Ballast Water Management Under the Ballast Water Management Convention

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Abstract The importance of ballast water as a vector for moving non-indigenous species was initially addressed in a 1973 International Maritime Organization (IMO) resolution. Subsequently IMO worked towards the finalization of the *International Convention for the Control and Management of Ships' Ballast Water and Sediments* (BWM Convention) which was adopted in February 2004 at a diplomatic conference in London. The BWM Convention's main aim is to prevent, minimize and ultimately eliminate the risks to the environment, human health, property and resources which arise from the transfer of harmful aquatic organisms and pathogens via ships' ballast waters and related sediments. It should be noted that harmful aquatic organisms in this context are not limited to non-indigenous species, but covers all aquatic species irrespective of their origin. As defined at IMO "Ballast Water Management means mechanical, physical, chemical, and biological processes, either singularly or in combination, to remove, render harmless, or avoid the uptake or discharge of Harmful Aquatic Organisms and Pathogens within Ballast Water and Sediments." The BWM Convention and its supporting guidelines are described in this chapter, outlining the ballast water exchange and performance standards, warnings concerning ballast water uptake in certain areas, ballast water reception facilities, sediment management as well as exemptions and exceptions from ballast water management requirements. This chapter ends with the description of implementation options of the BWM Convention.

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The Ballast Water Management Convention

The importance of ballast water as a vector for moving non-indigenous species was initially addressed in a 1973 International Maritime Organization (IMO) resolution (IMO 1973). Subsequently IMO worked towards the finalization of the *International Convention for the Control and Management of Ships' Ballast Water and Sediments* (BWM Convention) which was adopted in February 2004 at a diplomatic conference in London (IMO 2004). This Convention's aim is to prevent, minimize and ultimately eliminate the risks to the environment, human health, property and resources which arise from the transfer of harmful aquatic organisms and pathogens (HAOP) via ships' ballast waters and related sediments. It should be noted that harmful aquatic organisms in this context are not limited to non-indigenous species, but covers all species irrespective of their origin.

The BWM Convention consists of 22 Articles followed by five sections with Regulations. In addition, two Appendices provide standard formats and requirements regarding the form of International Ballast Water Management Certificates as well as recording operations for reporting and verification in a Ballast Water Record Book.

The Regulations for the control and management of ships' ballast water and sediments are presented in five sections:

- Section A: General provisions: Definitions, General applicability, Exceptions, Exemptions, Equivalent Compliance;
- Section B: Management and control Requirements for Ships: Ballast Water Management;
- Section C: Special Requirements in Certain Areas;
- Section D: Standards for Ballast Water Management; and
- Section E: Survey and Certification requirements for Ballast Water Management.

Certain obligations are to be met by all stakeholders including the ship, the Administrations, i.e., both in their capacity as Flag state, Port State, and as the representative of a Party, and IMO.

The BWM Convention enters into force 12 months after the date on which more than 30 states, with combined merchant fleets not less than 35 % of the gross tonnage of the world's merchant shipping, have signed this Convention. As of December 2013, 38 states ratified the BWM Convention, representing 30.38 % of the world merchant shipping gross tonnage (for an update visit Status of Conventions at www.imo.org).

Table 1 Guidelines to the BWM Convention and their development status. MEPC = IMO Marine Environment Protection Committee

Title	Work progress
Guidelines for Sediment Reception Facilities (G1)	Adopted at MEPC 55, Oct. 2006 (IMO 2006a)
Guidelines for Ballast Water Sampling (G2)	Adopted at MEPC 58, Oct. 2008 (IMO 2008a)
Guidelines for Ballast Water Management Equivalent Compliance (G3)	Adopted at MEPC 53, Jul. 2005 (IMO 2005a)
Guidelines for Ballast Water Management and Development of Ballast Water Management Plans (G4)	Adopted at MEPC 53, Jul. 2005 (IMO 2005b)
Guidelines for Ballast Water Reception Facilities (G5)	Adopted at MEPC 55, Oct. 2006 (IMO 2006b)
Guidelines for Ballast Water Exchange (G6)	Adopted at MEPC 53, Jul. 2005 (IMO 2005c)
Guidelines on Risk Assessments under Regulation A-4 (G7)	Adopted at MEPC 56, Jul. 2007 (IMO 2007a)
Guidelines for the Approval of Ballast Water Management Systems (G8)	Adopted at MEPC 53, Jul. 2005, amended at MEPC 58, Oct. 2008 (IMO 2008b)
Procedure for Approval of Ballast Water Management Systems that make use of Active Substances (G9)	Adopted at MEPC 53, Jul. 2005, amended at MEPC 57, Apr. 2008 (IMO 2008c)
Guidelines for Approval and Oversight of Prototype Ballast Water Treatment Technology Programmes (G10)	Adopted at MEPC 54, Mar. 2006 (IMO 2006c)
Guidelines for Ballast Water Exchange Design and Construction Standard (G11)	Adopted at MEPC 55, Oct. 2006 (IMO 2006d)
Guidelines for Sediment Control on Ships (G12)	Adopted at MEPC 55, Oct. 2006 (IMO 2006e)
Guidelines for Additional Measures Including Emergency Situations (G13)	Adopted at MEPC 56, Jul. 2007 (IMO 2007b)
Guidelines on Designation of Areas for Ballast Water Exchange (G14)	Adopted at MEPC 55, Oct. 2006 (IMO 2006f)
Guidelines for Port State Control	In preparation

In total 15 guidelines support the uniform implementation of the BWM Convention (see Table 1) by providing technical guidance to implement the BWM Convention principles. The majority of these guidelines (G1–G14) have already been adopted, however the *Guidelines for Port State Control* that have the purpose of harmonizing port State control activities and to define criteria for a detailed inspection of the ship (Article 9 of the BWM Convention) are still not yet finalised.

Guidelines at IMO are intended to be at high level, providing an overall structure for the implementation of the BWM Convention. However, because of the highly complex nature of the subject matter and the sophistication of the technology, many Guidelines have become quite specific and detailed.

Agreements reached on a global level usually represent a compromise, and the BWM Convention is not an exception. During the BWM Convention and over the BWM Convention's Guidelines negotiations many issues were controversial and in certain cases it proved extremely hard and difficult to reach agreements. In order to explain all the concepts, controversial views and agreements reached in its entirety a separate book of its own would be needed. Therefore, the focus of this chapter will remain with the requirements of the BWM Convention, as well as the availability and feasibility of ballast water management (BWM) options. Compliance control measures are also found to be closely related to the BWM requirements and options, hence these are presented in chapters "Ballast Water Sampling and Sample Analysis for Compliance Control" and "Ballast Water Management Decision Support System".

What Is Ballast Water Management?

As defined at IMO: "Ballast Water Management means mechanical, physical, chemical, and biological processes, either singularly or in combination, to remove, render harmless, or avoid the uptake or discharge of Harmful Aquatic Organisms and Pathogens within Ballast Water and Sediments."

BWM in its core sense means the prevention, minimization and ultimate elimination of the transfer of HAOP via vessels' ballast waters and sediments. In light of this, BWM cannot only be understood as mechanical, physical, chemical, and biological processes preventing the transfer of HAOP, because the process includes also different precautionary measures to minimize the uptake of HAOP and sediments. Those include the avoidance of ballast water uptake, where practicable,

- in areas identified by the port State in connection with advice provided by ports;
- in darkness when the organism concentration in upper water layers increases;
- in areas with outbreaks, infestations or known populations of HAOPs;
- in very shallow water because it is more likely to pump in bottom living organisms;
- where propellers may stir up sediment;
- where dredging is or recently has been carried out; and
- nearby sewage outfalls.

Furthermore, no mixing of ballast water should occur and additional management practices may apply, e.g., risk assessment (RA) (see chapter "Risk Assessment in Ballast Water Management"), decision support system (see chapter "Ballast Water Management Decision Support System"). Hence BWM should be understood as a complex, multi-facetted process of all precautionary measures, preventive and treatment procedures, as well as additional measures taken to prevent, minimize and ultimately eliminate the transfer of HAOP via ballast water and sediments.

Vessels should also, whenever possible, implement precautionary practices, i.e., avoid the unnecessary discharge of ballast water. Should it be necessary to take on and discharge ballast water in the same port to facilitate safe cargo operations, unnecessary discharge of ballast water that has been taken up in another port should be avoided. Managed ballast water which is mixed with unmanaged ballast water is no longer in compliance with Regulations D-1 and D-2.

Ballast Water Management Requirements

By the basic principle, vessels (not ports) are required to conduct BWM according to the requirements of the BWM Convention. However, port reception facilities are also considered by the BWM Convention as a BWM option, i.e., Regulation B-3.6 and Guidelines for ballast water reception facilities (G5) (G5 Guidelines) (IMO 2006b). During the BWM Convention negotiations ballast water reception facilities were considered as the primary BWM measure. However, as ships may need to conduct ballast water operations also outside ports (see chapter "Vessels and Ballast Water"), such reception facilities would not cover all ballast water discharges. Therefore, treatment on board ship before ballast water discharge is required.

Standards for BWM are dealt with by the BWM Convention in Regulations D-1 and D-2. The BWM Convention introduces these two different protective regimes as a sequential implementation regime:

- *Ballast Water Exchange Standard* (Regulation D-1, so called D-1 standard) requiring ships to exchange a minimum of 95 % ballast water volume;
- *Ballast Water Performance Standard* (Regulation D-2, so called D-2 standard) requires that the discharge of ballast water have the number of viable organisms below the specified limits.

The D-2 standard is based on a limited number of organisms that can be discharged with ballast water. The phase-in of the D-2 standard was originally planned gradually, based on the vessels total ballast tanks capacity and if these vessels are existing or are new builds (see Fig. 1). When the phase-in dates were set, the expectation was that technology and manufacturing capacity would be first available for vessels with lower ballast water capacities and flow rates. As such dates were set to allow a gradual maturity of the technology with the expectation that the very high flow rates would come later due to the technical challenges. These include that on smaller vessels due to engine room limited space it might be difficult to install ballast water management systems (BWMS) at that time. Higher flow rates were considered difficult as the first generation of BWMS was not able to meet these flow requirements.

However, the BWM Convention has not come into force and certain phase-in dates have already passed. This resulted in a debate at IMO and Marine Environment Protection Committee (MEPC) at its 65th session (May 2013) approved a draft IMO Assembly resolution on the application of Regulation B-3 of the BWM Convention, which addresses the fixed dates, to ease and facilitate the smooth implementation of the BWM Convention. This was approved at the 28th session of the IMO Assembly (25 November to 4 December 2013). This resolution recommends that ships

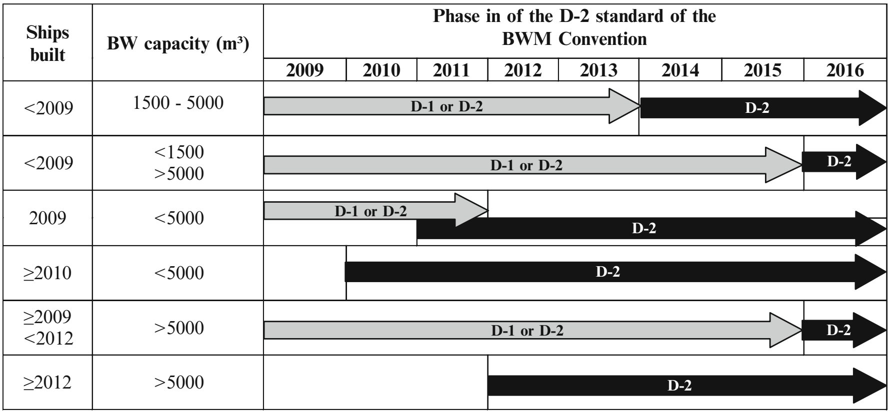

Fig. 1 The original phase-in plan of the ballast water performance standard (Regulation D-2) in relation to the ballast water exchange standard (Regulation D-1) (David and Gollasch 2008) (Reprinted from David and Gollasch 2008, copyright 2008, with permission from Elsevier)

constructed before the entry into force of the BWM Convention will not be required to comply with Regulation D-2 until their first renewal survey following the date of entry into force of the BWM Convention. The aim of the resolution is to clarify that although the BWM Convention itself cannot be changed prior to entry into force, Regulation B-3 may be enforced on a realistic timeline upon entry into force of the BWM Convention. This needs consensus amongst all IMO Member states. One issue that was not anticipated was that the term "renewal survey" is not specifically tied to any statutory requirement. That was solved by using the requirements for the date of the issuance of the International Oil Pollution Prevention (IOPP) certificate as the trigger for the renewal survey.

Several Delegations at MEPC65 expressed their concerns regarding this approach because, due to the reduced urgency to implement BWM methods on board, it may result in a relaxation of efforts to ratify the BWM Convention. It was further assumed that this new approach would negatively impact the developers of BWMS as sales of their units may be delayed.

Ballast Water Exchange Standard: D-1 Standard

Approximately 10 years ago when the D-2 standard was negotiated at IMO no BWMS was readily available. In the absence of full scale BWMS to be installed on vessels, it was suggested by MEPC that ballast water exchange (BWE) at sea may reduce the risk of species introductions. Most vessels are enabled to conduct a BWE without needing extra installations.

The reasoning behind BWE is that coastal organisms pumped on board during ballast water uptake, when discharged at sea are unlikely to survive due to, e.g., salinity issues and the lack of a hard substrate to complete their life cycle. In addition, high sea organisms when pumped on board during the BWE will unlikely survive when released in coastal waters also due to possible salinity changes and the lack of suitable habitats. Further, it is well-known that organism concentrations are much lower in high seas compared to coastal waters which reduces the risk of species introductions. However, sampling studies on board of commercial vessels have shown that in certain instances after BWE a higher concentration of organisms was found in the ballast water (e.g., Macdonald and Davidson 1998; McCollin et al. 2001). This specifically occurred when the BWE was undertaken in shallower seas or during high organism concentrations, such as algal blooms, which are also known to occur in the high seas.

Other BWE efficiency limitations include that, due to ballast tank design, a certain amount of unpumpable ballast water and sediments always remains inside the tank on almost all ships (see chapter "Vessels and Ballast Water"). As a result a one time BWE will not be sufficient to reduce the organism load. IMO noted this and therefore Regulation D-1 of the BWM Convention requires at least a 95 % water exchange. This may be met by emptying and refilling the tank or by pumping through three times the tank volume (Rigby and Hallegraeff 1994). However, when Gollasch and David conducted shipboard tests of different BWM methods it was noticed that on vessels which were trimmed ahead, about 15 % and more of unpumpable water remained in the tanks during the empty-refill (sequential) BWE. Furthermore, a 95 % volumetric BWE is unlikely equivalent with a 95 % organism removal because the organisms are not homogeneously distributed in a tank (e.g., Murphy et al. 2002). In contrast, under certain circumstances, the 95 % volumetric exchange may result in an even higher than 95 % organism removal. In conclusion, pumping through less than three times the volume may also be acceptable provided the ship can demonstrate that at least 95 % volumetric exchange limit is met.

When conducting BWE Guidelines for Ballast Water Exchange (G6) are to be considered. Three methods are accepted to conduct BWE and can be described as follows (IMO 2005c):

Sequential method – is a process by which a ballast tank is first emptied and then refilled with replacement ballast water to achieve at least a 95 % volumetric exchange.

Flow-through method – is a process by which replacement ballast water is pumped into a ballast tank, allowing water to flow through an overflow on deck or other arrangements.

Dilution method – is a process by which replacement ballast water is filled through the top of a ballast tank with simultaneous discharge from the bottom at the same flow rate so that a constant water level is maintained in the tank throughout the BWE.

In addition to the requirements to be met in relation to the BWE methods used, a ship should also consider requirements regarding where BWE shall, whenever possible, be conducted. In the first place, this is at least 200 nautical miles from nearest land and in water depths of at least 200 m. If this is impossible, then the

BWE should be conducted as far from nearest land as possible, and in all cases at least 50 nautical miles from nearest land and in waters of at least 200 m depth (IMO 2004).

Ballast Water Exchange Areas

In sea areas where these BWE depth and distance requirements cannot be met, the port State may designate a ballast water exchange area (BWEA). This should be done in consultation with adjacent or other states, as applicable. Any such designation should follow the principles of Guidelines on Designation of Areas for Ballast Water Exchange (G14).

However, a ship shall not be required to deviate from its intended voyage, or delay the voyage to conduct BWE. In contrast, a port State may require a ship to deviate from its intended route or delay its voyage in case a designated BWEA has been established. The BWE activity for each tank should not start if the process cannot be fully completed.

In general, ships should follow the G6 Guidelines and shall only be required to comply with any BWE requirements if those would not threaten the safety or stability of the ship, its crew, or its passengers because of, e.g., adverse weather, ship design or stress, equipment failure, or any other extraordinary condition.

Vessels operating in coastal areas are unlikely to meet the distance (200 nm or 50 nm distance from nearest land) and water depth (200 m depth) requirements of the BWM Convention. Further, routes may be too short to conduct a complete BWE of all ballast tanks intended to be discharged in the port of call. Management options for those vessels may therefore be based on a selective approach, i.e., use a designated BWEA or by granting exemptions based on RA (see chapter "Risk Assessment in Ballast Water Management").

The rationale for the BWEA designation is that it provides an area where ships can safely exchange ballast water as a risk reducing measure while at the same time minimising harmful environmental effects. However, next to shipping and nautical aspects, the challenge is to identify such areas from a biological perspective. It is understood that coastal BWEA pose a higher risk of species introductions compared to mid-ocean exchange, but at the same time it may be preferred to use specially designated BWEA rather than to discharge unmanaged ballast water in a port or across the entire coastal area.

Strong concerns have already been voiced that the designation of near-shore BWEA may expose certain regions to additional ballast water discharges, which may pose a risk to those ballast water receiving environments. This is why BWEA need to be selected very carefully using RA to prove it is environmentally safe. Ideal would be a BWEA with off-shore directed water currents, it should be as far from nearest land and as deep as possible, free of pollution or HAOP. When these requirements are met the BWEA may be considered environmentally safe and effective. When considering shipping aspects, the BWEA needs to be designed as large as possible and as close as possible to shipping routes (David 2007).

In practice this implies difficulties especially for the designation of BWEA in shallow seas (e.g., North Sea, Baltic Sea) or semi-enclosed seas (e.g., Adriatic). Considerations should be given to the trade-offs between (a) additional ballast water discharges in such areas, (b) the dimension of the BWEA to allow complete BWE and (c) to its location to avoid major deviations from the vessels' intended routes. To meet the requirements vessels with bigger ballast water capacities may slow down when sailing through BWEA to gather extra time to complete the BWE operation or to exchange just the "critical" (i.e., assessed as highest risk ballast) ballast water. A decision on the minimum management measure required should be taken according to the level of RA (see chapter "Risk Assessment in Ballast Water Management").

BWEA should be biologically monitored frequently to document the presence/absence of introduced species or other HAOP. A worst case scenario may be that HAOP become introduced and established in such an area and are rapidly spread unnoticed due to the ongoing BWE activities in this area.

A unique situation occurs in e.g. Europe and USA as some of the busiest ports are located in estuaries with brackish or even freshwater conditions (e.g., Antwerp, Hamburg and parts of Rotterdam, inner parts of Chesapeake Bay and San Francisco Bay). A high risk for a species introduction occurs when freshwater organisms (e.g., the zebra mussel) are transported in ballast tanks between two freshwater ports, but these two ports are separated by marine water conditions, which poses a natural migration barrier so that the freshwater organisms cannot spread by their natural means between these freshwater ports. In those instances BWE in higher saline waters, also in coastal waters (i.e., <50 NM from the nearest land and <200 m depth), may be a risk reducing measure. However, some organisms show a very wide salinity tolerance, i.e., BWE alone will not completely eliminate the risk of species introductions.

We therefore recommend that freshwater ballast should be exchanged in marine waters even if this is in coastal waters provided that the voyage is sufficiently long to complete BWE en-route in marine waters for the ballast water intended for discharge.

Undue Delay and Deviation from Planned Route

As per the BWM Convention vessels should not be forced to deviate or be unduly delayed by BWM requirements. The BWM Convention gives the vessel a right for compensation when it has been unduly delayed. However, the term "undue delay" has never clearly been defined by IMO in relation to the BWM Convention or other IMO applications.

The designation of BWEA should not require major vessel deviations. However, a cost/benefit analysis considering the costs caused by negative impacts of introduced species vs. re-routing costs for shipping may reveal that a slight re-routing of vessels may be considered. Similarly, if a RA identifies that a vessel carries ballast water with an unacceptable risk, then the reasoning for a deviation may apply and it is therefore not "undue". It may therefore be considered that vessels use specific routes even if this results in a delay of a few hours.

Ballast Water Performance Standard: D-2 Standard

The *Ballast Water Performance Standard* as outlined in Regulation D-2 stipulates that ships meeting the requirements of the BWM Convention must discharge:

- less than 10 viable organisms per cubic meter greater than or equal to 50 μm in minimum dimension, and
- less than 10 viable organisms per millilitre less than 50 μm in minimum dimension and greater than or equal to 10 μm in minimum dimension, and
- less than the following concentrations of indicator microbes, as a human health standard:
  - Toxigenic *Vibrio cholerae* (serotypes O1 and O139) with less than 1 colony forming unit (cfu) per 100 ml or less than 1 cfu per 1 g (wet weight) of zooplankton samples,
  - *Escherichia coli* less than 250 cfu per 100 ml, and
  - Intestinal *Enterococci* less than 100 cfu per 100 ml.

This standard formed the basis for significant discussions and continuing controversy at IMO. The acceptable organism numbers and the method to determine their size classes were debated intensively. This compromise was reached through negotiations by various countries which ranged from an acceptable number of organisms above 50 μm in minimum dimension between 100 and 0.01 per cubic meter. The current version of the D-2 standard is seen as a considerable reduction compared to the amount of organisms discharged in unmanaged ballast water or even that obtained by BWE.

The D-2 standard for both organism groups greater than or equal to 10 μm in minimum dimension refers to all organisms, not per species, and not only for non-indigenous or harmful organisms. As a result the individual taxonomic species identification is not required for purposes of compliance testing.

Also of note is the inclusion of a discharge limit for "indicator microbes" with a human health impact in the D-2 standard. A number of delegations insisted on incorporating these bacteria as they had specific issues, hoping this would result in a strong signal to R&D interests. Existing and developing ballast water treatment technologies are able to meet these standards using a combination of treatment methods (see chapter "Ballast Water Management Systems for Vessels").

Although the D-2 standard results in a considerable reduction in organisms being released we note that vessels carry up to 100,000 tonnes of ballast water or more so that still a high number of organisms may be discharged with ballast water being in compliance with this Convention. Assuming that 10,000 tonnes of ballast water are discharged, the acceptable D-2 standard organism concentration for individuals greater than or equal to 50 μm in minimum dimension is less than 100,000, which theoretically means 99,999. The number of organisms to establish a founder population in new environments is largely unknown, but we suspect that an inoculation of approximately 100,000 individuals (although of different species) may not *eliminate* the risk of species introductions in all cases. Another weak point regarding the D-2 standard is that it does not address organisms below 10 µm (in minimum dimension), but a considerable number of species, including bloom forming harmful algae, are smaller than 10 µm (e.g., *Phaeocystis* spp., *Pfiesteria* spp. and *Chrysochromulina* spp.).

How to Achieve Compliance with the D-2 Standard?

The D-2 standard is based on a limited number of organisms that can be discharged with ballast water, and is not considering only non-indigenous or harmful organisms, but all viable organisms in relevant size classes, or limited number of cfu per indicator microbes. Indicator microbes are in general present only in coastal environments, into which these may be discharged with untreated river run-offs contaminated with human influence or due to improper sewage treatment plants. Therefore BWE may still be efficient to manage ballast water according to the D-2 standard in terms of indicator microbes as in open ocean these organisms are absent. However, the open ocean concentration of viable organisms greater than or equal to 10 µm in minimum dimension, and especially those greater than or equal to 50 µm in minimum dimension, may be higher in BWEA than the D-2 standard (Gollasch and David, own observations). Consequently BWE is not an option to manage ballast water to comply with the D-2 standard. With this the on board installation of ballast water treatment systems, so called BWMS, became a viable option and requirement. It is interesting to note that a recent summary of existing and developing BWMS revealed more than 100 such systems. However, some of these are not considered realistic, but if only half of those make it to the market, a large variety of BWMS becomes available so that all vessel types with their specific BWM requirements can be equipped with BWMS. As of the December 2013, 33 BWMS have been type approved. Details about BWMS are given in chapter "Ballast Water Management Systems for Vessels".

Issues which further may need to be considered are the possible regrowth of organisms in ballast tanks after treatment and also that organisms may remain in the tank from previous ballast water operations and may become re-suspended during ballast water operations (Murphy et al. 2008). Consequently, upon discharge, treated water may contain unacceptably high organism numbers although the treatment systems proved that the D-2 standard was met during water uptake. To ensure that ballast water discharges always meet the D-2 standard it is recommended to treat the water during uptake and discharge and also to develop BWMS which by far exceed the standards set forth in the BWM Convention.

In the case of fresh water ecosystems, some countries such as Canada are examining the possibility of continuing the use of BWE to take advantage of the salinity shock imposed on fresh water organisms when vessels travel between freshwater donor and freshwater recipient ports, i.e., in cases when vessels ballast in freshwater, a marine water BWE would provide a salinity shock to the originally pumped in freshwater organisms. At the same time, marine organisms pumped on board during

BWE would be exposed to a salinity shock when released in a recipient freshwater port. Land-based trials have indicated an up to tenfold reduction of risk compared to the use of BWMS alone (Briski et al. 2013).

Warnings Concerning Ballast Water Uptake in Certain Areas

The BWM Convention encourages Administrations to conduct monitoring programmes in their coastal waters, i.e. typical ballast water uptake zones, and further to notify mariners if ballast water uptake restrictions are necessary. Such notifications may include suggestions for alternative ballast water uptake areas. Ballast water uptake warnings are useful e.g., in cases of outbreaks of toxic algal blooms (e.g., Hallegraeff 1998), in the presence of human pathogens, or other (potentially) harmful organisms. Ballast water uptake should also be avoided near sewage outfalls and when tidal flushing is poor. Relevant notifications should be communicated to IMO and potentially affected states.

These monitoring activities may be conducted within the framework of a regional cooperation. One key problem is that in most countries existing monitoring programmes were created for other purposes and lack sampling sites in ports or port regions, i.e. in ballast water uptake areas.

Ballast Water Reception Facilities

BWM requirements in the BWM Convention do not apply to ships which intend to discharge ballast water to a reception facility. If available, such facilities should be designed according to the G5 Guidelines. A ballast water reception facility may be a good solution for a vessel that didn't manage ballast water properly and would need to discharge it. This would be especially important when the ballast water is posing a high risk to the recipient environment (see chapter "Risk Assessment in Ballast Water Management").

Reception facilities may be land based or floating, e.g., barges, tankers (IMO 2013). Reception facilities may have a capacity to receive ballast water and treat it later before the discharge into the environment, or the treatment process is applied directly during the discharge to the environment. Where ballast water is discharged into the aquatic environment it should at least meet the D-2 standard of the BWM Convention (IMO 2006b).

A reception facility should provide adequate pipelines, manifolds, reducers, equipment and other resources to enable, ships wishing to discharge ballast water in a port to use the facility (IMO 2006b). However, today ships are lacking a (standardised) pipework connection, which would enable the discharge of ballast water to reception facilities. Tankers have standardized piping and manifolds for cargo transfers and the concept of standard fittings is embedded in ship design and construction. Therefore, for these vessels ballast water transfer to a reception facility could easily be achieved provided the cargo transfer pipes may be used for ballast water discharge. Hence, ships planning to use this option need to have adequate equipment installed.

It should be noted that prior to the introduction of double hulls and segregated ballast tanks, designed to minimize the threat of oil pollution to the environment, tankers pumped their ballast ashore. Refineries worldwide have ballast water reception facilities. Major crude oil exporting ports, such as Valdez (Alaska, USA) and Scapa Flow (Orkney Islands, United Kingdom) still use these shore-based facilities for the reception and treatment of oily ballast from crude oil tankers. This proves that the engineering, pumping, storage etc. of massive quantities of ballast is technically possible and economically feasible within the operating cost structures of modern shipping and ports. Adapting this approach to include biological treatment to remove or render harmless the ballast water organisms is unlikely to be any more challenging or less feasible than the original development of these facilities – especially as technology has advanced.

Land-based ballast water reception facilities may also be used to provide biologically clean ballast water at the source ports, which prevents the problem already at ballast water uptake.

Sediment Management

Regulation B-5 of the BWM Convention requires that all ships shall remove and dispose ballast water related sediments in accordance with the vessels' ballast water management plan.

All possible practical steps should be taken during ballast uptake to avoid sediment accumulation, but it is known that it cannot be avoided to take sediment on board and this will settle on tank surfaces and bottoms. The sediment amount in a ballast tank should be monitored on a regular basis. When sediment has accumulated, tank bottoms and other surfaces should be flushed when in suitable areas, i.e. areas complying with the minimum depth and distance requirements as described for BWE.

The frequency and timing of sediment removal depends on several factors, including dimension of sediment build up, ship's trading pattern, availability of reception facilities, work load of the ship's personnel and safety issues.

The removal of sediment should preferably be undertaken under controlled conditions in a port, at a repair facility or in a dry dock. The removed sediment should be disposed of in a sediment reception facility in line with the waste disposal requirements of the coastal state. Regulation B-5 further requires that ships constructed in or after 2009 should, without compromising safety or operational efficiency, be designed and constructed to minimize the sediment uptake and entrapment, facilitate removal of sediments, and to provide safe access for sediment removal and sampling, taking into account the Guidelines for sediments control on ships (G12). This also applies to ships constructed prior to 2009, to the extent practicable.

Exemptions from BWM and Additional Measures

Some ships may be exempted from BWM requirements provided that the risk level of such a discharge is acceptable based on Guidelines on Risk Assessments under Regulation A-4 (G7). In other cases, when the risk is identified as (very) high, such ships may be required to take additional measures based on Guidelines for Additional Measures Including Emergency Situations (G13). The level of risk is a result of RA (see chapter "Risk Assessment in Ballast Water Management").

The BWM Convention addresses the selective BWM approach in Article 4.2. This article requests a party to develop BWM policies, strategies or programs regarding to its particular conditions and capabilities. It was understood that no "one size fits all" approach is available because different states may have different geographical, environmental, socio-economic, organizational, political and other conditions as well as different shipping patterns. In light of RA based exemptions from BWM requirements, these can be given on the basis of Regulation A-4, while additional measures may be introduced based on Regulation C-1 (see Fig. 2).

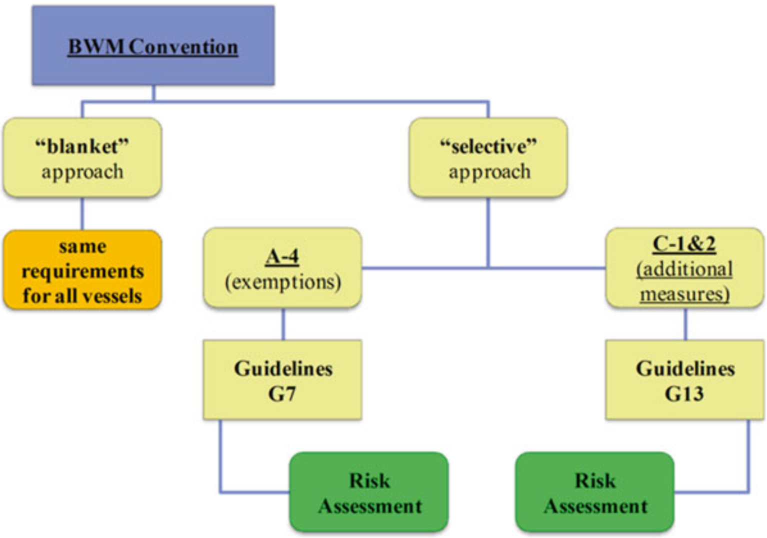

Fig. 2 Risk assessment procedures according to the BWM Convention (Enhanced after Gollasch et al. 2007) (Reprinted from Gollasch et al. 2007, copyright 2007, with permission from Elsevier)

Exceptions from BWM

Further to the above mentioned exemptions, the BWM Convention also includes provisions for cases where vessels do not need to manage their ballast water at all. This refers to vessels being in line with the Regulation A-3 *Exceptions*. Exceptions are identified for specific cases including (IMO 2004):

1. ballast water uptake or discharge is needed for ensuring the safety of a ship in emergency situations;
2. accidental discharge results from damage to a ship or its equipment;
3. uptake or discharge of ballast water is used to avoid or minimize pollution incidents;
4. uptake and discharge of the same ballast water is conducted on the high seas; or
5. uptake and discharge occurs at the same location, provided no mixing occurs with other locations.

The “high seas” and “same location” exceptions may apply permanently if this is a regular vessel operation. Granting an exemption or a permanent exception means that a vessel is not required to install a ballast water treatment system with the clear benefit of avoiding capital and operational costs as well as burdens associated with the certification and inspections. However, the BWM Convention is not specific in defining the term “same location” (IMO 2004; Gollasch and David 2012; David et al. 2013). Therefore the concept is subject to different interpretations which depend on the interpreters’ approach and this may be based on one or a combination of the following: environmental parameters, hydrological regimes, biological meaningful parameters, or political aspects. The shipping industry would benefit from a larger “same location”, as it avoids ballast water management requirements on voyages inside each such location. In contrast maximizing environmental protection requires that a “same locations” should be as small as possible. As a result, the “same location” may be of different dimensions, including a mooring, port basin, port, anchorage, part of a sea, or even an entire sea with numerous ports. These different interpretations introduce difficulties in the uniform implementation of the BWM Convention, including an opportunity for the secondary transfer of organisms between ports within a large “same location” (Gollasch and David 2012; David et al. 2013).

In light of the above the identification of a “same location” for ballast water management is not an easy task. This should be port specific and each port has its unique peculiar situation regarding the number of port basins, it may extend over waters of different salinity regimes, and ports likely have different cargo patterns resulting in different ballast water operation profiles. The issue becomes more complex when the same location needs to be explained in biologically meaningful terms addressing aquatic species invasions. To biologically identify a “same location” the species diversity and their abundance may be considered. This assessment should include indicator microbes and human pathogens as listed in the D-2 standard. Should all species, including indicator microbes and human pathogens, be identical and their abundance is very similar, this area could be considered as the same location (Gollasch and David 2012; David et al. 2013).

National authorities responsible for the BWM Convention implementation may receive applications from shipping companies for permanent exceptions based on the "same location" concept. Consequently the authorities will need to decide, on a case-by-case basis, how the term should be applied. We recommend that "same location" means the smallest practicable unit, i.e., the same harbour, mooring or anchorage, as stated in IMO Guidelines G3. When considering the diversity of ships ballast operations and ports, as well as possible differences in environmental conditions and species compositions among port terminals or basins, we recommend that an entire smaller port, possibly also including the anchorage, should be considered as "same location". For larger ports with a gradient of environmental conditions, the "same location" should mean a terminal or a port basin. We further suggest that IMO considers the preparation of a guidance document to include concepts, criteria and processes how to identify a "same location", which limits should be clearly identified. Large areas encompassing more ports should not be identified as a "same location" as this would seriously undermine purpose of the BWM Convention, as unmanaged ballast water would be transferred in this area (Gollasch and David 2012; David et al. 2013). (see also the U.S. same port or place concept in chapter "Policy and Legal Framework and the Current Status of Ballast Water Management Requirements").

Compliance Monitoring

In accordance with Article 9.1, ships to which the BWM Convention applies may be subject to inspections for the purpose of revealing violations of the provisions of the BWM Convention. These inspections shall:

- Verify that the ship is carrying a valid Ballast Water Management Certificate;
- Verify that a Ballast Water Management Plan specific to the ship and approved by the Flag state is onboard;
- Undertake an inspection of the Ballast Water Record Book.

As a part of the Port State Control and to demonstrate compliance with the D-2 standard, port authorities may consider sampling ballast water for subsequent analyses. IMO provided guidance on sampling ballast water in Guidelines for Ballast Water Sampling (G2). We have summarised the state of knowledge regarding ballast water sampling in chapter "Ballast Water Sampling and Sample Analysis for Compliance Control".

Implementation of the Ballast Water Management Convention

A Blanket or a Selective Approach?

The BWM Convention incorporates two different basic BWM regimes; i.e., the "blanket" and the "selective" approach. A blanket approach results in a situation where all ships intending to discharge ballast water in a port are required by the port

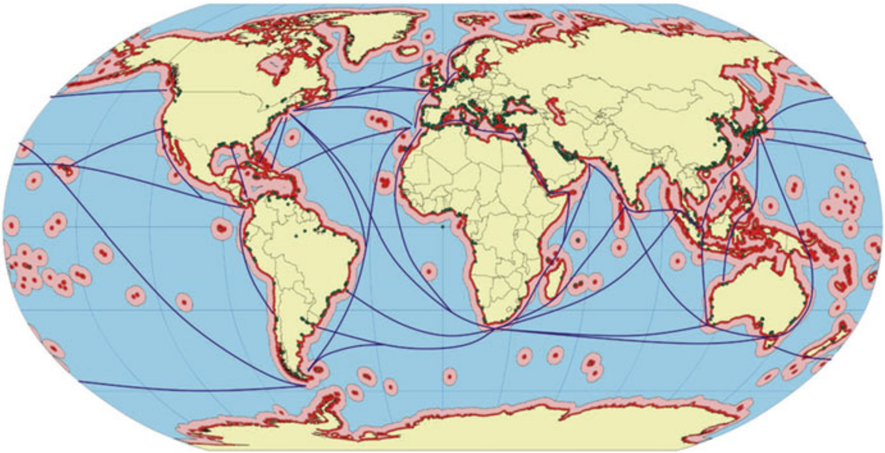

Fig. 3 World map indicating the main intercontinental shipping routes (*blue lines*) and BWE areas according to the BWM Convention (*red shading* = 50 NM and *pink shading* = 200 NM limit to nearest land and >200 m water depth) (After David et al. 2005)

State to conduct BWM. The selective approach means that the appropriate BWM measures to take vary depending on the different levels of risk posed by the intended ballast water discharge, which also depends on the BWM feasibility in certain circumstances.

Ballast Water Management Feasibility

Whenever possible and until the D-2 standard is required, BWE should be undertaken as a risk reducing measure. Provided safety permits, it is assumed that most vessels operating on oceanic voyages are enabled to undertake BWE that meets the IMO water depth and distance to nearest land limits (see Fig. 3).

However, there are limitations in BWE applications, which are primarily due to shipping patterns of a port (e.g., shipping routes, length of voyages) and local specifics regarding the required/available conditions according to the BWM Convention (i.e., distance from nearest land, water depth, BWEA). BWE has also substantial limitations in its biological effectiveness especially in semi-enclosed or enclosed areas. Ships in these areas usually sail within 50 nautical miles distance from the nearest land, and therefore, according to the BWM Convention, cannot meet the requirements to conduct BWE. Because of geographical specifics, not only ships in Short-Sea-Shipping fall into this category (see Fig. 4).

Hence, from the most effective BWM perspective worldwide, the use of BWMS would be essential.

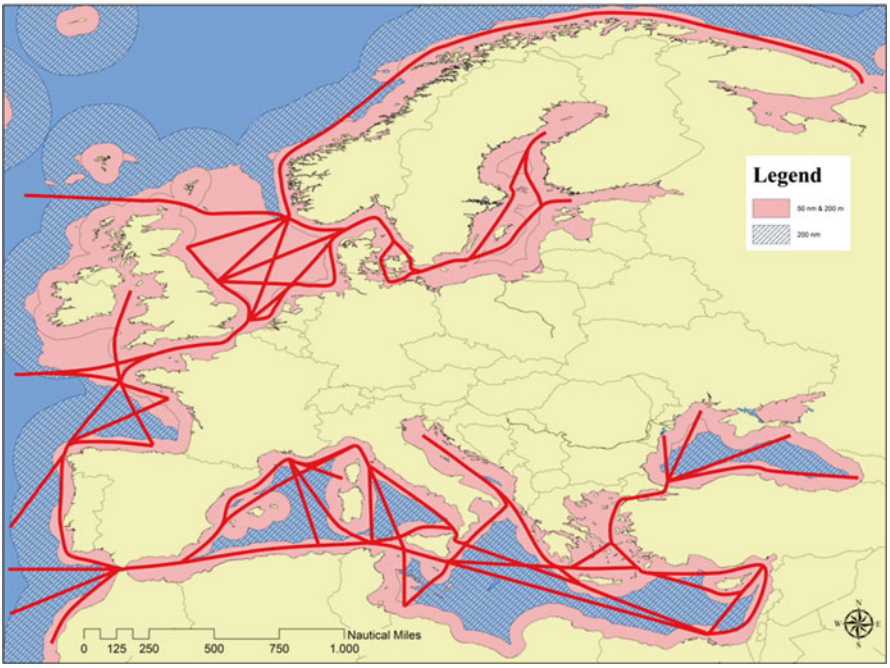

Fig. 4 The seas surrounding Europe with the 50 nautical miles and 200 m depth limit shown in *pink*, and *pink shaded* the 200 nautical miles limit. The *red lines* show the main shipping routes (After David and Gollasch 2008) (Reprinted from David and Gollasch 2008, copyright 2008, with permission from Elsevier)

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