HOW MANDATORY TESTING OF BALLAST WATER MANAGEMENT SYSTEMS PROTECTS FISHERIES AND AQUACULTURE

By Ersi Zacharopoulou, Lisa Drake, and Guillaume Drillet

Invasive species can cause irreversible damage to both marine biodiversity and industries such as fisheries and aquaculture, which depend on a clean environment. As one source of pathogens is the ballast water that is discharged from ships, it is crucial for regulatory authorities and industry stakeholders to ensure that vessels are in compliance with the International Convention for the Control and Management of Ships' Ballast Water and Sediments, 2004 (BWM Convention), which entered into force globally on 8 September 2017. This article calls for mandatory testing of the ballast treatment management systems (BWMS) installed in ships to verify their efficacy in preventing harmful species from being introduced.

Greater than 50µm viable organisms (typically zooplankton)

In all areas of the world, the fisheries and aquaculture sector contributes significantly to food security, supporting the wellbeing of billions of people, from food-abundant regions to the most food-limited regions. Aquaculture is expected to be the main driver for the increase of fish production globally. By 2030, global aquaculture production is projected to reach 103 million tonnes, six tonnes more than the capture sector, as mentioned in the OECD-FAO Agricultural Outlook 2021-2030 report.

One way to secure and optimise food security is for countries to prevent invasive, harmful aquatic organisms from entering coastal aquatic ecosystems and causing irreversible damage to marine biodiversity. Further, industries dependent on the marine environment, like fisheries and aquaculture, can be potentially negatively affected. These introductions may occur through many sources. One notable vector is shipping activity, and aquaculture activities are particularly vulnerable as they are typically located in the vicinity of ports. As ships discharge ballast water, they could introduce pathogens to aquaculture facilities. Indeed, there is clear evidence of the role of ships in the global distribution of protozoans, bacteria, and viruses via ballast water and sediments, as well as in biofilms on the ballast tank surface.

International response: the BWM Convention

The International Maritime Organization (IMO) addressed this broad concern of ballast water transferring "harmful aquatic organisms and pathogens" by adopting the International Convention for the Control and Management of Ships' Ballast Water and Sediments, 2004 (BWM Convention), which entered into force globally on 8 September 2017. Its aim is to reduce and prevent the spread of potentially invasive species in ships' ballast water. Most ships are transitioning to use onboard, specialised, approved equipment — called ballast treatment management systems (BWMS) — to reduce the risks from vessels' discharges in aquatic environments. This article examines the necessity of mandatory testing when new BWMS are installed and undergo "commissioning testing" to verify their efficacy as a preventive measure against the introduction of harmful species, which may enter coastal waters and affect the sustainability of fisheries and aquaculture.

The BWM Convention dictates that ships trading internationally shall carry a ballast management plan, a ballast water record book, and an International Ballast Water Management (IBWM) certificate. This certificate, which is issued by, or on behalf of, the Administration (i.e. the ship's flag State), certifies that the ship carries out ballast water management in accordance with the BWM Convention. For nearly all ships, this involves installing BWMS designed to treat the ballast water to meet the BWM Convention's discharge criteria (outlined in regulation D-2, also known as the D-2 standard). The D-2 standard specifies that ships must discharge ballast water with a very low concentration of living organisms, thereby reducing the transfer of potentially invasive species. The criteria in the D-2 standard are:

- <10 viable organisms per cubic metre which are ≥50 μm in minimum dimension (typically zooplankton);
- <10 viable organisms per millilitre which are ≥10 μm and <50 μm in minimum dimension (typically phytoplankton);
- Less than 1 colony-forming unit (cfu) per 100 millilitres of toxicogenic *Vibrio cholerae;*
- Less than 250 cfu per 100 millilitres of Escherichia *coli;* and
- Less than 100 cfu per 100 millilitres of Intestinal *Enterococci.*

The D-2 standard seeks to limit, as far as possible, the release of invasive species along with ballast water

Commissioning testing is the process to verify that a BMWS' installation is correct. It is logical that after a BWMS is installed at a shipyard, it should be tested as a whole to validate that the system is operating as intended and according to its type approval requirements. By also conducting biological efficacy testing, the D-2 standard of the BWM Convention can be verified as having been met at that time. Thus, effective management of the discharge is confirmed, and a level of protection is provided to marine biodiversity and marine economies.

As more BWMS are installed and commissioning testing proceeds worldwide, the observations and results from commissioning and compliance testing events conducted by approved service providers will be studied thoroughly by the IMO during the "Experience Building Phase" of the BWM Convention. These results will be used to inform rules for future mandatory testing. This will reduce the risk of unmanaged ballast water having economic impacts (e.g., reduced food safety, unemployment).

BWMS commissioning testing becomes mandatory this June

During the recent virtual 77th Meeting of the IMO's Marine Environment Protection Committee (MEPC) held from 22-26 November 2021, matters related to the BWM Convention were considered. The MEPC approved a "unified interpretation" of the date to implement mandatory commissioning testing of BWMS in accordance with resolution MEPC.325(75); in other words, BWMS commissioning testing will be mandatory after 1 June 2022. Currently, some flag States (e.g., Australia, Canada, Croatia, Cyprus, France, Greece, India, Singapore, and Tuvalu) are already requiring mandatory testing. Other flag States have declared that commissioning testing is strongly recommended until 1 June 2022.

For the flag States that have not yet implemented mandatory commissioning testing—in advance of it being required by the BWM Convention—doing so would be an important decision, as it would reduce risks to marine environments as well as blue enonomies, including fisheries and aquaculture. Note that some clarifications by the IMO are expected in the future concerning the commissioning testing of BWMS that were installed before 1 June 2022; a good approach would allow testing to remain optional or at the discretion of the Administration. In this way, older BWMS installations, when there was limited or lack of experience at shipyards, could be tested and corrected as appropriate.

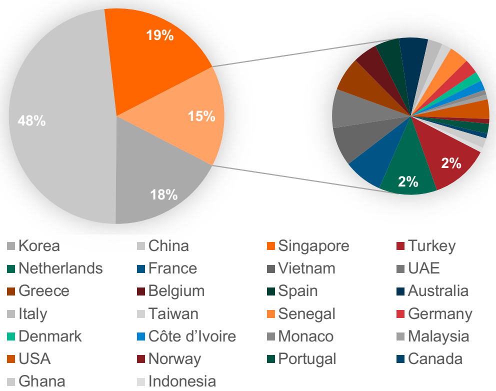
MEPC 77 also commented on developments regarding the BWM Convention's Experience Building Phase. The IMO urges port States, flag States and other stakeholders to collect and submit data to the ballast water experience-building phase. In November 2021, it was noted that data are now available from 35 Member States and seven other stakeholders, corresponding to approximately 15 000 ships (approximately 60 000 ships in the global fleet are expected to install BWMS). This data are being analysed by the World Maritime University, and a full report will be submitted to MEPC 78, which will be held on 6 -10 June 2022. All of these events are strong drivers in the protection of the marine environment, including fisheries and aquaculture development.

Experience gained from commissioning testing data

SGS Marine Field Services & Monitoring, as an approved service provider by most Classification Societies, has conducted 660 BWMS commissioning tests as of January 2022. Of these BWMS, some were tested on a single ship (multiple BWMS installed), and some were tested multiple times (e.g. re-tested after a failure).

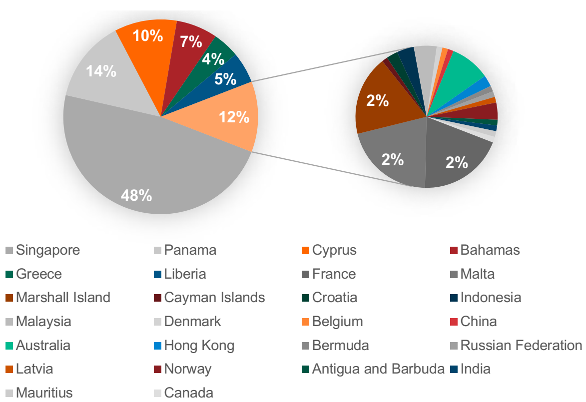
SGS marine teams have carried out commissioning testing on BWMS from 29 manufacturers in 26 countries worldwide, representing in-line and in-tank treatment. As is reflective of the industry, the BWMS tested typically consisted of a filtration step followed by physical (e.g. ultraviolet) or chemical (e.g. chlorination and ozonation) disinfection. Given the location of the bulk of the world's shipyards, it is not surprising that most of the commissioning testing so far has occurred in Asia: China (48%), Singapore (19%), and S. Korea (18%) (Figure 1).

Figure 1: Locations of commissioning tests



Accordingly, the ships on which the commissioning tests occurred were mainly flagged under Singapore (48%), Panama (14%), Cyprus (10%), Bahamas (7%), Liberia (5%), and Greece (4%) (Figure 2). It is expected that more flag States will make the commissioning test mandatory before 1 June 2022, when it will be required according to the BWM Convention, as mentioned previously.

Figure 2: Flag States of the ships tested



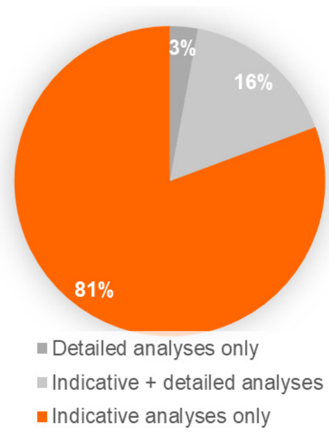
Sampling and analysis

For the purpose of commissioning testing, a volume of 3m^3 is filtered to determine the concentration of organisms in the ≥50 µm size class, and a sample volume of 10 L (sampled continuously) is collected for organisms in the ≥10 µm and <50 µm size class and the group of indicator microbes. Sampling is implemented through a validated portable Ballast Water Sampler following the IMO G2 Guidelines. In some cases, because the sampling probe installed onboard may be small and/or because operational situations limit the volume of treated water that may be discharged, the volume of the sample for the ≥50 µm size class may sometimes be lower than 3 m^3. Regardless, it is always at least 1 m^3.

Two types of analysis may be conducted: "indicative" analysis (a rapid assessment, typically done onboard the ship) and "detailed" analysis (more in-depth, typically completed in a laboratory). To determine the concentration of organisms in all three size classes using indicative analysis, the concentration of adenosine triphosphate (ATP) is measured in the samples. Next, the concentration of ATP is correlated to the concentration of viable organisms. For detailed analysis of organisms in the ≥50 µm size class, the collected organisms are counted using a stereomicroscope in a Bogorov counting chamber.

Notably, because the results of detailed analyses prevail over those of indicative analyses, most clients would agree that detailed analyses should be carried out in cases where indicative analyses show a likelihood of non-compliance. In 81% of the tests, the analyses were stopped after the indicative analyses, and in 16% of the tests, additional detailed analyses were carried out after the indicative tests showed likely non-compliance, and 3% of tests were conducted only using detailed analysis (Figure 3).

Figure 3: Analysis approaches



When both indicative and detailed analyses were completed, in 76% of the cases, the detailed analyses provided data to refute the results from indicative testing, therefore demonstrating the ship's compliance with the discharge standard. This result clearly indicates the great value in considering detailed analyses in commissioning testing—even if it is used as a secondary testing approach—to ensure that the owner does not have to carry out a second, separate sampling event.

Overall, combining all testing approaches, 13% of the installations did not meet the D-2 performance standard of the BWM Convention. Failures were overwhelmingly found in the largest size class of organisms (≥50 µm). In many respects, the resistance of the larger organisms to treatment is not surprising, and it illustrates to need to ensure that the filtration step (which is present in nearly all BWMS) is well-functioning (e.g. the integrity of the filter must be assured). In the future, it will be important to ensure that the BWMS continue to function as intended; i.e. port State control measures will be needed to maintain environmental protection.

In 10% of the tests, the total residual oxidant (TRO) level in treated, discharged water from BWMS using active substances was higher than the limit of 0.1 mg/L used by the Joint Group of Experts on the Scientific Aspects of Marine Environmental Protection (GESAMP) to evaluate BWMS. High TRO values in treated, discharged ballast water are an emerging issue for ballast water management, because while high TRO concentrations likely ensure that the D-2 standard is met, the concentrations may be in violation of local, state, or federal requirements and may negatively affect the marine environment where the treated water is discharged.

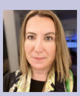
Observations

At this stage, not all the causes for the failures observed are evident. The failures noted—while not providing a clear picture of the source of failure—indicate that installation can affect the performance of BWMS shown to be effective during type approval testing. If not corrected, this pattern of failures will continue to be seen during compliance assessments by port State control authorities during the life of the ship, resulting in an ongoing compliance risk to the vessel as well as risk to the marine environment and blue economies in the locations where ballast water is discharged.

Conclusions and call for action

Overall, combining all commissioning testing approaches, 13% of the installations did not meet the D-2 performance standard of the Convention, and failures were mainly found in the largest size class of organisms (≥50 µm). This percentage is high relative to the number of vessels in the global fleet that have not yet installed and commissioned BWMS. To avoid adverse economic and ecological impacts from discharges of unmanaged ballast water, a main objective of members of fisheries and aquaculture communities should be to interact with Administrations to ensure that the BWM Convention is appropriately implemented in their area.

It is recommended that stakeholders (authorities, fisheries and aquaculture companies, etc.) should develop (or refine) specific action plans for preventing and managing invasions. This includes monitoring, mitigating, and restoring affected areas to ameliorate the effects of marine biological invasions on local biodiversity, human health, and ecosystem health. Monitoring would include, for example, water quality parameters, continuous monitoring of physicochemical parameters, ecotoxicological testing, and molecular approaches (e.g. environmental DNA testing). Part of this plan should be proposals for the management of coastal and marine protected areas and the development of campaigns to engage citizens. In sum, at the moment, international organisations and stakeholders are committed to using the BWM Convention to protect marine ecosystems and economies. It will be important to ensure this protection continues.



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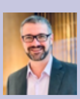

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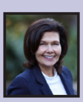

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