

**Status of international and domestic regulations on installation and use of
ballast water management systems**

Final Report

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1. Introduction

Ballast water is globally recognized as a dominant transport vector of nonnative aquatic species, representing a significant threat to the environmental and economic health of coastal areas worldwide. As such, management of ballast water is a longstanding, heavily researched, and evolving field (Bailey et al. 2015). The International Maritime Organization (IMO) has led efforts for decades to control the negative effects of unmanaged ballast water transfer at the international scale. Domestically, the United States Coast Guard (USCG) and the United States Environmental Protection Agency (EPA) have led similar efforts at the federal level. In recent years, regulations have transitioned toward implementing numeric limits of organism concentration in ballast water discharge based on size class. These limits will primarily be met with the use of shipboard management systems. Following is a brief review of the regulations and guidelines related to the installation and use of ballast water management systems by the IMO and US federal entities, summarized in Table 1.

2. International

The International Convention on the Control and Management of Ship's Ballast Water and Sediments, known as the Ballast Water Management Convention (BWM Convention), will enter into force on September 8, 2017. The BWM Convention was adopted by the IMO on February 13, 2004, set to enter into force one year following ratification by 30 States representing 35% of the world's merchant shipping tonnage. This target was slowly met during the next twelve years, reaching 52 States and 35.1441% of tonnage with Finland's ratification in September 2016.

The BWM Convention, overseen by the Marine Environment Protection Committee (MEPC) of the IMO, is organized by Articles and an Annex and is accompanied by fourteen Guidelines to assist with implementation (IMO 2016a). Of importance to this summary are Section D of the Annex and the "Guidelines for approval of ballast water management systems", or G8 Guidelines. Section D Regulation D-1 stipulates a ballast water exchange standard (95% volumetric exchange) while Regulation D-2 stipulates a ballast water performance standard. The performance standard is a list of numeric discharge limits for organisms and indicator microbes and is as follows:

- Organisms ≥ 50 micrometers in minimum dimension: < 10 viable organisms per cubic meter.
- Organisms ≥ 10 micrometers in minimum dimension and < 50 micrometers in minimum dimension: < 10 viable organisms per milliliter (mL).
- Less than the following concentrations of indicator microbes:
 1. Toxigenic *Vibrio cholerae* (O1 and O139) with < 1 colony forming unit (cfu) per 100 mL or < 1 cfu per 1 gram (wet weight) zooplankton samples;
 2. *Escherichia coli* < 250 cfu per 100 mL;
 3. Intestinal *Enterococci* < 100 cfu per 100 mL.

Regulation D-3 requires that ballast water management systems are approved under IMO Guidelines; namely, the G8 Guidelines, but also the G9 Guidelines if the system uses an Active Substance to meet the standards. Adopted in 2008, the G8 Guidelines were later refined with a Guidance document (BWM.2/Circ.28, 2010) that was further amended in 2013 (BWM.2/Circ.43, 2013). At its 70th session in October 2016, the MEPC adopted revised G8 Guidelines that include more robust testing protocols. Beginning on October 28, 2020, systems installed on vessels must have been approved via the revised guidelines. Prior to that date, system approval via either set of guidelines is acceptable. As of October 2016, the IMO has approved 69 ballast water management systems under the original G8 Guidelines, represented by a variety of manufacturers (IMO 2016b).

Though the BWM Convention is slated to enter into force in 2017, the implementation schedule of Regulation D-2 (i.e., compliance dates for vessels to operate ballast water management systems) remains undetermined. Original implementation dates (Regulation B-3) passed prior to entry into force of the Convention and prior to the broad availability of management systems. Implementation, therefore, was recommended to be linked to a vessel's first renewal survey of its International Oil Pollution Prevention Certificate (IOPPC) following entry into force of the BWM Convention. The MEPC will consider at their next meeting in mid-2017 to allow implementation after the second renewal survey if the first renewal survey occurs prior to September 8, 2019 (Hellenic Shipping News 2017). IOPPC renewal occurs roughly every five years and is currently linked with a vessel's drydocking schedule. However, reported recent efforts to remove the connection between certificate renewal and drydock may prolonging

the time until vessels must install a management system (in effect, until the following drydock, potentially an additional five years) (The Maritime Executive 2017).

3. United States

The United States is not a signatory to the BWM Convention, though has maintained standards with similarities to the IMO. The USCG and EPA have separately released regulations, in 2012 and 2013 respectively, regarding ballast water discharge standards and compliance dates for meeting those standards by vessels under their corresponding jurisdiction (EPA 2013, USCG 2012). The standards do not apply to seagoing vessels less than 1,600 gross register tons and vessels that take on and discharge ballast water within one USCG Captain of the Port Zone.

The discharge standards from both entities are equivalent and are as follows:

- Organisms ≥ 50 micrometers in minimum dimension: < 10 living organisms per cubic meter.
- Organisms ≥ 10 micrometers in minimum dimension and < 50 micrometers in minimum dimension: < 10 living organisms per milliliter (mL).
- Indicator microbes must not exceed:
 1. For Toxigenic *Vibrio cholerae* (O1 and O139) a concentration < 1 colony forming unit (cfu) per 100 mL;
 2. For *Escherichia coli* a concentration of < 250 cfu per 100 mL;
 3. For intestinal *Enterococci* a concentration of < 100 cfu per 100 mL.

There are currently five independent laboratories recognized by the USCG to conduct testing on ballast water management systems for compliance with these standards. Testing protocols are in accordance with the EPA's Environmental Technology Verification Program (NSF 2010) and are jointly recognized by the EPA and USCG. In December 2016, the USCG approved the first three onboard systems from manufacturers Otimarin AS, Alfa Laval Tumba AB, and OceanSaver AS (USCG 2017b). However, implementation dates for existing vessels have passed, and there remains a shortage of USCG type approved systems.

Implementation dates for many vessels have been extended and further extensions may be granted as appropriate. Over 11,500 extensions were granted by the USCG as of December 2016, with vessels citing the absence of type approved systems. Extensions were not granted to vessels with implementation (compliance) dates on or after January 1, 2019. Since the recent

approval of three ballast water management systems, these applications are considered “held in abeyance” and require additional documentation to support the claim that compliance is not possible (over 1,300 applications). The USCG will continue to accept extension requests on a per vessel basis if accompanied by evidence that installation of an approved system remains not possible, though an extension will now only be granted for the minimum time needed to comply (e.g., the vessel’s next scheduled drydocking). The availability of type approved systems does not interfere with previously granted compliance date extensions (USCG 2017a).

To temporarily meet compliance with USCG regulations, vessels may install Alternate Management Systems (AMS). AMS are systems that have been approved by foreign governments, in accordance with IMO standards, but not approved by the United States. As of July 2016, the USCG has approved 56 AMS. If an AMS is installed on a vessel, the system may be used for a period of five years from the vessel’s implementation date. If a vessel receives an extended compliance date, it may install an AMS prior to that date and operate with the AMS for five years past the extended compliance date (USCG 2016).

The USCG also created the voluntary Shipboard Technology Evaluation Program (STEP) to promote installation of ballast water management systems. STEP was designed to encourage vessels to install trial management systems, despite that the systems may not meet future discharge standards. To provide incentive, vessels enrolled in STEP may continue to use a properly functioning system for the life of the vessel or the system. More recently, vessels that are used by independent laboratories to test ballast water management systems must enroll in STEP if they will be discharging treated ballast water in US waters.

EPA regulations generally complement the USCG. The EPA will accept USCG type approved systems, USCG AMS, or others systems approved by a foreign administration that have undergone third party testing acceptable by the ETV protocol. The 2013 EPA Vessel General Permit also outlines monitoring requirements for vessels using ballast water management systems. These requirements include verifying functionality of a system at least once a month, calibrating equipment annually, monitoring organism concentrations within ballast water effluent, and monitoring for biocides or other treatment residuals within ballast water effluent, if applicable per management system (EPA 2013).

4. Challenges to Implementation & Discussion

The complexities surrounding installation and use of ballast water management systems continue to develop as the IMO and USCG approach implementation. In the United States, the recent type approval of multiple systems marks a step away from blanket compliance date extensions for many vessels. Conversely, the potential for further IMO delay of implementation dates may affect the global movement toward adherence to numeric discharge limits. These and several other growing pains stand between routine installation and standardized use of ballast water management systems both internationally and domestically: following is a representative list of challenges.

- (1) Current discharge standards and testing protocols are likely not fixed targets:
 - a. To date, the USCG requirement for detection of “living” organisms in ballast water and associated ETV testing protocols has been deemed more stringent than IMO detection of “viability” (Coast Guard Maritime Commons 2015). For example, the most probable number (MPN) method of determining system compliance has been rejected by the USCG for not measuring the ability of a system to kill organisms rather than leave them nonviable¹.
 - b. The recently revised G8 Guidelines call for more stringent testing of management systems and will influence the types of systems available on the global market in years to come, notably by 2020.
 - c. The USCG has previously proposed, though not executed in regulation, discharge limits 1,000 times the current standards, and has stated its intention to consider stricter standards in the future.
 - d. The 2018 version of the EPA’s Vessel General Permit may consider more robust discharge standards per court order (see Verna & Harris 2016).
 - e. The state of California will begin to enforce discharge limits stronger than current federal standards in its waters in 2020.
- (2) USCG and EPA regulations recognize other viable management strategies that are being investigated, such as shoreside treatment systems. However, shoreside systems are not likely to be implemented as an alternative to shipboard systems in the immediate future.

¹ The MPN method is accepted by the IMO; systems approved under this method can be used as AMS in the United States.

- (3) Protocols for testing and approving ballast water management systems are complex and still developing:
 - a. Testing is time-intensive and must consider the efficacy of a system across multiple vessel types and ballast water flow rates.
 - b. Despite that implementation dates are looming, system availability is limited by the testing phase, at least over the initial hurdle of putting systems on the market (Davidson et al. 2017).
 - c. Protocols for testing systems' ability to remove microbes that spread human disease have been called into question (Cohen & Dobbs 2015).
 - d. Laboratories may implement different procedures for meeting the testing requirements (K. Holzer, personal communication).
- (4) As vessels overcome the installation phase and prepare for regular system use, port state control officers and domestic inspectors will face a lack of compliance monitoring tools (Drake et al. 2014).

Notwithstanding the uncertainty that persists around ballast water management system installation and use, the aim of these systems and accompanying regulations remains valuable. Nonnative aquatic species continue to present a high-risk threat to coastal and marine ecological integrity. Surpassing the efficacy of ballast water exchange, management systems are expected to further reduce this risk by limiting the number of organisms released in each discharge event. As international and domestic regulatory bodies continue their pursuit of how and when to achieve these limits, regulations and management options will adapt.

Table 1. Comparison of international and United States federal regulations on the installation and use of ballast water management systems.

	IMO	USCG	EPA
Guiding regulations	2004 International Convention on the Control and Management of Ship's Ballast Water and Sediments	2012 Standards for Living Organisms in Ships' Ballast Water Discharged in U.S. Waters	2013 Vessel General Permit
Discharge limits	Yes	Yes	Yes
Organism detection standard¹	Viable	Living	Living
Organism discharge limits based on size²			
≥50 μm	<10 viable organisms per m ³	<10 living organisms per m ³	<10 living organisms per m ³
<50 μm and ≥10 μm	<10 viable organisms per mL	<10 living organisms per mL	<10 living organisms per mL
Approved ballast water management systems	60+ type approved	3 type approved 56 AMS	Accepts USCG type approved, AMS, and equivalent foreign approved
Implementation dates	Original dates passed; now linked to vessel IOPPC renewal after entry into force of the BWM Convention	Passed; many vessels operating on extensions, accepting extension requests	Passed; low enforcement priority

¹ The IMO uses a viable/nonviable organism detection standard. Nonviable has been interpreted as an organism's inability to reproduce following ballast water treatment. The USCG and EPA use a living/nonliving organism detection standard. The IMO-accepted MPN method for determining organism viability is not used by the USCG, as the USCG believes determining viability is too difficult to achieve accurately.

² Does not include indicator microbe limits, see pages 2 & 3 for details.

5. References

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