment De-ballasting: UV re-treatment	France	YES	YES	YES	YES
BioViolet UV Kwangsan Co., Ltd.	Ballasting: Filtration and UV treatment De-ballasting: UV re-treatment	Republic of Korea			YES	
Blue Ocean Shield (BOS) China Ocean Shipping Group Company (COSCO)	Ballasting: Filtration and UV treatment De-ballasting: UV re-treatment	China		YES	YES	YES
BlueZone™ SUNBO Industries Co., Ltd	Ballasting: Ozone (O_3) injection De-ballasting: TRO neutralization	Republic of Korea			YES	
BSKY™ Wuxi Brightsky Electronic Co., Ltd.	Ballasting: Hydrocyclone, ultrasonic (US), and UV treatment De-ballasting: US and UV re-treatment	China		YES	YES	
Cathelco Evolution Cathelco Limited	Ballasting: Filtration and UV treatment De-ballasting: UV re-treatment	Germany	PENDING	YES	YES	

BWMS Manufacturer	Treatment Method	BWM Conv. Flag Admin. Approvals	USCG Type Approved	USCG IL LOI	USCG AMS	ABS PDA/ TA
CleanBallast® RWO GmbH Marine Water Technology	Ballasting: Filtration and in-line electrolytic De-ballasting: TRO neutralization	Germany		YES	YES	
ClearBallast Hitachi Plant Technologies, Ltd.	Ballasting: Coagulation and flocculation De-ballasting: None	Japan				
Coldharbour GLD™ Coldharbour Marine Ltd.	Ballasting: None In-voyage: IGG/GLD-5 phases of deoxygenation treatment De-ballasting: None	UK MCA		YES	YES	
CrystalBallast® Auramarine Ltd.	Ballasting: Filtration and UV treatment De-ballasting: UV re-treatment	Norway			YES	YES
Cyeco™ Shanghai Cyeco Environmental Technology Co., Ltd.	Ballasting: Filtration and UV treatment De-ballasting: UV re-treatment	China		YES	YES	YES
Damen InvaSave Damen Green Solutions B.V.	1) Single pass during vessel de-ballasting 2) Single pass during vessel ballasting Filtration and UV treatment	The Netherlands				
EcoBallast™ Hyundai Heavy Industries Co., Ltd.	Ballasting: Filtration and UV treatment De-ballasting: UV re-treatment	Republic of Korea	Pending	YES	YES	
Ecochlor® Ecochlor, Inc.	Ballasting: Filtration and ClO_2 injection De-ballasting: None	Germany	YES	YES	YES	YES
EcoGuardian™ Hanla IMS Co., Ltd.	Ballasting: Filtration and side-stream EC injection De-ballasting: TRO neutralization	Republic of Korea		YES	YES	
ECOMARINE™-EC Sumitomo Electric Industries, Ltd.	Ballasting: Filtration and UV treatment De-ballasting: UV re-treatment	Japan			YES	
Electro-Cleen™ Techcross, Co., Ltd.	Ballasting: Coarse strainer and in-line EC De-ballasting: TRO neutralization	Republic of Korea	YES	YES	YES	YES
Envirocleanse inTank™ Envirocleanse, LLC	Ballasting: NONE In Voyage: Side-stream EC and tank circulation De-Ballasting: NONE	Norway	YES	YES		

BWMS Manufacturer	Treatment Method	BWM Conv. Flag Admin. Approvals	USCG Type Approved	USCG IL LOI	USCG AMS	ABS PDA/ TA
ERMA FIRST ERMA FIRST ESK Engineering Solutions S.A.	Ballasting: Pre-filtration, cyclone and in-line EC De-ballasting: TRO neutralization	Greece			YES	YES
ERMA FIRST FIT ERMA FIRST ESK Engineering Solutions S.A.	Ballasting: Filtration and in-line EC De-ballasting: TRO neutralization	Greece	YES	YES	YES	YES
FineBallast® MF Mitsui Engineering & Shipbuilding Co., Ltd.	Ballasting: Pre-filtration, micro-filtration, H_2O_2 CIP De-ballasting: Pre-filtration, micro-filtration, H_2O_2 CIP and TRO monitoring	Japan			YES	
FineBallast® OZ Mitsui Engineering & Shipbuilding Co., Ltd.	Ballasting: Pre-filtration and ozone injection De-ballasting: Pre-filtration and activated carbon treatment tank	Japan				
GloEn-Patrol™ Panasia Co., Ltd.	Ballasting: Filtration and UV treatment De-ballasting: UV re-treatment	Republic of Korea	YES	YES	YES	YES
GUARDIAN®/ GUARDIAN Gold® Hyde Marine	Ballasting: Filtration and UV treatment De-ballasting: UV re-treatment	United Kingdom		YES	YES	
HiBallast™ Hyundai Heavy Industries Co., Ltd.	Ballasting: Filtration and side-stream EC De-ballasting: TRO neutralization	Republic of Korea	YES	YES	YES	
HY™-BWMS Shanghai Hengyuan Marine Equipment Co., Ltd	Ballasting: Filtration and UV treatment De-ballasting: UV re-treatment	China			YES	
KBAL® Knutsen Technology	Ballasting: PV (pressure vacuum) and UV treatment De-ballasting: PV and UV re-treatment	Norway		YES	YES	YES
Kurita Kurita Water Industries, Ltd.	Ballasting: Stored sodium hypochlorite/ Phosphate injection De-Ballasting: TRO neutralization	Japan		YES		
LeesGreen Shanghai LEE's FUDA Electromechanical Technology Co, Inc.	Ballasting: Filtration and UV treatment De-ballasting: UV re-treatment	China				YES

BWMS Manufacturer	Treatment Method	BWM Conv. Flag Admin. Approvals	USCG Type Approved	USCG IL LOI	USCG AMS	ABS PDA/ TA
MARINOMATE™ KT Marine Co., Ltd.	Ballasting: Plankill™ pipe and in-line EC De-ballasting: TRO neutralization	Korea			YES	
MICROFADE™ KURARAY CO., LTD.	Ballasting: Filtration and stored chemical dosing De-ballasting: TRO neutralization Calcium hypochlorite	Japan			YES	
Miura HK Miura Co., Ltd.	Ballasting: Filtration and UV treatment De-ballasting: UV re-treatment	Japan	PENDING	YES	YES	
MMC MMC Green Technology AS	Ballasting: Filtration and UV treatment De-ballasting: UV re-treatment	Norway		YES	YES	
NiBallast™ Jiangsu Nanji Machinery Co., Ltd	Ballasting: Filtration, membrane micro-filtration and deoxygenation (N_2 supersaturation) De-ballasting: NONE	China		YES	YES	YES
NK-O3 BlueBallast NK Co., Ltd	Ballasting: Ozone injection De-ballasting: TRO neutralization	Republic of Korea	PENDING	YES	YES	YES
Ocean Guard CompactClean DESMI Ocean Guard A/S	Ballasting: Filtration and UV treatment De-ballasting: Filtration and UV re-treatment	Denmark	YES	YES		
Ocean Guard OxyClean DESMI Ocean Guard A/S	Ballasting: Filtration, ozone and UV treatment De-ballasting: UV re-treatment	Denmark			YES	
Ocean Guard RayClean™ DESMI Ocean Guard A/S	Ballasting: Filtration and UV treatment De-ballasting: Filtration and UV re-treatment	Norway		YES	YES	
Ocean Protection System (OPS) MAHLE GmbH	Ballasting: Pre-filtration, filtration and UV treatment De-ballasting: UV re-treatment	Germany				
OceanDoctor® Jiujiang Precision Measuring Technology Research Institute	Ballasting: Filtration, UV treatment and AOT De-ballasting: NONE	China			YES	YES
OceanGuard® Qingdao Headway Technology Co., Ltd.	Ballasting: Filtration and EUT De-ballasting: TRO neutralization	Norway	YES	YES	YES	YES

BWMS Manufacturer	Treatment Method	BWM Conv. Flag Admin. Approvals	USCG Type Approved	USCG IL LOI	USCG AMS	ABS PDA/ TA
Optimarin Ballast System (OBS) Optimarin AS	Ballasting: Filtration and UV treatment De-ballasting: UV re-treatment	Norway	YES	YES	YES	YES
PACT Marine™ PACT Environmental Technology Co., Ltd.	Ballasting: Filtration and UV treatment De-ballasting: UV re-treatment	China			YES	
PureBallast 250-2500 Alfa Laval Tumba AB	Ballasting: Filtration and AOT Reactor (UV with TiO_2 catalyst) De-ballasting: AOT re-treatment	Norway			YES	
PureBallast 2.0, 2.0Ex Alfa Laval Tumba AB	Ballasting: Filtration and UV treatment De-ballasting: UV re-treatment	Norway		YES	YES	
PureBallast 3.0/3.1, 3.0Ex/3.1Ex Alfa Laval Tumba AB	Ballasting: Filtration and UV treatment De-ballasting: UV re-treatment	Norway	YES	YES	YES	YES
PureBallast 3.2 Alfa Laval Tumba AB	Ballasting: Filtration and UV treatment De-ballasting: UV re-treatment	Norway	Pending	YES		
Purimar Samsung Heavy Industries Co., Ltd.	Ballasting: Filtration and side-stream EC injection De-ballasting: TRO neutralization	Republic of Korea	YES	YES	YES	YES
Resource Ballast Technologies System Resource Ballast Technologies (Pty) Limited	Ballasting: Filtration, cavitation, and ozone or in-line EC De-ballasting: TRO monitoring	South Africa				
SeaCURE® Evoqua Water Technologies LLC	Ballasting: Filtration and side-stream EC injection De-ballasting: TRO neutralization	Germany		YES	YES	
Seascape® Elite Marine Ballast Water Treatment System Corp.	Ballasting: Filtration, UV treatment and ultrasound (US) De-ballasting: UV re-treatment and US	China		YES	YES	YES
SEDNA® Hamann AG	TAC WITHDRAWN	Germany				
Semb-Eco LUV Ecospec Marine Technology Pte Ltd	Ballasting: Filtration and UV treatment De-ballasting: UV re-treatment	Singapore	PENDING	YES	YES	
SKY-SYSTEM® Nippon Yuka Kogyo Co., Ltd.	Ballasting: PERACLEAN Ocean De-ballasting: TRO neutralization	Japan			YES	

BWMS Manufacturer	Treatment Method	BWM Conv. Flag Admin. Approvals	USCG Type Approved	USCG IL LOI	USCG AMS	ABS PDA/ TA
Smart Ballast® STX Heavy Industries Co., Ltd.	Ballasting: Strainer and in-line EC De-ballasting: TRO neutralization	Republic of Korea			YES	
TeamTec OceanSaver TeamTec OceanSaver AS	Ballasting: Filtration, cavitation, deoxygenation and side-stream injection De-ballasting: TRO neutralization	Norway				
TeamTec OceanSaver Mk II TeamTec OceanSaver AS	Ballasting: Filtration and side-stream EC injection De-ballasting: TRO neutralization	Norway	YES	YES	YES	YES
Trojan Marinex™ Trojan Technologies	Ballasting: Filtration and UV treatment De-ballasting: UV re-treatment	Norway		YES	YES	YES
Van Oord Van Oord Ship Management BV	Ballasting: Potable water and chlorine De-ballasting: TRO neutralization	The Netherlands				
VOS™ N.E.I. Treatment Systems	Ballasting: Inert gas and Venturi Oxygen Stripping (VOS) De-ballasting: NONE	Republic of Liberia (initial approval)		YES	YES	
YP-BWMS Zhejiang Yingpeng Marine Equipment Manufacturer Co., Ltd.	Ballasting: Filtration and UV treatment De-ballasting: UV re-treatment	China		YES	YES	YES

Appendix C | BWMS with Only IMO Basic and Final Approvals

The following BWMS have received Basic and Final Approval by MEPC but have not received Type Approval by a flag State.

Final Approval

- Evonik BWTS with PERACLEAN® Ocean developed by Evonik Industries AG and TeamTec AS (MEPC 66)
- ECS HYBRID™ System developed by TECHCROSS Inc. (MEPC 71)
- ECS HYCHEM™ System developed by TECHCROSS Inc. (MEPC 70)
- ECS HYCHLOR™ System developed by TECHCROSS Inc. (MEPC 69)
- Neo-Purimar™ developed by Samsung Heavy Industries (SHI) Co., Ltd. (MEPC 63)
- NK-Cl BlueBallast System developed by NK Co. Ltd (MEPC 69)
- Sedinox BWMS developed by Greenship Ltd. (MEPC 59)

Basic Approval

The following BWMS have received Basic Approval by MEPC but have not received Final Approval.

- AquaTriComb BWTS developed by Aquaworx ATC GmbH (Aalborg Industries) (MEPC 59)
- BIOBALLAST 1000 developed by Biomarine S.r.l (MEPC 73)
- BlueSeas BWMS developed by Envirotech and Consultancy Pte. Ltd.; National University of Singapore (MEPC 62)
- BlueWorld developed by Envirotech and Consultancy Pte. Ltd. (MEPC 62)
- ClearBal BWMS developed by University of Strathclyde (MEPC 70)
- DMU •OH BWMS developed by Dalian Maritime University (MEPC 63)
- ECOLCELL BTs BWMS developed by Azienda Chimica Genovese (MEPC 66)
- ElysisGuard BWMS developed by KALF Engineering Pte Ltd (MEPC 67)
- En-Ballast™ BWMS developed by Kwang San Co., Ltd. (MEPC 60)
- GloEn-Saver™ developed by Panasia Co., Ltd. (MEPC 64)
- HS-BALLAST BWMS developed by HWASEUNG R&A Co., Ltd. (MEPC 64)
- MICROFADE II developed by Kuraray Co. Ltd. (MEPC 71)
- REDOX developed by REDOX Maritime Technologies (RMT) AS (MEPC 65)
- VARUNA BWTS Kadalneer Technologies Pte. Ltd. (MEPC 68)

Appendix D | Copy of the Ballast Water Reporting Form

OMB number 1625-0069
Exp. date: 31-Dec-2018

Ballast Water Management Report

Vessel Information

Vessel name

ID number — IMO number

Country of Registry — Select country

Owner/operator

Type — Select vessel type — Gross Tonnage

Ballast water volume units — Select units

Total ballast water capacity — Number of tanks on ship

Onboard BW Management System

Voyage Information

Arrival port (port and state) — Select state

Arrival date

Last port (port and country) — Select country

Next port (port and country) — Select country

Total ballast water on board — Number of tanks in ballast

Number of tanks discharged

Alternative BW management conducted, per instructions from COTP

Certificate of accurate information

By checking this box, I attest to the accuracy of the information provided and that ballast water management activities were in accordance with the ballast water management plan required by CFR 151.2050(g). ☐

Responsible Officer's name and title

Report type — Select report type

Submitted by — Contact information

Ballast Water History

On the following page(s), provide the ballast water history for each tank discharged into the waters of the United States or to a reception facility, en route to or at the arrival port. Vessels entering the Great Lakes or Hudson River (north of George Washington Bridge) from beyond the US EEZ must also provide the history for empty tanks that underwent alternative management.

Submit report via e-mail | Submit report on-line

Ballast Water History

Tank name/number ______ Tank capacity ______

Event	Date	Location(s) (for Management event include Start pt. / End pt.)	Volume
Discharge to US waters			
Select event			
Select event			
Select event			
Select event			

If BW management was *not* conducted for this tank, select one of the following reasons Select reason

Tank name/number ______ Tank capacity ______

Event	Date	Location(s) (for Management event include Start pt. / End pt.)	Volume
Discharge to US waters			
Select event			
Select event			
Select event			
Select event			

If BW management was *not* conducted for this tank, select one of the following reasons Select reason

Tank name/number ______ Tank capacity ______

Event	Date	Location(s) (for Management event include Start pt. / End pt.)	Volume
Discharge to US waters			
Select event			
Select event			
Select event			
Select event			

If BW management was *not* conducted for this tank, select one of the following reasons Select reason

Tank name/number ______ Tank capacity ______

Event	Date	Location(s) (for Management event include Start pt. / End pt.)	Volume
Discharge to US waters			
Select event			
Select event			
Select event			
Select event			

If BW management was *not* conducted for this tank, select one of the following reasons Select reason

Ballast Water History

Tank name/number | | Tank capacity |

Event	Date	Location(s) (for Management event include Start pt. / End pt.)	Volume
Discharge to US waters			
Select event			
Select event			
Select event			
Select event			

If BW management was *not* conducted for this tank, select one of the following reasons: Select reason

Tank name/number | | Tank capacity |

Event	Date	Location(s) (for Management event include Start pt. / End pt.)	Volume
Discharge to US waters			
Select event			
Select event			
Select event			
Select event			

If BW management was *not* conducted for this tank, select one of the following reasons: Select reason

Tank name/number | | Tank capacity |

Event	Date	Location(s) (for Management event include Start pt. / End pt.)	Volume
Discharge to US waters			
Select event			
Select event			
Select event			
Select event			

If BW management was *not* conducted for this tank, select one of the following reasons: Select reason

Tank name/number | | Tank capacity |

Event	Date	Location(s) (for Management event include Start pt. / End pt.)	Volume
Discharge to US waters			
Select event			
Select event			
Select event			
Select event			

If BW management was *not* conducted for this tank, select one of the following reasons: Select reason

Ballast Water History

Tank name/number ______ Tank capacity ______

Event	Date	Location(s) (for Management event include Start pt. / End pt.)	Volume
Discharge to US waters			
Select event			
Select event			
Select event			
Select event			

If BW management was *not* conducted for this tank, select one of the following reasons Select reason

Tank name/number ______ Tank capacity ______

Event	Date	Location(s) (for Management event include Start pt. / End pt.)	Volume
Discharge to US waters			
Select event			
Select event			
Select event			
Select event			

If BW management was *not* conducted for this tank, select one of the following reasons Select reason

Tank name/number ______ Tank capacity ______

Event	Date	Location(s) (for Management event include Start pt. / End pt.)	Volume
Discharge to US waters			
Select event			
Select event			
Select event			
Select event			

If BW management was *not* conducted for this tank, select one of the following reasons Select reason

Tank name/number ______ Tank capacity ______

Event	Date	Location(s) (for Management event include Start pt. / End pt.)	Volume
Discharge to US waters			
Select event			
Select event			
Select event			
Select event			

If BW management was *not* conducted for this tank, select one of the following reasons Select reason

Ballast Water History

Tank name/number | | Tank capacity | |

Event	Date	Location(s) (for Management event include Start pt. / End pt.)	Volume
Discharge to US waters			
Select event			
Select event			
Select event			
Select event			

If BW management was *not* conducted for this tank, select one of the following reasons Select reason

Tank name/number | | Tank capacity | |

Event	Date	Location(s) (for Management event include Start pt. / End pt.)	Volume
Discharge to US waters			
Select event			
Select event			
Select event			
Select event			

If BW management was *not* conducted for this tank, select one of the following reasons Select reason

Tank name/number | | Tank capacity | |

Event	Date	Location(s) (for Management event include Start pt. / End pt.)	Volume
Discharge to US waters			
Select event			
Select event			
Select event			
Select event			

If BW management was *not* conducted for this tank, select one of the following reasons Select reason

Tank name/number | | Tank capacity | |

Event	Date	Location(s) (for Management event include Start pt. / End pt.)	Volume
Discharge to US waters			
Select event			
Select event			
Select event			
Select event			

If BW management was *not* conducted for this tank, select one of the following reasons Select reason

Ballast Water History

Tank name/number Tank capacity

Event	Date	Location(s) (for Management event include Start pt. / End pt.)	Volume
Discharge to US waters			
Select event			
Select event			
Select event			
Select event			

If BW management was *not* conducted for this tank, select one of the following reasons Select reason

Tank name/number Tank capacity

Event	Date	Location(s) (for Management event include Start pt. / End pt.)	Volume
Discharge to US waters			
Select event			
Select event			
Select event			
Select event			

If BW management was *not* conducted for this tank, select one of the following reasons Select reason

Tank name/number Tank capacity

Event	Date	Location(s) (for Management event include Start pt. / End pt.)	Volume
Discharge to US waters			
Select event			
Select event			
Select event			
Select event			

If BW management was *not* conducted for this tank, select one of the following reasons Select reason

Tank name/number Tank capacity

Event	Date	Location(s) (for Management event include Start pt. / End pt.)	Volume
Discharge to US waters			
Select event			
Select event			
Select event			
Select event			

If BW management was *not* conducted for this tank, select one of the following reasons Select reason

Appendix E | List of Acronyms

AMS	Alternate Management System
BWE	Ballast Water Exchange
BWM	Ballast Water Management
BWMP	Ballast Water Management Plan
BWMS	Ballast Water Management System
BWT	Ballast Water Treatment
BWTE	Ballast Water Treatment Equipment
BWTS	Ballast Water Treatment System
CAPEX	Capital Expenses
CFR	Code of Federal Regulations
COTP	Captain of the Port
CVC	Commercial Vessel Compliance
DBP	Disinfection Byproduct
DGAP	Data Gathering and Analysis Plan
EBP	Experience Building Phase
EC	Electrochlorination
IL	Independent Laboratory
IMO	International Maritime Organization
IOPP	International Oil Pollution Prevention
LOI	Letter of Intent
MEPC	Maritime Environment Protection Committee
NM	Nautical Mile
NPDES	National Pollutant Discharge Elimination System
NOBOB	No Ballast On Board Condition
NVIC	Navigation and Vessel Inspection Circular
OSV	Offshore Support Vessel
OPEX	Operating Expenses
PSC/PSCO	Port State Control/Port State Control Officer
SRA	Same Risk Area
TCO	Total Cost of Ownership
TRC	Treatment Rated Capacity
TST	Topside Tank(s)
USCG	United States Coast Guard
UV	Ultraviolet
UVI	UV intensity (mJ/cm^2 or W/m^2)
UVT	UV transmittance (%)
UWILD	Underwater Inspection in Lieu of Drydocking
VIDA	Vessel Incidental Discharge Act

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ABS

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