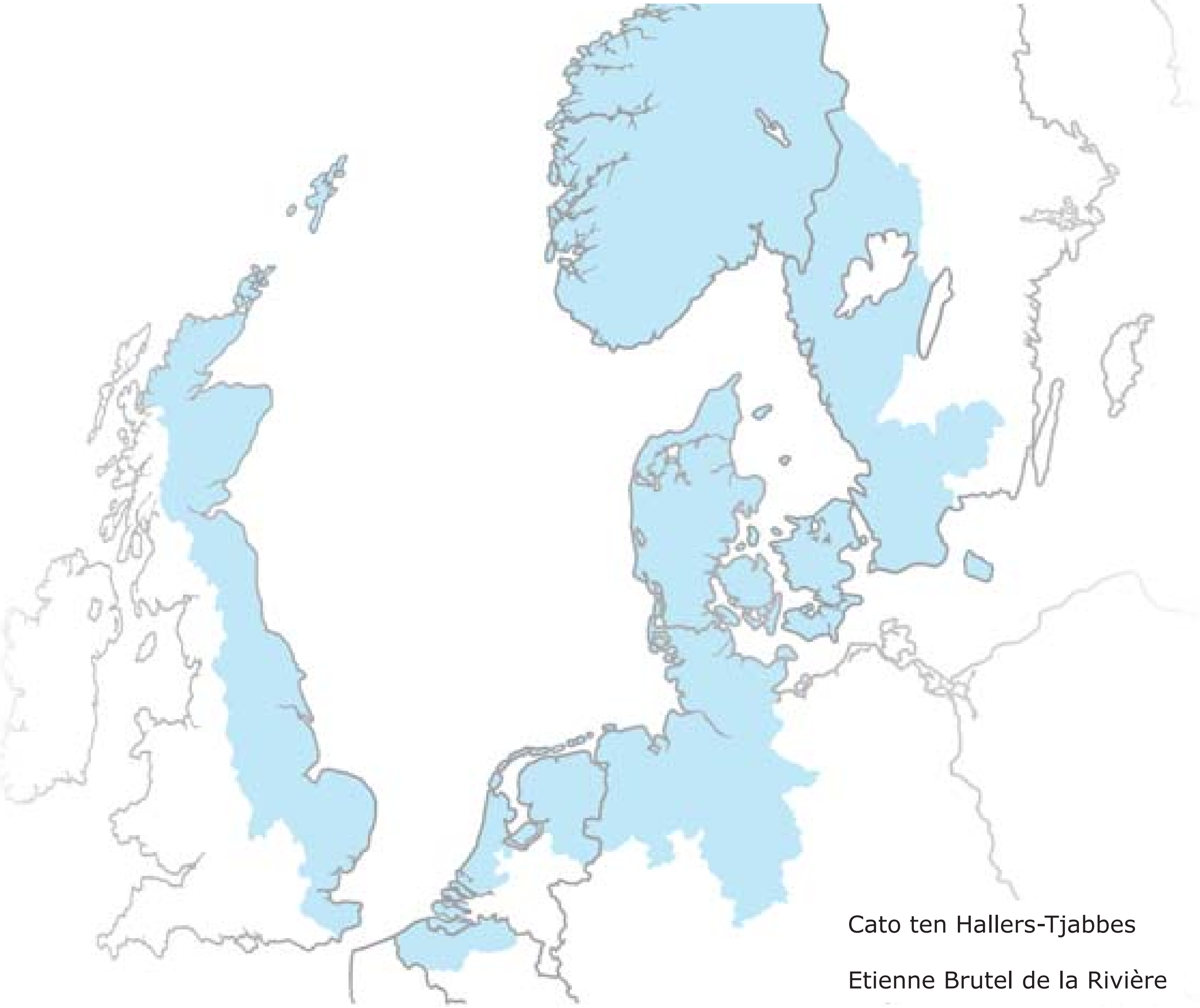
North Sea Ballast Water

The Interreg IVB North Sea Region Programme

*Investing in the future by working together for a sustainable and competitive region*

# Proceedings NSBWO Europort 2011 Conference "Threat or Treat"?




Cato ten Hallers-Tjabbes

Etienne Brutel de la Rivière


EUROPORT 2011

connecting the maritime world

8 - 11 november, Ahoy Rotterdam

# PROCEEDINGS NSBWO-EUROPORT 2011 CONFERENCE

# "THREAT OR TREAT"?

Dr. Cato C. ten Hallers-Tjabbes, FRIN

CaTO Marine Ecosystems

Etienne J. Brutel de la Rivière, M.Sc

NIOZ Royal Netherlands Institute for Sea Research, presently at MEA-nl

Reporting period 9, mar 2013 to Aug 2013

8-7-2013

**Disclaimer**

## TABLE OF CONTENTS

# 1 EXECUTIVE SUMMARY

The conference's main aim was to reach the maritime community, in particular the shipping world. The co-operation with the organisers of the Europort 2013 Maritime Fair proved to be an optimal route to an open platform for access by the maritime world.

The main objective of the conference was to familiarise the maritime world with the challenges and options posed by ballast water management and the Ballast Water Management Convention 2004 (BWM Convention). To achieve this end we developed a two-day programme, where the first day focused on the challenges: What is expected from the maritime community as to BWM, while the second day presented the many options available to meet such challenges. Both days offered ample options for questions and discussion.

The challenges that needed highlighting were:

- Regulatory framework, time- frame, IMO and regional requirements
- Certification and the role of Classification Societies/Recognised Organisations
- Protecting the aquatic environment from side effects of BWM, Environmental Acceptability and the relevant IMO Guidelines
- BWM on-board ships, installation and retrofits
- Compliance Control, regulations and responsibilities

As to solutions we focused on:

- The role of the North Sea Ballast Water Opportunity Project in implementing the BWM Convention
- Contributions of science to risk assessment underlying exemption strategies
- Solutions for BWM on board ships, the different types of BWM systems developed by the industry and an evaluation
- Meeting the challenges of installing BWM on ship-board
- Ship owner's view on BWM and managing the options
- Guidance in deciding how to manage BWM on board ships

As additional guidance invited speakers were also asked to consider addressing specific issues below:

- Indicate how your aims/work/expertise/organisation relate to the context of North Sea Ballast Water Opportunity.
- Demarcate what really matters and what does not, although sometimes assumed to matter (such as 'fairy tales').
- Guidance to help replacing the present feeling of insecurity on the BWMC and its implementation into curiosity about what more is going on/is or will become available/present and future options and windows of opportunities.
- Options you may have identified for enhancing progress in the process of implementing the BWMC, or for enhancing the process itself.
- Clarity about the responsibilities in implementing the BWMC from your perspective.
- If a window of access to your expertise would be relevant, views on what window that would be, where to found and how best/most easily accessed.

- Views on optimising communication between your field of expertise/perspective and the shipping world
- Views on the future of your work in relation to the NSBWO project and beyond.

Speakers were invited to consider addressing specific issues in their talks (Appendix 2).

Although it was the first conference in this way in combination with Europort exhibition in Rotterdam, both days were well attended by 266 representatives from the shipping industry, policy makers, manufacturers and many others. See the figure below.

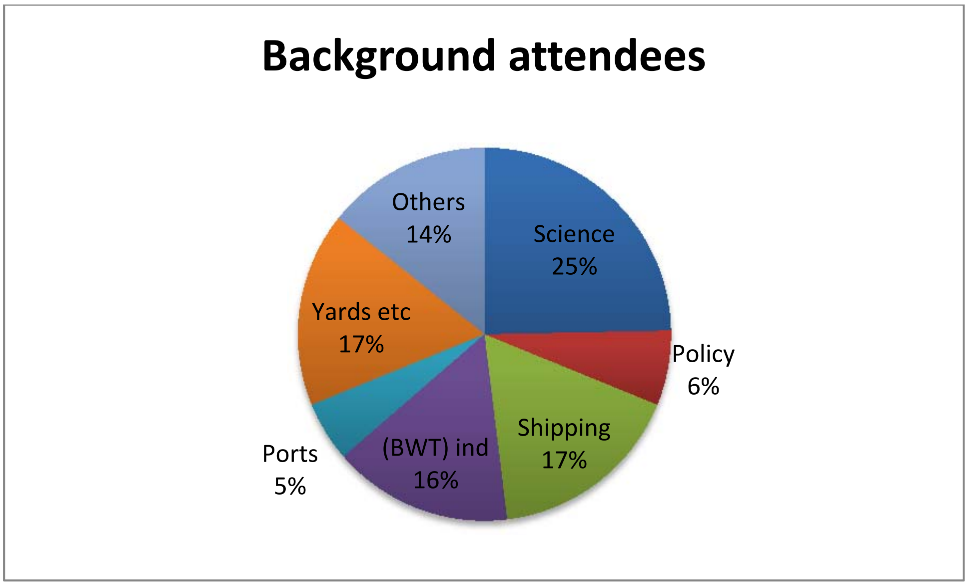



**Figure 1:** Background of attendees

Further information about the country of origin etcetera will be given in Appendix 1 Statistical analysis.

The success of this conference calls for a follow up at Europort 2013, when things have been developed further. The North Sea Ballast Water Opportunity (NSBWO) project clearly shows its importance as a contribution to implementing the BWMC Convention. We also hope that at the time of Europort 2013 the BWMC has entered into force and that states in general have adopted a policy in accordance with the Convention.

# 2 BALLAST WATER MANAGEMENT INTRODUCTION

### Dick Brus, Ministry of Infrastructure and the Environment

He introduced the background of the Ballast Water Management Convention. Ratifications and possible entry into force and availability of Ballast Water Management systems.

### The Problem

Why do we have ballast water regulations? Because harmful species have traveled, in ballast tanks, to other areas, sometimes with devastating effects. The Zebra mussel in the Great Lakes in North America is a well known example, but there are many more.

**Ten of the Most Unwanted:**

- Cholera
- Cladoceran Water Flea
- Mitten crab
- Toxic Algae (Red/Brown/Green Tides)
- Round Goby
- North American Comb Jelly
- North Pacific Seastar
- Zebra Mussel
- Asian Kelp
- European Green Crab

Something had to been done, and something was done. In 2004 the IMO agreed on the Ballast Water Management Convention. However, this convention has not come into force yet.

### History

- 1990's Invasion of the Eurasia Zebra Mussel in the North America The Great Lakes, with devastating effects
- 2004 Febr 13 Ballast Water Management Convention
- 2004-2009, 14 guidelines on ballast water sampling, reception facilities, approval, of ballast water systems
- 2004-2011. Ballast water guidelines,
- 2010 The Netherlands ratifies the Convention

### When does the convention come into force?

- Conditions of entry into force: 12 months after the ratification of 30 States, 35% of the world's tonnage
- 1 November 2011: 30 states have ratified, 26,4% of world tonnage
- Coming into force: 2013??

Regulations will enter into force retroactive. For example, regulations for ships constructed in 2011 and 2012 will retroactive become mandatory once the convention enters into force! So it is important for ship owners to be prepared and plan it's ballast water requirements in time.

**Ballast water treatment systems**

The Ballast Water Management Convention includes limits for the maximum amount of viable organisms for treated ballast water. In 2004, when the convention was agreed, no ballast water treatment technology existed to comply with these standards. So this was a convention which forced new technology. A worry from ship owners was, understandably, if suitable technology would become available in time. The last years showed that a large amount of ballast water treatment systems has been approved and has become available on the market.

Amount of ballast water treatment systems:

- Basic approval 34
- Final Approval 20
- Type approval 19

**BE PREPARED**

**Ship owners: start preparing yourself today**

**yesterday was much better**

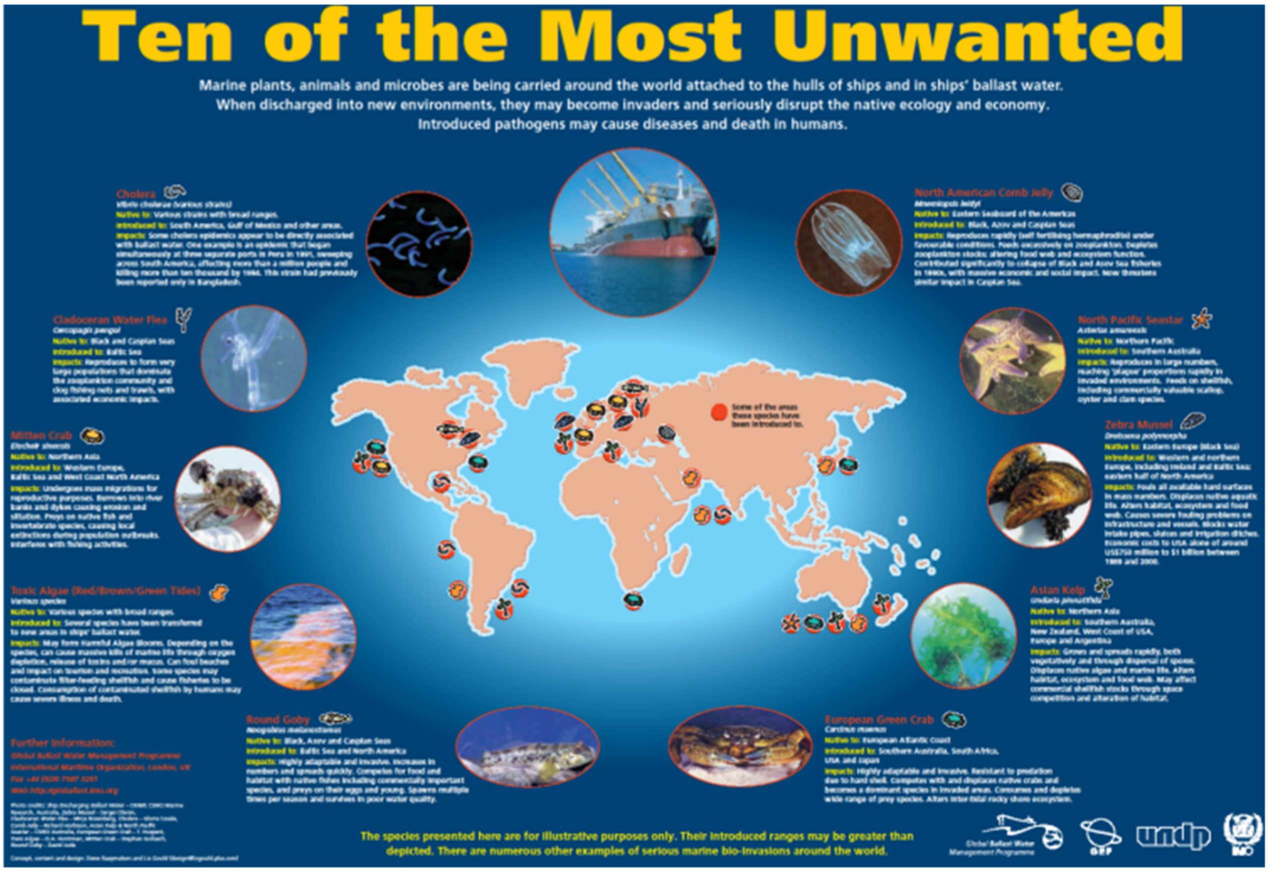



**Figure 1:** Ten of the most unwanted (GloBallast)

# 3 OBLIGATONS OF THE BWMC AND CONSEQUENCES FOR SHIPS

**Kai Trümpler, BSH**

The impacts of invasion of alien species to ecosystems around the globe are significant. Studies estimate that every nine weeks an alien species newly establishes itself somewhere in the world. The economic costs of controlling the species are spiraling upward (for Europe this is estimated to be over 11 billion Euros, including land-based invaders).

The North Sea region has been a particular target for the introduction of alien species. A study by Dr. Stephan Gollasch in 2006 (ref.) estimated that 230 species have been introduced into the North Sea, giving it second place in a ranking of most invaded seas in Europe. Of the invasions, about one third is estimated to have been caused by transfer of ballast water.

With more frequent shipping on existing routes, the increase in ship sizes, the shortening of transfer times, and possibly the effects of climate change, ballast water can reasonably be expected to increase in importance as a vector for alien species.

This imminent threat to the world's oceans has led the international community to adopt the International Convention for the control and management of ships' ballast water in 2004 (BWMC). 30 States have ratified the convention to date (31.10.2011), representing close to 27% of the world's merchant shipping tonnage. As several states have indicated their impending ratification it is widely expected that the necessary 35% will be attained in 2012. This will mean entry into force of the convention in 2013.

The convention sets stringent discharge limits to reduce the risk of further invasions. Regulation B-3 of the convention sets out a clear timeframe for the implementation of the limits for existing and newly constructed ships.

The discharge limits can only be met if the ship installs a ballast water management system (BWMS). The installation of a BWMS involves significant expenditure and planning on the part of the ship owner. While at present sufficient technologies are available for ships that need to retrofit , calculations show an increasing demand until 2017 with only a slight decrease till 2019.

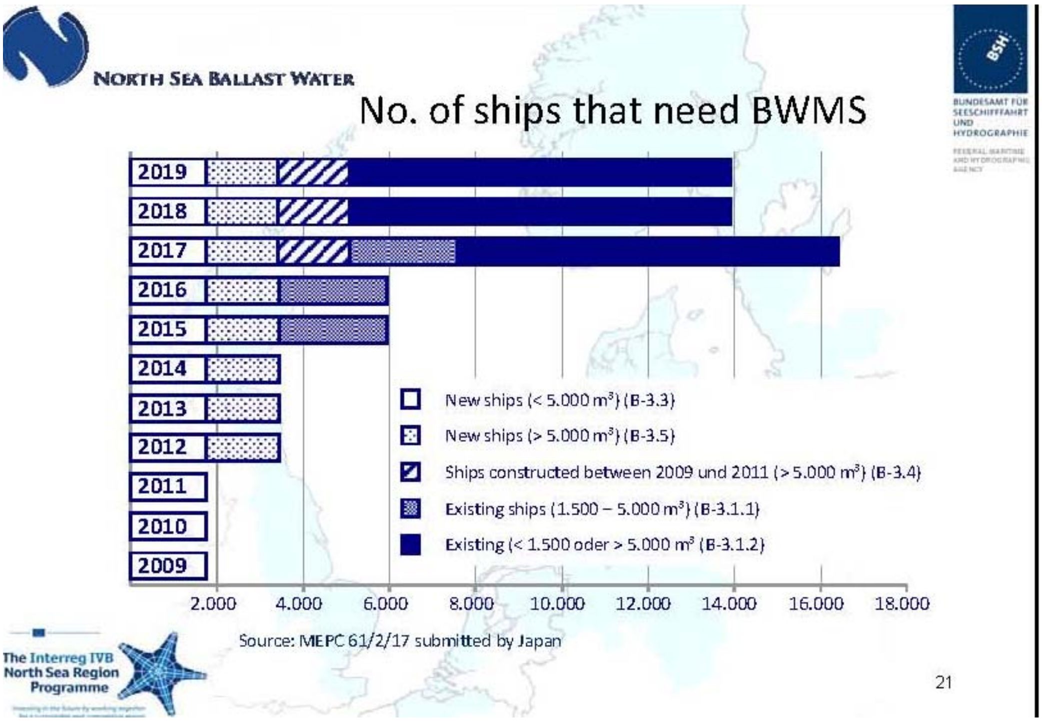



**Figure 1:** No. of ships that need BWMS

It is to be expected that the implementation of the convention will be a challenge for operators, yards, and BWMS manufacturers alike. Planning for the next couple of years needs to start now, waiting is not an option.

# 4 UNDERSTANDING THE UNITED STATES BALLAST WATER REGULATIONS & REQUIREMENTS

**Doug Schneider, government affairs World Shipping Council**

Owners and operators whose ships call at the United States face some important questions. What ballast water discharge standards will be adopted in the United States? Might ships face different standards when calling at different U.S. states? What will be the timeframe for the installation of ballast water treatment technologies in new builds and existing ships that call at the United States? Will the U.S. accept type approvals issued by foreign administrations? Might ships be required to reinstall systems in a ship if more stringent discharge standards are adopted in the future? While firm answers to all such important questions may not be available, the fog regarding U.S. ballast water requirements is likely to clear somewhat in the near future. A discussion of the U.S. process of setting standards, and some factors that influence those processes, follows.

**U.S. Federal Ballast Water Standard Setting**

***U.S. Coast Guard*:** In 1996, the U.S. Congress passed the National Aquatic Invasive Species Act (NISA), which amended the Nonindigenous Aquatic Nuisance Prevention and Control Act of 1990 and directed the U.S. Coast Guard (USCG) to establish a voluntary ballast water management program for ships operating in U.S. waters. In 1998, pursuant to NISA, the USCG established a voluntary program in which ships were advised to exchange the ballast water in their ballast tanks for deep ocean water to reduce the likelihood that aquatic invasive species would be transferred from foreign ecosystems to the United States. In 2004, the USCG issued regulations (33 CFR 151) converting this voluntary program into a mandatory one.

In August 2009, the USCG published a proposed rule to establish a federal treatment standard for ballast water discharges. The rule proposed that standards be adopted in two phases. The proposed phase-one standard would apply to new ships beginning construction in 2012 and large existing ships (with a ballast water capacity greater than 5,000 cubic meters) as of the first dry-docking after 2016. The phase-one standard would be the standard contained in regulation D-2 of the Ballast Water Management Convention of the International Maritime Organization (IMO). The proposed phase-two standard would be one-thousand times (1,000X) more stringent than the IMO D-2 standard and would apply, if deemed feasible by a practicability review, to new ships constructed in 2016 and large existing ships on the first dry-docking after January 1, 2016. Under the proposed rule, ships that installed treatment technologies between 2012 and 2016 to comply with phase-one would be required to comply with the phase-two standard five years after the installation of the phase-one system.

Since circulating the proposed ballast water rule in 2009, the USCG has worked in close collaboration with the U.S. Environmental Protection Agency (EPA) to adopt a common federal ballast water performance standard based on an assessment of what standard can be achieved using commercially available technology. The USCG Final Rule, which is in the final stages of Administration review and is due to be published later this year or in early 2012, is likely to adopt the IMO standard as the initial U.S. federal treatment standard.

The USCG Final Rule will also contain the U.S. type approval requirements for ballast water treatment technologies. While the USCG will likely adopt a program through which it can grant equivalencies to treatment technologies that have already obtained foreign type approval certification, USCG officials have noted that they will not automatically grant an equivalency to such technologies. In addition to reviewing each system's existing testing data, the USCG will assess whether the laboratory that conducted the type approval testing was, in fact, an "independent laboratory." The proposed rule contains the parameters for such assessments. Technologies that obtained type approvals based on testing conducted at laboratories that are not deemed to be independent may run into difficulty in obtaining a U.S. equivalency.

Treatment technologies that seek direct U.S. type approval are, in addition to meeting the requirements on independent laboratory testing, likely to need to complete land-based testing according to the EPA Environmental Technology Verification (ETV) protocol[1] and shipboard testing similar to the IMO guidelines (but with less difficult challenge water conditions). The ETV protocol, which was developed by the EPA and USCG, was published in September of 2010 and contains some land-based testing requirements that are more prescriptive than the requirements contained in the IMO protocols.

Since the USCG's type approval and equivalency processes will take some time to be implemented after the final rule is published, vessels will not know immediately what treatment technologies will be acceptable in the United States. Although the rule porposed by the USCG would require vessels that begin construction in 2012 to comply with the standard contained in the final rule, the USCG is aware that it would not be reasonable to require such vessels to procure technology to comply with the U.S. standard without first knowing what technology has been either U.S. type approved or granted an equivalency to U.S. type approval. The USCG has advised industry that the final rule will include accommodations for this situation.

***<u>Environmental Protection Agency (EPA) Vessel General Permit</u>*:** Following a 2006 court order vacating a 35-plus year old vessel exemption from Clean Water Act (CWA) requirements, the U.S. EPA published rules in 2008 requiring commercial vessels of 79 feet or more to obtain CWA National Pollutant Discharge Elimination System (NPDES) permits for all vessel discharges -- including ballast water. These "Vessel General Permit" (VGP) requirements incorporated the provisions of the USCG ballast water management regulations (i.e. mandatory ballast water exchange) and came into effect on February 6, 2009[2]. The current VGP will remain in effect for a term of five years and will be replaced at the end of 2013 by a new VGP, which will supercede all of the requirements contained in the current VGP.

Pursuant to a settlement agreement following a court challenge to the first VGP, the EPA is required to publish the draft of the next VGP, which will include numeric ballast water performance standards, before the end of 2011. EPA will then invite comments on the draft from interested parties and from U.S. states, which will have an opportunity to include their own state certification conditions in the VGP (discussed in further detail below). EPA intends to finalize the terms of the next VGP by the end of 2012. The next VGP will then take effect on December 19, 2013 and is expected to remain effective for four years thereafter.

What ballast water performance standard and compliance timeline will be contained in the next VGP? First, notwithstanding their different statutory authorities, both the EPA and the USCG have committed to arrive at a single federal ballast water performance standard and to adopt a reasonable timeline for the installation of compliant technology on ships. To inform the standard setting process, the EPA and the USCG cosponsored an EPA Science Advisory Board (SAB) study to determine, among other things, what the most stringent, commercially available ballast water treatment standard is and what the technology capability was likely to be in the near future. As already mentioned, the USCG final rule will likely adopt the IMO D-2 standard as the federal ballast water treatment standard with a compliance timeline similar to that contained in the IMO ballast water management convention. Given the EPA SAB findings, which are discussed below, we expect that the next VGP will adopt the IMO D-2 standard and a compliance timeline similar to the one contained in the USCG final rule.

***EPA Science Advisory Board***: In July, the EPA SAB published the official report documenting the results of its year-long study on the efficacy of available ballast water treatment technologies[3]. The SAB report, in addition to other independent reports on ballast water treatment technology efficacy and availability, found that the most stringent standard that is commercially achievable is the IMO D-2 standard. The SAB report's principal findings are that:

1) None of the systems reviewed by the SAB could meet a standard as stringent as 100 or 1000 times the IMO ballast water treatment standard;

2) Modifications or fine-tuning of existing treatment systems will not enable those systems to meet the 100X or 1000X IMO standards;

3) Entirely new treatment systems will need to be developed to achieve the 100X or 1000X IMO standards;

4) None of the systems reviewed could demonstrate that they could consistently and reliably kill all organisms in the ballast water; and

5) If treatment-system performance and testing procedures improve, some systems may, in the near future, be able to achieve a standard 10 times the IMO standard.

The EPA SAB findings are consistent with the findings of a panel of scientists, vendors, and regulators assembled by the Great Lakes Ballast Water Collaborative to consider whether treatment technologies existed to comply with the State of Wisconsin's 100X IMO standard. The Collaborative panel found that while technologies compliant to IMO were commercially available, 100X IMO technologies were not. Based on the Collaborative panel's findings, the State of Wisconsin decided to repeal its 100X IMO ballast water standard and adopt in its place a requirement that vessels treat their ballast water discharges to the IMO D-2 standard.

**U.S. State Standard Setting**

In the United States federal ballast water standards do not inherently preempt state regulation of ballast water discharges. This means that individual U.S. states may adopt their own laws and regulations governing ballast-water discharges into their waters. Section 401 of the CWA also allows individual U.S. states to add state certification conditions to the EPA's Vessel General Permit that exceed the federal permit conditions. While this feature of the CWA may be appropriate for the regulation of point source dischargers that are fixed, such as factories, treatment plants, and power plants, this is not a suitable regime for regulating commercial vessels engaged in domestic and international commerce. Commercial vessels by design call at multiple U.S. states during a single voyage and cannot reasonably be expected to comply with different ballast-water treatment standards in each state's waters. Two states - New York and California – added state certification conditions to the VGP that are worth mentioning. Neither state, however, intends to certify or approve technologies as meeting the state ballast water treatment requirements.

*New York*: Although prior to the VGP the state of New York had not passed any state laws regulating ballast water discharges, the state added two significant certification conditions to the VGP. The first condition requires, by January 1, 2012, that all existing vessels that operate in New York waters be equipped with ballast water treatment technology meeting a standard 100 X the IMO D-2 standard. Earlier this year, New York extended this deadline to August 1, 2013 based on requests by vessel owners/operators for extension that acknowledged that technology meeting a 100X IMO standard does not exist. Because the new compliance is before the end of the current VGP term and experts have concluded that technology will not be available to meet the 100X IMO standard, vessel owners/operators will need to file additional requests to extend the deadline until the current VGP term ends in December 2013.

The second unrealistic New York condition requires that all vessels constructed on or after January 1, 2013 must be equipped with a ballast-water treatment technology meeting a standard 1,000X the IMO D-2 standard. At the end of September, vessel owners/operators filed requests that the 1000X IMO deadline be extended to the end of the current VGP term because experts have concluded that such technology does not exist.

*California*: In 2006, the California legislature adopted ballast water treatment standards that apply to vessels discharging ballast water in state waters. In 2008, these standards were added to the VGP as state certifications conditions. The California ballast water performance standard is "no detectable living organisms" for organisms larger than 50 microns, and is 1,000X times the IMO standard for the other organism size classes. This standard applies to vessels constructed on or after January 1, 2012 and to large existing vessels on January 1, 2016. The California standards do not have an extension request process but instead have a process whereby the State Lands Commission staff generates an annual review of the availability of technology meeting the California standards.

Because of the limitations of testing data and variable conditions in the real world, the Commission's 2011 report assessed not whether technology exists to meet the California standards, but whether the Commission staff believed systems had the "potential" to meet California's standards. The report concluded that systems do have the potential to meet California's standards. The report also acknowledged that because the "no detectable living organism" standard contains no volumetric requirement, compliance with that standard could not be determined until the State completes development of compliance verification protocols sometime in mid-2012. Whether the California legislature will amend the state's current, unachievable standards, remains an open question.

**Update on Recent U.S. Legislation**

In early September, the Chairman of the House Subcommittee on Coast Guard and Maritime Transportation introduced H.R. 2840, the Commercial Vessel Discharges Reform Act of 2011. This bill would, among other things, preempt individual U.S. states from regulating ballast water and other commercial vessel discharges, adopt the IMO D-2 standard as the initial U.S. national treatment standard, require vessels to comply with the standard pursuant to the timeline that will be published in the USCG final rule, and bring the regulation of ballast water and other commercial vessel discharges under one statute rather than the two which currently govern such discharges. On October 13, 2011 H.R. 2840 was approved by the full House Transportation and Infrastructure Committee and will next be scheduled for a vote by the entire House of Representatives. If it passes the House, the bill will then be considered by the Senate, where its chances for passage are unclear.

**Conclusion**

To say that the regulation of ballast water discharges in the United States is multifaceted would be a serious understatement. Arriving at a single federal standard requires two federal agencies operating under two different statutory mandates to adopt identical ballast water performance standards and timelines. Furthermore, arriving at a single U.S. national standard in the absence of legislation would require the various U.S. states that are currently regulating ballast water discharges to put aside their own requirements and agree to the federal standard. Although the debate about what the U.S. standard should be will continue into the future, what is clear is that experts have determined that the most stringent standard that is commercially achievable is the IMO D-2 standard. Adherence to unachievable standards such as 100X or 1000X IMO will not cause vessel owners and operators to procure and install such technologies, because they do not exist. Adoption of the IMO D-2 standard throughout the United States would, however, be a substantial improvement over the current regime because it would establish an environmentally protective, commercially available, and uniform ballast water treatment standard in the United States that matches the international standard.

---

[1] A copy of the ETV protocol may be downloaded at: **www.epa.gov/nrmrl/pubs/600r10146/600r10146.pdf**

[2] The term of the first VGP started on December 18, 2008.

[3] The SAB Report may be found at: **http://yosemite.epa.gov/sab/sabproduct.nsf/fedrgstr_activities/6FFF1BFB6F4E09FD852578CB006E0149/$File/EPA-SAB-11-009-unsigned.pdf**

# 5 THE PHASING-IN AND APPLICATION OF CERTAIN STANDARDS REGARDING OBLIGATORY BALLAST WATER MANAGEMENT SYSTEMS ON BOARD SHIPS

**Kilian O'Brien, University of Trier**

### Introduction

The adoption on 13 February 2004 of the Ballast Water Management Convention (BWMC) by the Assembly of the International Maritime Organization (IMO), which has not yet entered into force, represented a first attempt to reduce the potential damage[1] that may be caused by the transportation and introduction elsewhere than at the point of uptake of harmful organisms often found in ballast water.[2] The specific provisions of the Convention require, inter alia, the development of individual ships' ballast water management plans, the maintenance of appropriate records and, most importantly for the present purpose, the compliance with certain concentration-based discharge limits which are dependent on the date of construction and ballast-water capacity of the ship in question. Demanding water- quality standards are included, however, they are subject to a phasing-in period according to which they will only become effective on the basis of newly developed technology as well as considerations of feasibility and cost-effectiveness.[3] Based on considerations of the need for certainty in the planning and installation of appropriate ballast water treatment systems, the question relating to the deadline for the application of the ballast water performance standard set out in Regulation D-2 of the Annex to the BWMC will be dealt with, first, in the broader legal and technical context and, second, by way of a series of examples. Although the examples which will be provided in this paper are fictitious, the pertinent information regarding the ballast water treatment systems, the date of construction of the ship etc. is based on actual existing and planned vessels.[4]

### Legal Basis / Structure

The 1982 United Nations Convention on the Law of the Sea (UNCLOS) imposes on its State Parties a number of obligations relating to the reduction of alien invasive species. Aside from general obligations to ensure the protection of the marine environment,[5] Article 196 UNCLOS contains a specific duty to take "all measures necessary to prevent, reduce and control pollution of the marine environment resulting

---

1 On the potential damage which may be caused by the presence of foreign organisms in ballast water see *N. Bax et al*., Marine Invasive Alien Species: A Threat to Global Biodiversity, Marine Policy 27 (2003), pp. 313-323.

2 *J. Firestone/J.J. Corbett*, Coastal and Port Environments: International Legal and Policy Responses to Reduce Ballast Water Introductions of Potentially Invasive Species, ODIL 36 (2005), pp. 291-316, at 293.

3 See *M. Tsimplis*, Alien Species Stay Home: The International Convention for the Control and Management of Ships' Ballast Water and Sediments 2004, IJCML 19 (2005), pp. 411-445, at 428.

4 All ships' names are purely fictitious and any resemblance or similarity to names of genuine ships is merely coincidental.

5 Arts. 192 and 194 United Nations Convention on the Law of the Sea of 10 December 1982 (1833 UNTS 3).

from [...] the intentional or accidental introduction of species, alien or new."[6] Spurred on by the need for standards based on globally applicable regulations, the BWMC was adopted. The BWMC itself contains a number of broad obligations as well as provisions on their application. As is often the case with IMO Conventions, technical provisions relating to the management of ballast water are contained in the Annex to the BWMC. It is nonetheless acknowledged in Article 2.2 BWMC that the Annex "forms an integral part of the Convention" and that "a reference to [the BWMC] constitutes at the same time a reference to the Annex."[7] It is (primarily) in Section B ("Management and Control Requirements for Ships") of this Annex that the provisions on the standards of ballast water exchange are contained.

Before examining the provisions of the Annex on the point in time at which the applicability of the standards in question becomes relevant (assuming timely entry into force of the Convention, however unlikely that actuality may be), it is worthy of bearing in mind that Regulation D of the Annex to the BWMC makes a distinction between two alternative standards, namely the ballast water exchange standard and the ballast water performance standard. The former involves the pumping through of three times the water contained in the tanks[8] or, an exchange of a minimum of 95 per cent of the ballast water in volume.[9] The latter standard is considerably stricter and focuses on the volumetric concentration of viable organisms contained in the ballast water as well as prescribing a maximum limit for the concentration of toxic microbes in the discharged ballast water.[10] Essentially, the impact of these requirements is that ballast water exchange will be phased out as an acceptable method of complying with the Convention in the period between 2009 and 2016, depending on the capacity of the ship's ballast water and the date of construction. Thereafter, ballast water treatment will be the only option for complying with the Convention; however, considerable uncertainty still exists as to when this process should be completed. The IMO has been rather active in attempting to shed some light on this issue and it is to this question that this paper now turns its attention.

**Applicability of D-1 and D-2 standards** Regulation B-3 of the Annex to the BWMC determines the applicability of the ballast water management scheme. A distinction is to be made, first, between four broad types of ships according to the date upon which the construction of the ship began and, as a result of which, the specifications of the Regulation apply with varying effect. The term "constructed" as it is used in Regulation B-3 does not necessarily refer exclusively to the laying of the ship's keel. Regulation A-1 provides three further alternatives: construction identifiable with the specific ship begins; the assembly of the ship has commenced comprising at least 50 tonnes or 1 per cent of the estimated mass of all structural material, whichever is less; or, the ship undergoes a major conversion. Thus, although the effect of this may be insignificant in practice, it is to be borne in mind that it might have an effect on the application of Regulation B-3. The four types of ship referred to are, first, ships constructed before 2009[11]; second, ships constructed in or after 2009; third, ships constructed in or after 2009, but before 2012, and; fourth, ships constructed in or after 2012. These three latter categories are referred to in this opinion as "new ships". A further distinction is also made with respect to the ballast water capacities of

---

6 Art. 196 UNCLOS as referred to in: Ballast Water Management Convention of 13 February 2004 (RMC I.7.250), Preamble, para. 1.

7 Art. 2.2 BWMC.

8 Reg. D-1.2.

9 Reg. D-1.1.

10 Reg. D-2.1.

11 For the sake of convenience, such ships can be referred to as "existing ships".

the individual ships with three manifest categories: ships where the ballast tank capacity is less than 1,500 cubic metres, where the tank capacity is more than 5,000 cubic metres and, tanks with a capacity between 1,500 and 5,000 cubic metres. Hence, in determining whether, or more correctly, when the D-2 standards will become applicable, an initial 2-step process is proffered. First, based on the date upon which the construction of the vessel began, one must determine which of the four potential ship types one is dealing with. Within these four categories one must then, secondly, make a distinction based on the ballast water capacity of the vessel. This alone, however, is not sufficient to make a determination concerning the applicability of the performance standard. The precise determination of the date of compliance can only be made in conjunction with the certification schedule of the individual ship.

**Existing Ships**

With respect to ships where the construction date is prior to 31 December 2008 (so-called existing ships), and which have a ballast water capacity of less than 1,500 cubic metres or greater than 5,000 cubic metres, the minimum compulsory standards (D-1) are applicable until 31 December 2015.[12] Thereafter, the performance standard (D-2) becomes the applicable minimum compulsory standard. For ships constructed prior to that date with a capacity between these two values, which is to say between 1,500 and 5,000 cubic metres (inclusive), the D-1 standards are also applicable. The fundamental difference, however, for this category is the earlier date upon which the D-2 standards become applicable, namely 31 December 2013.[13]

In the period following the conclusion of the BWMC, it became apparent that certain technical difficulties had come to the fore concerning the speed at which technological measures were being made available which could satisfy the standards contained in the Convention. Thus, the IMO Assembly issued a Clarification regarding the application dates contained in regulation B-3.1, which sought to clarify the terms of regulation B-3.2. This clarification stated that regulation B-3.1 must be complied with "not later than the first intermediate or renewal survey, whichever occurs first, after the anniversary date of the ship in [the year of compliance]."[14] Despite this attempt to provide precision regarding the provision, uncertainty persisted as it was possible that alternative interpretations could be attributed to the term "anniversary date" as it appears in the clarification.[15] A further clarification was issued with the effect of revoking the prior clarification.[16] The Marine Environmental Protection Committee of the IMO clearly specified therein that the anniversary date being referenced in regulation B-3.1 is indeed the anniversary date of delivery of the ship as that term is understood in regulation B-3.2 of the Annex.

According to this clarification, the D-2 standard must be fulfilled by the time of the next intermediate or renewal survey of the ship which occurs after the date prescribed for the ship depending on the capacity

---

12 Reg. B-3.1.2.

13 Reg. B-3.1.1.

14 BWM.2/Circ.19 of 21 July 2010, Clarification Regarding the Application Dates Contained in Regulation B-3.1 of the BWM Convention, Annex, para. 3.

15 MEPC 61/2/16 of 20 July 2010, Harmful Aquatic Organisms in Ballast Water, Clarification of certification and compliance with the D-2 standard under the BWM Convention, paras. 4 and 9.

16 BWM.2/Circ.29 of 7 October 2010, Clarification Regarding the Application Dates Contained in Regulation B-3.1 of the BWM Convention, Annex, para. 3.

of its ballast water tanks.[17] Thus, ships with a capacity of between 1,500 and 5,000 cubic metres must fulfil the D-2 standards by the time of the first intermediate or renewal survey after the anniversary date of delivery of the ship post 31 December 2013,[18] whereas ships with less than 1,500 or more than 5,000 cubic metres are only required to fulfil the performance standard by the time of the first intermediate or renewal survey arising after the anniversary date of delivery post 31 December 2015.[19] Ultimately, this results in a potential postponement of the D-2 standards of potentially two and a half years. Indeed, it is imaginable that a postponement of up to three years is foreseeable depending on the survey programme to which the individual ship is subject.

Example 1: The M/V Archie

The M/V Archie is a vessel constructed prior to 1/1/2009. It has a ballast water capacity of 1,000 cubic metres. Thus, the vessel is required to conform with Regulation B-3.1.2 of the Annex to the BWMC. This means that the D-1 standard is applicable until 31/12/2015. However, an extension is possible under the clarification meaning that compliance is only necessary by the time of the next survey (intermediate or renewal) after the anniversary date of delivery in the year of compliance. The initial survey on the Archie was completed on the 1/10/2008. An intermediate survey was carried out on 1/4/2011 and, continuing in that survey rhythm, a further renewal and intermediate survey on 1/10/2013 and 1/4/2016 respectively. Accepting that the anniversary date of delivery of the Archie in the year of compliance is 1/10/2016, the ship must therefore be compliant with the D-2 standards by the time of the next survey on the 1/10/2018, an extension of 34 months in this instance on the D-2 standards as represented in Reg. B-3.1.2.

Example 2: The M/V Sligo

Her sister vessel, the M/V Sligo was constructed (for the purposes of the BWMC) in 2008 but it has a considerably larger ballast water capacity of 4,000 cubic metres. The initial survey was carried out on 15/12/2008. Regulation B-3.1.1 is applicable and requires that the D-2 standard be met by 31/12/2013. However, an extension is similarly possible under the clarification meaning that compliance is only necessary by the time of the next survey (intermediate or renewal) after the anniversary date of delivery in the year of compliance, i.e. 2014. Thus the Sligo, with its larger ballast capacity, must be compliant by the next survey after the anniversary date of delivery. This would be the 15/12/2014 and the next scheduled survey would then be on the 15/6/2016, an extension in this instance of 30 months.

**New Ships**

In respect of ships constructed in or after 2009 where the capacity of the ballast water tanks is less than 5,000 cubic metres, Regulation B-3.3 stipulates that the D-2 performance standard must be met. However, based on the recognition of the difficulties regarding the introduction of type-approved technologies in a timely manner, the IMO adopted a Resolution in 2007 pardoning ships constructed in 2009 from complying with the D-2 standard until the second annual survey, but not later than 31

[17] BWM.2/Circ.29 of 7 October 2010, Clarification Regarding the Application Dates Contained in Regulation B-3.1 of the BWM Convention, Annex, para. 3.

[18] Reg. B-3.1.1. in conjunction with BWM.2/Circ.29, Annex, para. 3.

[19] Reg. B-3.1.2. in conjunction with BWM.2/Circ.29, Annex, para. 3.

December 2011.[20] It should be noted that this Resolution applies to ships constructed in 2009 only. As such, the ships that are constructed after 2009 which also come under the terms of Regulation B-3.3 in that they have a capacity of less than 5,000 cubic metres must still ensure that the D-2 standard is met upon delivery.[21]

The terms of regulation B-3.4 govern the requirement to comply with the ballast water performance standard with respect to ships constructed in or after 2009, but before 2012 with a ballast water capacity of 5,000 cubic metres or more.[22] This regulation states that ballast water management must be conducted in accordance with paragraph 1.2 of regulation B-3. This provision includes a period of grace with respect to the compliance such that the D-2 standard is applicable not later than the first intermediate or renewal survey after the anniversary date of delivery of the ship in 2016. This interpretation flows from the conclusion reached by the MEPC at the 61st meeting which resulted in the amendment to the circulation BWM.2/Circ.29 outlined above. It was confirmed in a further clarification that the D-2 standard is the requisite performance paradigm requiring compliance no later than 1 January 2016 with the caveat that this may be extended by the application of the period of grace foreseen by regulation B-3.2. The end result of all of these clarifications is that ships to which B-3.4 applies will now be required to install a ballast water treatment system no later than the first intermediate or renewal survey after the anniversary date of the ship's delivery in 2016.[23]
Where a ship is constructed in or after 2012 and is designed with a ballast water capacity of 5,000 cubic metres or more, Regulation B-3.5 simply states that the D-2 standard is applicable.

**Summary**

The BWMC makes a general distinction between existing and new ships in terms of the date upon which the various ballast water standards must be met. It further distinguishes between ships depending on the capacity of the ballast water tanks present on board.

For ships constructed prior to 2009, a distinction is made between two types of ships:
Ships with less than 1,500 or more than 5,000 cubic metres capacity are required to comply with the D-1 standard until 31 December 2015. From 1 January 2016, the D-2 standard applies.

Ships with between 1,500 and 5,000 cubic metres capacity are required to comply with the D-1 standard until 31 December 2013. From 1 January 2014, the D-2 standard applies.

However, the clarification issued by the IMO envisages an extension of these deadlines to a date not later than the first intermediate or renewal survey, whichever occurs first, after the anniversary date of delivery of the ship in the years 2014 or 2106 respectively.

---

20 IMO Doc. A 25/Res.1005 of 4 December 2007, Application of the International Convention for the Control and Management of Ships' Ballast Water and Sediments, 2004, para. 2.

21 Reg. B-3.3. This is in keeping with the interpretation forwarded by IACS in MEPC 61/2/16 of 20 July 2010.

22 Reg. B-3.4.

23 BWM.2/Circ.29/Rev.1 of 26 September 2011, Clarification Regarding the Application Dates Contained in Regulation B-3 of the BWM Convention

With respect to ships constructed in 2009, the D-2 standard applies in principle from delivery. Nonetheless, Resolution A.1005(25) of the IMO envisages an extension of the applicability of the D-1 standard until 31 December 2011.

Ships constructed in or after 2009 but prior to 2012 with a capacity of 5,000 cubic metres or more must meet the D-2 standard by 31 December 2015. However, the clarification issued by the IMO in 2011 foresees an extension of this period in accordance with regulation B-3.2 so that the ballast water treatment system need not be functional until the first intermediate or renewal survey after the anniversary date of delivery of the ship.

Ships constructed in or after 2012 with a capacity of 5,000 cubic metres or more must meet the D-2 standards on delivery.

**Table 1.** Ballast Water Standards and their Implementation Dates

| **Date of Construction** | **Ballast Water Capacity** | **D-1 Standards** | **D-2 Standards** | **Relevant Law** |
|---|---|---|---|---|
| Before 31/12/2008 | Less than 1,500 or more than 5,000 cubic metres | Until 31/12/2015 | Applicable from 01/01/2016 However, **clarification**!!! Extension to survey after anniversary date of delivery | B-3.1.2 & clarification BWM.2/Circ.29 |
| | Between 1,500 and 5,000 cubic metres | Until 31/12/2013 | Applicable from 01/01/2014 However, **clarification**!!! Extension to survey after anniversary date of delivery | B-3.1.1 & B-3.2 & clarification BWM.2/Circ.29 |
| 01/01/2009 | Less than 5,000 cubic metres | Not applicable Exception: until 31/12/2011 | In principle from construction Exception: applicable from 01/01/2012 | B-3.3 & Resolution A.1005(25) |
| 01/01/2009 – 31/12/2011 | More than 5,000 cubic metres | Until 31/12/2015 | Applicable from 01/01/2016 However, **clarification**!!! Extension to survey after anniversary date of delivery | B-3.4, B-3.1.2 & BWM.2/Circ.29/Rev.1 |
| 01/01/2012 onwards | More than 5,000 cubic metres | Not applicable | From construction | B-3.5 |

# 6 APPROVAL OF BALLAST WATER TREATMENT SYSTEMS A CLASSIFICATION SURVEYOR'S PERSPECTIVE AND THE ROLE OF CLASS

**Tjitse Lupgens, Lloyd's Register**

### Why ballast water management?

A holistic approach is required to provide an improved environment for marine bio-diversities. Ballast water is one of the threats. All water discharged from vessels has the potential to influence the local biodiversity. Introduction of invasive species is by far the greatest threat to our ecosystem and our economy. Today it is estimated that already introduced invasive species have a negative affect on the world economy of annually $100Bn.

### Can we add some more ballast water?

- Ballast water may contain aquatic organisms which, if introduced into the sea water, may create hazards to the environment, human health, property or resources, impair biological diversity or interfere with other legitimate uses of such areas.
- It is estimated that at least 7,000 different species are being carried in ships' ballast tanks around the world every day.
- When all factors are favourable, an introduced species may survive to establish a reproductive population in the host environment; it may even become invasive, out-competing native species and multiplying into pest proportions.

### What is a classification society ?

- Classification societies are organizations that establish and apply technical standards in relation to the design, construction and survey of marine related facilities including ships and offshore structures.
- Classification societies contribute to maritime safety and regulation through technical support, compliance verification and research and development
- Classification societies have a great deal of experience in approving equipment required by IMO Conventions

### What is the link between classification societies and the BWM Convention

- International Conventions permit the flag Administration to delegate the inspection and survey of ships to a Recognised Organization (RO).
- Classification societies are delegated as an RO for over 100 flag Administrations world wide
- Classification societies may also be a "nominated body" under the EU Marine Equipment Directive

### The classification societies role in BW treatment system approvals

Classification societies:

- Provide an independent oversight and verification of the approval process on behalf of the flag Administration as an RO.
- Issue a certificate on behalf of the flag Administration on satisfactory completion of all aspects required by the approval process.

**Criteria to meet the Convention requirements**

- The main criteria is the **D-2** standard of the Convention
- Approval to **D-2** is required by regulation **D-3**
- Verification that a system meets **D-2** is via:-
  - Guidelines for Approval of Ballast Water Management Systems (**G8**); and
  - Procedure for Approval of Ballast Water Management Systems that make use of Active Substances (**G9**)

**The approval process**

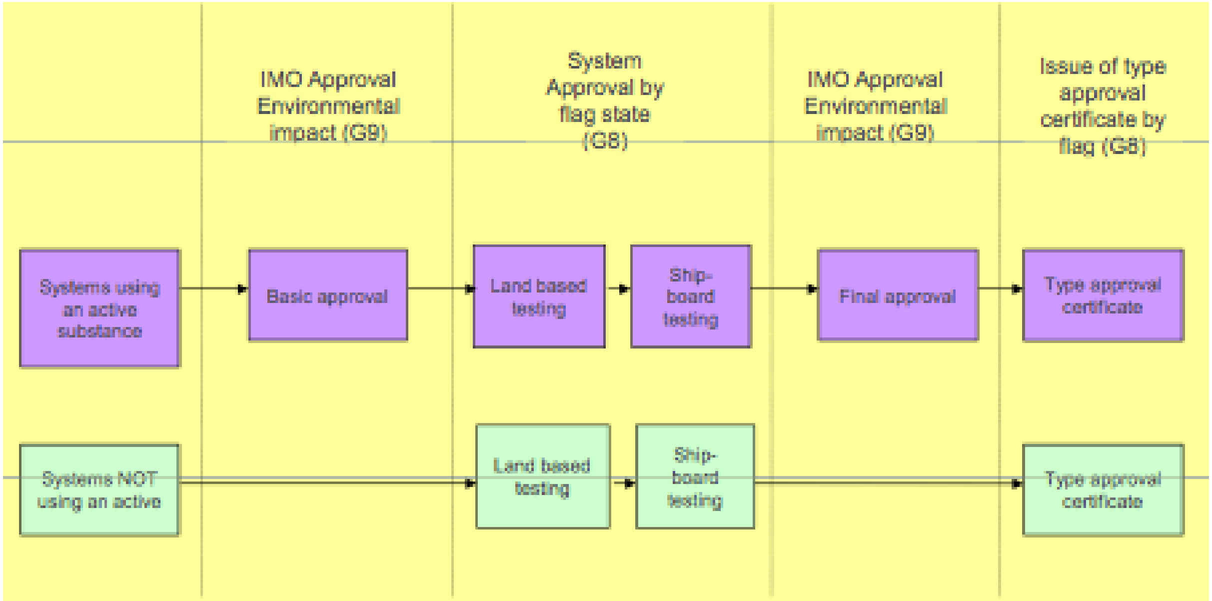



Figure 1: the approval process

**Who is involved ?**

- The system manufacturer
- A Flag Administration
- A recognised organisation (RO) acting for the flag
- A Land based test facility
- A ship and on-board test team

**A classification societies role in BW treatment system approvals**

- Acts as a central point of contact and a coordinator of the various parties involved in the approval process
- Verify land based test facilities and shipboard test teams capabilities
- Undertakes the "in service" surveys required by the Convention

**Responsibilities**

With many parties involved it is vital that the process and the responsibilities of each party are defined and understood by all involved, i.e.

- Who is responsible for doing what
- Who is responsible to who

Responsibilities

- **Flag Administration** - over all responsibility for the approval and the certificate
- **RO** - responsible to the flag for the oversight and verification of the approval process, plan approval, test result review and issue the certificate
- **Manufacturer** - applying to flag and RO for approval - arranging land and shipboard tests - submitting required documents to flag/RO - obtaining "G9" approval via flag
- **Land based test facility** – carrying out the land based tests and provision of test reports to the RO
- **Shipboard test team** – carrying out the shipboard tests and provision of test reports to the RO

Using G8 from a class point of view **G8 is:**

- A guideline
- Open to interpretation
- Complex
- In need of a review in light of experience to date ?

Using G8 from a class point of view **G8 purpose is:**

- Test and performance requirements
- Design, construction and operational parameters
- Provide uniform interpretations of regulation D-3
- Give guidance
- Achieve D2 standards
- Class is to design Survey, Inspection Program around G8

Using G8 from a class point of view **Survey, Inspection Program:**

- Part 1;Technical Manual, BWMS Drawings, Env Health Impact
- Part 2; Quality Management and Quality Assurance Project Plan
  - 2.1 Shipboard test, 3 consecutive test cycles
  - 2.2 Land-based test, 5 valid replicate 5 days test cycles
- Part 3; Specification environmental testing
- Part 4; Sample analysis method

**Part 1;Technical Manual, BWMS Drawings, Environmental- and Health Impact**

- Process description
- Details major components
- Installation specs
- Limitations , maintenance
- Link to BWMP
- Identification potential hazards for the environment and health

**Part 2; Quality Management and Quality Assurance Project Plan**

**2.1 Shipboard test, 3 consecutive test cycles**

- 6 months trial period
- Sampling regime
- Parameters source water

- System operation throughout trial period
- Test results
- Communication, start up meeting
- Review of plans (System Engineering), situation on board
- Review Quality Assurance Project Plan, Test Plan
- Safety aspects Ship and Crew
- Witnessing Sampling and Analysis
- Quality Control, Labelling, Storage, Transport, Checklists

**Part 2; Quality Management and Quality Assurance Project Plan**

**2.2 Land-based test, 5 valid replicate 5 days test cycles**

- Different water conditions
- Test at rated capacity
- Minimum simulated ballast tank >200 m3
- Inlet/outlet criteria, influent water
- Land-based monitoring and sampling
- Analysis processing within 6 hours
- Communication, start up meeting
- Review of Plans, Test Protocol and documentation, Technical Manual
- Successful pre test?
- Safety, potential hazards
- BWT according to G8, G9? Review by Flag and Class? Agreement G8 only?
- Environmental parameters, PH, Temp, Turbidity
- Influent water meets minimum criteria
- Samples analysed within 6hrs
- Results
- Approval Check report and issuance of Detailed witness report
- Valid test?
- Inform Flag State
- Review of result

**Part 3; Specification environmental testing**

- Electrical and electronic sections
- Vibration test
- Temperature test
- Humidity test
- Protection against heavy seas
- Fluctuation power supply
- Inclination test
- Reliability components

**Part 4; Sample analysis method**

- Widely accepted standard methods for collection, handling, analysis
- To be described in test plans and reports
- If no standard method available, new method to be developed

- Meant to determine species composition and number of viable organisms in sample
- Live/dead judgement

Using G9 from a class point of view - **Survey, Inspection Program:**

- General requirements
- Risk characterization
- Evaluation criteria
- Regulation of use of active substances
- Approval
- Identification, description of Active Substance
- Proposal should include data set on 29 aspects
- Quality Management Plan and Quality Assurance Project Plan, Material safety data to Administration, Class
- Risk characterization, (PBT-tests) Persistence, bioaccumulation, toxicity
- Evaluation criteria
- Ship and personnel safety
- Environmental protection
- Regulation of use of active substances
- Hazard documentation, Labelling, Procedures handling
- Approval
- Basic Approval – Laboratory report to Administration, GESAMP-use of technology
- Final Approval – toxicity part of land-based testing

Using INTERREG from a class point of view

**INTERREG IVB Program:-**

- Knowledge exchange
- Access to information
- Platform Open Discussion
- Aim to achieve result and learn more about BWM
- Approval development

**Conclusions**

- The approval process:
- Is complex and takes time
- Involves a number of diverse organisations
- Requires careful coordination
- Requires good relations between the parties involved
- Requires all parties to fully understand the process and responsibilities
- Is time consuming
- Learning process

# 7 BALLAST WATER TREATMENT RETROFITS – CHALLENGES AND STRATEGIES

**Jurrien Baretta, Goltens Green**

The approach to retrofit consists of accommodates the process through a series of steps

- Selection of BWT system
- Survey on board
- Pre-engineering
- Detailed design
- Purchasing / pre fabrication
- Installation
- Service

How do we choose a system?

The selection takes into account the ship and vessel service characteristics:

- High ballast dependent or low ballast dependent
- Flow rate
- Explosion-proof requirements
- Stripping of tanks
- Gravity filling or discharging
- Holding time in tanks

The space required

- Equipment plus piping

Power consumption / availability

- Peak consumption during ballasting and cargo activities
- Treatment system considerations
- Full approval
- Reliable supplier
- Life cycle costs
- Requirements of USCG or other national authorities
- Remaining lifetime of the vessel

Sailing area

- Fresh water / low temperature water
- Availability of chemicals / neutralization agents

Different scenarios can meet out goal:

- Engineering:
- Manual measuring, followed by prefabrication
- Laser scanning, followed by 3D modelling and prefabrication
- Fabrication on board (no prefabrication)

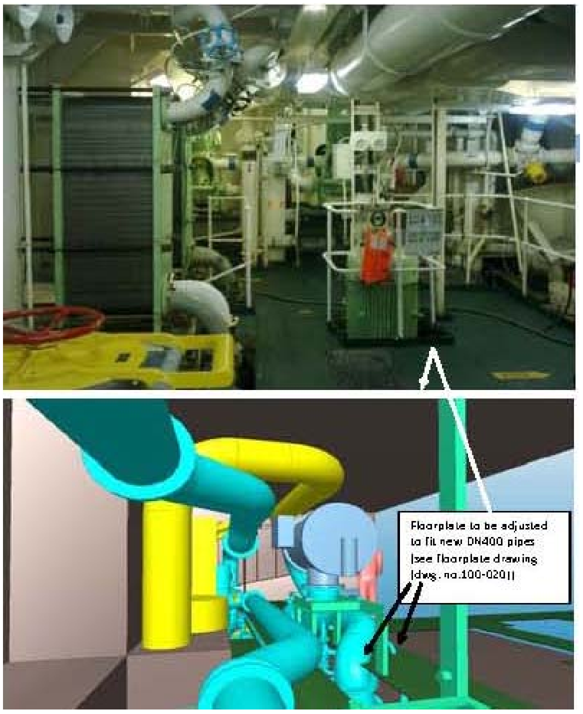
- Installation:
- Dry dock (vessel off hire)
- Alongside (vessel off hire)
- During normal operation

Option is 3D-Modelling

Laser scanning

- 5 – 8 hours on board
- Minimal disturbance of ships operation
- Result is put in a 3D computer model
- Different options can be compared
- Owner can see it before it gets carried out
- Prefabrication of all necessary parts including foundations

Below we present a few case studies




**Case 1**

•Manual measuring, followed
by prefabrication
•Installation during dry dock at
Chinese shipyard
•Supervision by Goltens

•Measuring on board took 10 days with2 engineers
•At Chinese yard: cheap labour but
poor quality of piping
•Inefficient working order
•Total installation time 39 days
•Supervision was essential

**Case 2**

•Manual measuring, followed by prefabrication
•Installation during normal operation of the vessel by Goltens

•This was a relative small system, installation while sailing was no problem
•Manual measurements required some pipe adjustments during installation
•No down time for the vessel at all
•A lot of travelling costs involved

**Case 3: Highland Eagle**

•The accuracy of the laser scanning plus the high quality and correct measurements of the piping increased the installation speed a lot
•Work still in progress because of calm weather
•No down time for the vessel

Advantages laser scanning

Quick and accurate survey

- Possible to change the design during the process without doing a new survey
- Design once for a series of sister vessels, only collision checks after that
- Optimum preparation and prefabrication
- Minimal installation time
- Clear picture of end result
- Cost-effective

# 8 RISK ASSESSMENT OF BALLAST WATER MANAGEMENT SYSTEMS UNDER PROCEDURE (G9)

**Jan Linders, chairman of GESAMP-BWWG**

**Abstract:**
Risk assessment of Ballast Water Management Systems (BWMS) that make use of Active Substances (AS) takes place in a tiered system with two tiers, the first tier is the Basic Approval evaluation and the second tier is the Final Approval. Before a BWMS can finally be put on the market the Administration of the applying country has to issue a Type Approval, indicating that all requirements have been met. The risk assessment is evaluating the risks for the environment as well as for humans, workers (the crew) and general public, and the ship itself.

A technical working group, the GESAMP Ballast Water Working Group (BWWG), is in charge of the evaluation of the BWMS; the Marine Environmental Protection Committee (MEPC) takes the decision on the approval of the BWMS.

The BWWG further developed its methodology to evaluate the BWMS. The latest proposals on the methodology are being dealt with. The methodology is considered to be a living document that will be updated if necessary and will be based on developments of the submission of BWMS within the framework of the Ballast Water Management Convention. The model MAMPEC-BW version 3.0 has been developed for the estimation of the Predicted Environmental Concentrations (PEC) in the marine environment after discharge of ballast water in a standardized model harbour. The new model will be used for the estimation of potential effects on humans and the environment. The presentation will focus on the risk assessment as defined in Procedure G9, where the actual data requirements are given and the methodology elaborates on the new elements. Some remarks will be made on the uncertainties that normally go along with risk assessments. The purpose is the protection of the world's oceans and coastal areas from bio-invasion, ensuring at the same time that ballast water management practices used to comply with the Convention do not cause greater harm that they prevent.

**Introduction**
In 2004 the Ballast Water Management Convention (BWMC) has been adopted, that would oblige ships to treat ballast water to prevent the discharge of ballast water containing harmful organisms that could cause bio-invasion in the area of discharge. The treatment of ballast water can be carried out by using certain chemicals. Therefore, a guideline (G9) became part of the BWMC regulating that the discharge of treated ballast water using chemicals (AS) should occur without any harmful effects to the ship, its crew, humans and the environment.

To provide advice on the effects of ballast water management systems (BWMS) using active substances to these topics at risk a technical group, the GESAMP-BWWG, was established. After about five years of experience, this working group has further developed its methodology on the conduct of work, to generate an advice to the Marine Environmental Protection Committee (MEPC)while taking in account the knowledge gained by evaluating ca. 60 BWMS. The proposed methodology is highlighted in this document.

### Evaluation of BWMS

The GESAMP-BWWG evaluates the BWMS with respect to several topics: 1) the risk of discharge of ballast water to the receiving environment (aquatic organisms); 2) the risk to the people that work with ballast water management systems because of their profession (crew and port state control); 3) the risk to the public at large that may recreate in waters where ships discharge ballast water or eat contaminated seafood; and 4) the ship itself (corrosion).

The process of risk assessment for chemicals is well developed. Many countries have to decide on the registration of chemicals intended for the control of harmful pests and diseases, such as pesticides and biocides, and on allowing industrial chemicals on the market. For such decisions the management tool of risk assessment is used. The basic principles of this process are also adopted by the GESAMP-BWWG to evaluate the risks of discharged ballast water. The applicant provides a dossier to the regulating authorities, in this case to IMO and MEPC, submitted through a national administration. The dossier contains information on the substance and its use, including data on the identity (physic-chemical properties), the fate and behaviour (sorption and degradation) and potential toxic effects (human toxicology and ecotoxicology).

First the data are evaluated on data quality and whether the data are generated using generally accepted methods, e.g. OECD-guidelines. Only scientifically justified data are accepted for further use in the risk assessment. Some data are used for estimating potential concentrations in the environment, the environmental exposure assessment. The final results of the evaluation are the predicted environmental concentrations (PEC). Often mathematical models are used to describe the behaviour of the substance in the environment based on typical information as the octanol / water partition coefficient, the sorption capacity to soil or sediment and the abiotic or biotic degradation potential of the substance, e.g. half-life in water or soil. In the hazard assessment the effect data are used for the estimation of safe levels of the substance in the environment or for humans. The (eco)toxicity data include acute and chronic endpoints. Using safety factors to account for required safety and uncertainty of the data, a safe level is estimated, resulting in a predicted no-effect concentration (PNEC) for the environment or a derived no-effect level (DNEL) for human exposure. Finally the results of the exposure assessment and the hazard assessment are compared to each other using a risk characterization ratio (RCR). The value of the RCR defines whether or not a potential risk may be expected for the topic under consideration. In case risk cannot be excluded a further in-depth assessment may be needed.

### Risk assessment tools for BWMS

In order to perform the approach outlined in section 2 the GESAMP-BWWG has developed the methodology on the conduct of work. The proposed methodology has been forwarded to MEPC for comments, suggestions and adoption. The focus of the new methodology has been on 1) the development of a data base for the most occurring disinfection by-products (DBP) generated during the BWMS operation, on 2) the model development and scenario description to calculate the PEC in a standardized harbour environment and on 3) the definition and analysis of the BWM unit operations for crew and port state control in the handling of BWMS. Especially if electrolysis of seawater is the main disinfection process, which is the case in the majority of the BWMS currently evaluated, a huge number of DPB may be formed, of which trihalomethanes (THM) and haloacetic acids (HAA) are the most important. A list of 18 DBP has been prepared, that contains The DPB that occur the most frequently and also in the highest amount. The physico-chemical properties and the data on fate and effect have been incorporated in the data base for further use in the risk assessment.

As the model to be used for the calculation of the PEC, the GESAMP-BWWG adopted the MAMPEC-model as the most suitable model currently available. In the model a specific scenario has been defined describing the harbour environment and an emission scenario for the discharge of ballast water. In the harbour scenario the most relevant parameters are defined as pH, temperature, particulate organic matter, dimensions of the port and exchange volume with the surroundings. The emission scenario defines the amount of ballast water discharged each day. The results of the MAMPEC calculation are the yearly average and median concentration of the substance under consideration, its maximum and minimum and its 95-percentile. As a worst-case situation the maximum value is currently used for the evaluation. The MAMPEC-BW, version 3.0, has been specifically developed for the GESAMP-BWWG. As an example, the discharge of ballast water in the model harbour was estimated at E+5 $m^3$/d. For the human exposure scenario the MAMPEC results may be used as well for the estimation of the exposure to the general public.

The Group considered that also for the area around the ship, where the actual discharge takes place, a situation of higher risk may occur. Therefore, a near-sea scenario has been defined as well, taking an additional dilution factor of five into account for the short-term exposure of aquatic species. The general public may be exposed by oral intake, dermal uptake and inhalatory of discharged ballast water during swimming in contaminated areas, while oral exposure also takes place during the consumption of fish caught in such contaminated areas. However, for the estimation of the risk to crew and port state control MAMPEC is not suited, as exposure may take place during handling of the chemicals used in the BWMS or during operation of the BWMS. The possibilities of exposure are defined in the BWM-unit operations involved in the BWMS. These unit operations have to be defined for each individual BWMS as the specific circumstances may change from one system to the other. The number of exposure events and the amount occurring have been estimated for a worst-case and a realistic case. As an example for human exposure, sampling of ballast water tanks may result in dermal and inhalatory exposure at a frequency of two hours per day and five days a week resulting in acute exposure; an additional assumption of exposure for 45 weeks a year would lead to chronic exposure.

**Conclusions**

The methodology of GESAMP-BWWG has been further developed during a series of 3 stock taking workshops to which additional experts have been invited on specific topics such as the model development and the human exposure scenario development. The Group considered the current methodology quite complete and more or less in place. Therefore, the time is there to request parties for suggestions and criticism on the proposals. The methodology should be considered a living document to which new information may be added or items be changed if scientific developments indicate such need. In addition, the methodology has to be tested in practice. Changes have been performed taking into account current experience and knowledge, which is based on the major use of disinfection by electrolysis of seawater and the production of DBP. If other substances will be proposed as active substances, changes or alternative concepts have to be developed and used to perform an acceptable risk assessment for such cases. Nevertheless the main principles of risk assessment, exposure assessment, hazard assessment and risk characterization will be kept as the basic keystones.

Potential areas of further development of the methodology can be the evaluation of key model parameters, such as the tidal exchange volume of water in the harbour, the temperature in the harbour in relation to the temperature at which degradation of the substance has been determined. A correction factor may be needed to account for the difference in temperature. An important area of research could be the necessity of a second or higher tier assessment situation in case the worst-case situation leads to an unacceptable risk. Also the occurrence of many other possible DBP should be further assessed. Literature sources have shown that over 600 different substances have been analysed in all types of disinfection processes. It remains to be seen whether applicants have to search more thoroughly for additional and as yet hidden DBP. Finally, the potential exposure to substances showing carcinogenicity, mutagenicity and reproductive toxicity, the so-called CMR-substances, should be further analysed as some of the DBP have such classifications.

To answer the questions posed in these potential areas of concern, stock-taking workshops will be held on a yearly basis and successively the group will discuss possible solutions together with invited experts in the field. The final aim of controlling the world-wide distribution of invasive aquatic species may require additional scientific input to gain more insight in the area of ballast water management to advance the protection of the world's oceans and coastal areas from bio-invasions, ensuring at the same time that ballast water management practices used to comply with the Convention do not cause greater harm that they prevent.

**Acknowledgment**
The author wishes to acknowledge the input of the GESAMP-BWWG and of all the invited experts who contributed to the current status of the methodology on the evaluation of the environmental and human risk assessment of ballast water discharges.

# 9 ENVIRONMENTAL ACCEPTABILITY OF BALLAST WATER MANAGEMENT SYSTEMS G8 (IMO GUIDELINES ON TYPE APPROVAL.

**Cato ten Hallers-Tjabbes, CaTO Marine Ecosystems**

**Abstract**

Ballast Water Management Systems that do not use active substances, which means they do not add or generate chemicals during treatment, have to adhere to a procedure for demonstration of environmental acceptability through the G8 BWM Guideline. G8 gives detailed guidance for preparing such environmental acceptability report. The procedure is consistent with the requirements of G9, without the parts on active substances and preparations. The environmental acceptability report is part of the documentation for application of certification that will be made available at notification of type approval of the system, in line with the methodology of GESAMP-BWWG and with Resolution MEPC.175(58), IMO 2008). The presentation explains the background, the process of demonstrating environmental acceptability and adequate approaches for preparing such report.

**Introduction**

In the development of Ballast Water Management policies environmental acceptability of strategies to minimise the transfer of harmful invasive organisms has consistently been a prime area of attention. Once the Convention was adopted MEPC set out to draft guidelines for uniform interpretation of the BWM Convention. As ballast-water management by specialised treatment was envisaged, in 2005 two sets of guidelines were adopted to this end:

- Guidelines for approval of Ballast Water Management Systems (G8) (IMO 2005a) and

- Procedure for approval of Ballast Water Management Systems that make use of Active Substances (G9) (IMO 2005b).

(IMO, 2005c)

The difference between the scope of the two guidelines refers to the different categories of disinfection used by the systems, which is done either by using or generating active substances or by physical processes that neither use an active substance or a preparation. The systems belonging to the second category that were developed at that time were predominantly based on treatment by UV, later to be completed by other physical methods, such as cavitation, ultrasound, inert gas and others.

**Environmental Acceptability and the Guidelines G8 and G9**

Guideline G9 addressed the protection of the environment from adverse effects caused by BWM treatment in reference to Article 2 of the Convention, whereas G8 did not. During the negotiations in IMO for developing the guidelines, for G9 a rigorous regime for transparency of reporting on impact on the environment was required. The requirement was specified in the developing methodology of GEAMP-BWWG, the advisory body to IMO on approval of G9 systems by listing all items that should be non-confidential, listing virtually every potential impact the system could have on the environment by releasing disinfection by- and end products (DBP) or 'Relevant Chemicals' (*Definitions G9*), (GESAMP reports of Stock-taking Meetings & GESAMP-BWWG Methodology). Identifying items for nonconfidentiality was guided by international instruments for access to information on the environment, such as the Aarhus Convention (Aarhus, 1998).

During the years thereafter concerns about environmental impact of BWM systems operating by physical disinfection increased, leading to a revision of G8 so as to include environmental acceptability reporting. Guidelines for Approval of Ballast Water Management Systems (G8, IMO, 2008a).

The provisions for evaluation of the system for environmental acceptability reporting refers to the relevant provisions of G9, with a focus on relevant chemicals, other substances and risk assessment. The provisions do not refer to the paragraphs of G9 that are relevant to active substances or preparations, as the physically-based systems have none. The provisions of the revised G8 do entail an evaluation of all substances that may play a role in possible effects in the receiving waters.

The revised Guidelines G8 include, but are not limited to Recommendations on Environmental Aceptability (EA) of ballast water management systems (Par.1.8), by evaluating:

- If the treatment process could result in changes to the chemical composition of the treated water with possible adverse impacts to receiving waters upon discharge.

EA logistics is illustrated in Figure 1.

The G8 requirements for evaluating Environmental Acceptability (EA) refer to paragraphs 5.2.3 to 5.2.7 of Procedure for Active Substances (G9, revised 2008) of the Procedure for Approval of Ballast Water Management Systems that make use of Active Substances (G9, IMO, 2008b).

For proper evaluation the paragraphs: referring to provisions from G9 have to be translated in adequate evaluation procedures according to the Methodology as set out by GESAMP-BWWG: Methodology for information gathering and conduct of work of the GESAMP-BWWG (IMO, 2008c; IMO, 2012a).

The G8 EA evaluation should be based on the paragraphs of G9 as referred to in G8, while it also should demonstrate that the system does not use or generate AS *(G9: 4.2.1: Dataset for Active Substances and Preparations).*

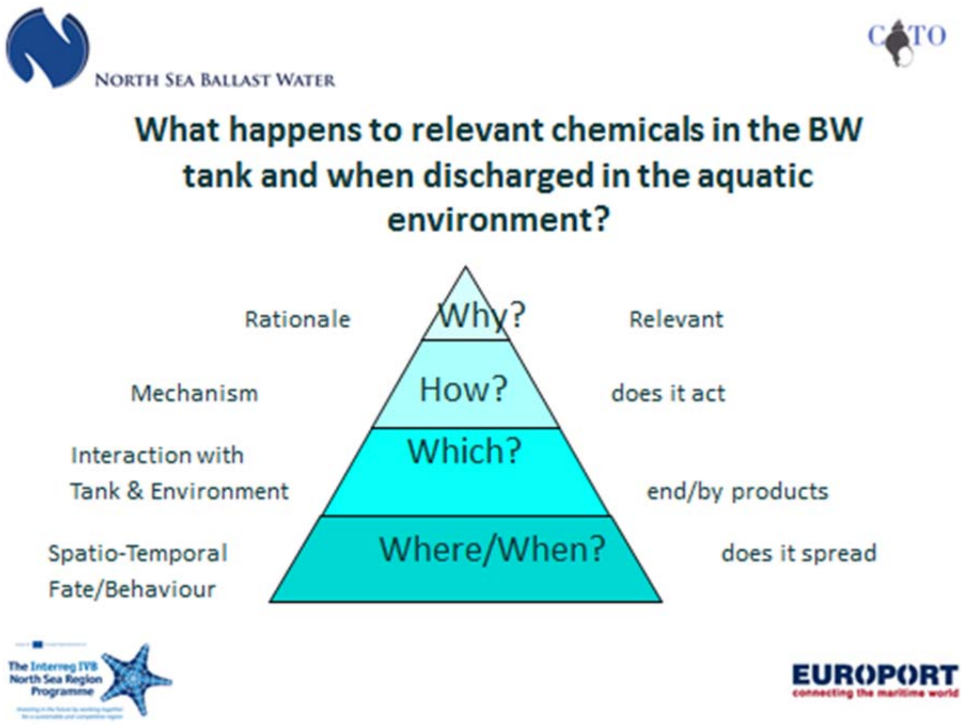



**Figure 1:** Top-down evaluation schedule for Environmental Acceptability of BWM systems

**Example of Environmental Acceptability evaluation under G8**

1. **UV disinfection**

   - Demonstrate: the system does not use or produce active substances for ballast water treatment
   - Evaluate potentially toxic by and end products and other substances generated during the process and their degradation path;
   - Assess the risk to environment, ship and crew

Issues that might be a concern in UV-based BWM systems:

*Oxygen radicals* ($O_3^{\bullet}$, $OH^{\bullet}$) that might be formed by UV treatment. Formation of oxygen radicals is depending on the wave length of the UV used; they are only formed below 180 nm. As UV-C (wave length 200-280 nm) covers the optimal wavelength for disinfection (256 nm) would generate no oxygen radicals, the evaluation has to show that the UV used for treatment is within the boundaries that bear no risk for the formation of oxygen radicals.

*Mercury in UV systems*

Mercury used in UV lamps used in BWM treatment is encapsulated within the UV reactor or lamps and hence remains within the disinfection unit. The UV reactor or lamps are well protected from the external environment, as such minimising the risk of damage or breaking. Security of configuration of the UV-generating unit has to be demonstrated.

### 2. Ultra sound

Other physical treatment methods that are being explored may bring about environmental impact of a non-chemical nature, which cannot be accommodated by the present G8 or G9. Methods that generate sound may cause such impact. Its potential effects are:

- Noise pollution resulting in deafening in marine animals that rely on hearing (hearing sensitivity covers a wide range of frequencies: <20 - >100.000 Hz.

- Effects on biological functioning and behaviour, such as feeding, reproduction, flight or fight responses, schooling, orientation /navigation; the impact may be lethal.

For those systems that use some form of sound waves for treatment or generate them during treatment, an evaluation of relevant chemicals would not be adequate, as impact from under-water noise is not of a chemical nature. Whereas relevant chemicals refer to matter, under-water noise refers to energy, a form of impact on the environment as yet not covered in G8 or G9. The Convention of the Law of the Sea, however, recognizes impact on the ocean from both matter and energy, and can hence commit IMO to demonstrate environmental acceptability of BWM systems that generate under-water noise. The consequence would be that a future revision of G8 would need to include a chapter to accommodate concerns on impact of under-water noise and potential other forms of energy input through BWM treatment.

Other than water-borne chemicals that spread with the flow of the carrier medium, under-water noise spreads in a spherical manner around the sound source, where the sound level is diminishing at further distances from source. Different sound levels around a source have different impact potential, as demonstrated in figure 2, left. When different ships with an acoustic BWM device are present in each others vicinity, the spheres of acoustic influence may overlap, so animals that tend to avoid higher sound levels may have no route of escape (figure 2, right).

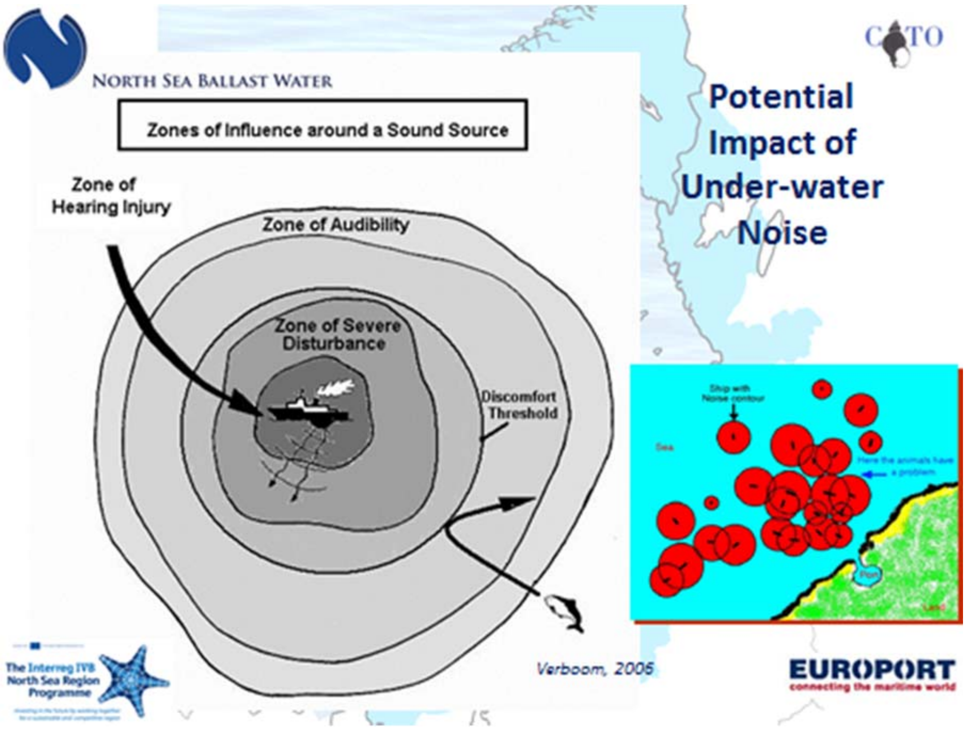



**Figure 2:** Possible impact of under-water noise that may be generated by BWM systems

**Transparency**

Type Approval of BWM systems is granted by National Administrations. Although Environmental Acceptability reporting is included in each type-approval process, the routes for approval differ between G8 and G9. Whereas approval of EA of G9 systems is granted by IMO, approval of EA for G8-only systems is granted by the National Administration.

The rules for transparency also differ between G9 and G8.

> For G9 obligatory reporting on non-confidential data/information on environmental performance is obligatory (GESAMP-BWWG Methodology, 2012a), for G8 only systems such reporting on non-confidential data is recommended (IMO, 2008d), but is not obligatory.

The uniform interpretation of the BWM Convention that the guidelines envisage, also supports the safeguarding of a level playing field. Such level playing field will benefit greatly from transparency of information as this helps creating confidence and trust in BWM. Transparency of information on Environmental Acceptability**,** and test procedures and results creates confidence in quality and in capability of BWM methods (IMO, 2012b).

**References**

Aarhus, 1998. Aarhus Convention on access to information, public participation in decision-making and access to justice in environmental matters, UNECE.

IMO, 2005a. Resolution MEPC.125(53), Guidelines for approval of Ballast Water Management Systems (G8).

IMO, 2005b. Resolution MEPC.126(53), Procedure for approval of Ballast Water Management Systems that make use of Active Substances (G9).

IMO, 2005c. Report of the Marine Environment Protection Committee on its fifty-third Session.

IMO, 2008a. Resolution MEPC.174(58), Guidelines for Approval of Ballast Water Management Systems (G8).

IMO, 2008b. Resolution MEPC.169(57), Procedure for Approval of Ballast Water Management Systems that make use of Active Substances (G9).

IMO, 2008c. BWM.2/Circ.13, 10 June 2008. Methodology for information gathering and conduct of work of the GESAMP-BWWG.

IMO, 2008d. Resolution MEPC.175(58), Information reporting on Type-Approved Ballast Water Management Systems.

IMO, 2012a. BWM.2/Circ.37, 14 June 2012. Information that should be made available in proposals for approval of ballast water management systems in accordance with the Procedure for approval of ballast water management systems that make use of Active Substances (G9).

IMO, 2012b. MEPC 64/2/12, Call for ratification of the BWM Convention – ballast water continues to transfer invasive aquatic organisms.

# 10 HARMONISATION IN COMPLIANCE CONTROL; WHAT DOES IT ENTAIL: REGULATIONS AND RESPONSIBILITY

**Eleonora Panella, EMSA**

### Introduction

The harmonization process for compliance control is a fundamental issue that as yet needs to be completely developed. However, at the same time, it is a vital step required for taking and processing samples for control, in order to prevent that the same vessel's ballast water is in compliance in one port, but not in another due to different sampling methods used. Ballast water sampling is nowadays one of the most practical ways to assess compliance with BWM requirements, but it is a sensitive issue which has different theoretical and practical applications.

Sampling for compliance control needs to use methods that deliver representative biological results and overcome the practical solutions of sampling large amounts of water from a ship's discharge. Therefore, it is necessary to develop sampling strategies resulting in accurate, i.e. representative, results of viable biota in the ballast water discharge.

### Background

The development of guidelines for Sampling for Enforcement is a key part of the MSA Ballast Water Action Programme, which programme has been agreed by the European Commission. The programme was formulated following a workshop with the EU Member States in November 2008 to identify where EMSA and the EC can add value to their joint work on ballast water. Ther action programme was further developed in a Workshop on Sampling for Enforcement in February 2010.

Sampling for enforcement of the BWM Convention has been discussed extensively at IMO over the last few years, resulting in a draft guidance to sampling as recommended in the Guidelines on Sampling (G2). According to the Guidance testing for compliance can be performed in two steps. As a first step, prior to a detailed analysis for compliance, an indicative analysis of ballast water discharge may be undertaken to establish whether a ship is potentially [compliant or] non-compliant.

However, it is recognised by the IMO that this document was not complete, so at BLG 14 the Sub-Committee agreed that sampling and analysis continues to be a high priority. This is because the shipping guidance has specific ramifications for the development of Guidelines for PSC under the BWM Convention, which are currently being developed by the FSI Sub-Committee of the International Maritime Organization (IMO). The BLG Sub-Committee also urged Member States and observers to submit technical contributions to the development of a circular to provide ballast water sampling and analysis protocols, taking into account the *aide-memoire* developed at BLG 13.

In response to this request for further information and to the IMO's direct enquiry, through the European Commission EMSA was invited to submit its work on this issue to BLG 15. Subsequently EMSA has developed this guidance through research and liaison with global experts in the fields of ballast water sampling, water analysis, statistical analysis, port State control (PSC) experts and experts in plankton biology. At BLG 15 this guidance was presented in three documents - BLG 15/5/2, BLG 15/5/4, BLG 15/5/5 - and after some discussion the BW sampling Correspondence Group was created. Using these documents as a background to develop further guidance on sampling, three drafts of this document have been circulated to the Correspondence Group resulting in the following draft guidance:

- "Guidance on Ballast Water Sampling and Analysis for Compliance with the BWM Convention";
- "Guidance for the Assessment of Compliance with the Discharge Standards of the BWM Convention – Additional PSC Guidance", operational issues; and,
- "Guidance on Ballast Water Sampling and Analysis for Compliance with the BWM Convention" in appendix of the document as detailed approaches.

This sampling guidance has been submitted by EMSA on behalf of the EC to BLG 16.
It represents the most update study of sampling methodologies and aims to develop a further guidance for PSC. Since the submission the guidance has been further developed in BLG 16; the process will continue at BLG 17.

**The Philosophy of sampling**

Ballast water sampling is a challenging task, sampling biota from a Ballast Water vessel has been developed from both environmental and laboratory sampling of plankton. Sampling and analysis methodologies have initially been developed for type approval testing and consequently for compliance testing. Sampling for compliance control on a ship's discharge needs to use methods that deliver representative biological results, whilst taking into account difficulties related with sampling procedures. There are several factors to consider before starting to sample, such as:

- the representativeness of the samples itself;
- the requirements of the D-2 Standard and whether to analyse for compliance with standard per se (detailed analysis) or for gross non-compliance (indicative analysis); and,
- the way to use an indicative sample and when to stop a discharge procedure.

Regardless of the purpose, however, any sampling programme has to be practical, rapid and, most importantly, needs to enable a comparison of results when samples are taken in different countries by different stakeholders. With respect to Indicative Analysis in order to evaluate the number in one of the organisms group of the D-2 standard, a procedure suggested , based on a study for EMSA, by GoConsult and David Consult. The procedure consists of starting with analysis phytoplankton (using Pulse-Amplitude Modulated fluorometry - PAM), followed by checking bacteria (with a hand-held fluorometer) and then inventory the status of zooplankton (by observing through a stereomicroscope).

For Detailed Analysis the EMSA study recommends to provide a direct and a precise measurement of the concentration of viable organism in the ballast water discharge, which measurement should be directly comparable with the D-2 standard for the different size category(ies) and to use a measurement method with an adequate detection limit.

From the Port State Control side, the authorities have the freedom to decide on their own procedure for sampling analysis and the handling of results of a detailed analysis. the feasibility of a procedure is usually dictated by the legal requirements for evidence in each country. For this purpose, the IMO Correspondence Group have developed specific guidance on:

- a range of sampling methods that can be used in compliance testing;
- the pros and cons of each method;
- how biological sampling fits with PSC; and,

- how the normal PSC procedures can be applied to testing for ballast water compliance.

**Conclusion**

The aim of the presentation was to introduce the different responsibilities and players during compliance control, in order to facilitate the harmonization of the sampling methodologies. EMSA has focused on compliance control for sampling methods, the PSC procedures for BWMC compliance monitoring under development at IMO, the difficulties faced by the Port State Control during ship inspections, and the efforts to harmonizing the different sampling and analysis methods.

The developments have since been discussed during BLG 16 (IMO), which discussion will continue during BLG 17.

# 11 THE ROLE OF THE NORTH SEA BALLAST WATER OPPORTUNITY PROJECT IN THE IMPLEMENTATION OF THE IMO BALLAST WATER MANAGEMENT CONVENTION - AN INTRODUCTION.

**Jan P. Boon, Louis Peperzak, Etienne Brutel de la Rivière, NIOZ Royal Netherlands Institute for Sea Research**

Ships use ballast water for stability and propulsion. For this purpose, natural water is taken in at the port of departure and released in or near the coast of the port of destination. As a result, the IMO has estimated that ships annually transport about 10 billion tons of natural water as ballast water all over the globe [1].

This water may contain up to a few million tiny organisms per ml of the local ecosystems; these hitch-hikers consist of tiny plants in the form of single celled algae (phytoplankton), small animals, eggs and larvae of larger animals (zooplankton), and -as the smallest creatures- bacteria, Archaea, and even viruses. The size range of these organisms roughly covers the range from about 1/10000 of a mm for viruses to a few mm for the largest algae and zooplankton.

When the species transported with ballast water do not occur in the ecosystem where the ballast water is discharged, they sometimes develop too good to be healthy for the environment and develop to plague organisms causing large economical as well as ecological damage to the receiving ecosystem.

Some well-known examples of the establishment of non-native species in coastal and fresh water ecosystems are the introduction of the European Zebra Mussel (*Dreissena polymorpha*) in the Great Lakes at the US/Canadian border, the introduction of the American Comb-Jelly *Mnemiopsis leidyi* in the Black Sea (now also common in the western Dutch Wadden Sea), and the Chinese Mitten Crab (*Eriocheir sinensis*). A map on the UNEP web site shows the global areas most heavily impacted by invasive species [2], among them the greater North Sea area including the Baltic Sea and the Wadden Sea.

A survey in the Dutch Wadden Sea carried out at the end of 2009, showed 29 non-native species of marine algae and animals on hard substrate of which 12 were newly discovered. Of course these animals do not carry a tag saying 'introduced by ballast water', but it is one of the possible vectors from shipping. Import of species for aquaculture is another main vector for import of non-native species. The total number of non-native species in the Dutch Wadden Sea was raised to 64 [3].

The IMO Ballast Water Management Convention (BWMC) of 2004 is meant to reduce this rapidly growing problem of unwanted effects of global shipping. The ballast water performance standard as given in Regulation D2 of the BWMC demands a drastic reduction at discharge in the large variety of organisms in natural sea water for several categories of organisms: the size-class of organisms between 10 and 50 μm; this class consists mainly of phytoplankton, and the class of organisms larger than 50 μm, containing mainly zooplankton. Besides these two size-classes, the BWMC recognizes 3 types of bacteria (typical size: about 1 μm) that can cause contagious diseases, such as the bacteria that can cause cholera (*Vibrio cholerae*) and two types of bacteria that grow in the gut of many animal species (*Escherichia coli* and Enterococcae).

Although the convention requires treatment of ballast water on board any ship, at this moment, it is still not obligatory, since the BWMC is not into force yet; this requires at least 30 flag-states representing 35% of the global shipping tonnage to have signed the Convention. This year (2011), the necessary number of states has reached the required number of 30, but together they represent 26.5% of the global tonnage. However, several other countries are also preparing to sign and it is generally expected that the 35% requirement will be met somewhere in 2012.

*What will happen then?* The Convention contains a scheme for ships of different age and different ballast water capacities. When the BWMC enters into force, ships must exchange their ballast water at the open sea (at least 200 miles from land and in water of at least 200m depth) and treat their ballast water with a special installation on board from the moment scheduled for the particular age and size of the ship. Ballast water exchange is only allowed for certain type of ships during a limited period, which is foreseen to end ultimately in 2017, depending on the survey routine of the ship. From that year onwards, the majority of ships have to treat their ballast water. Exemptions might be possible for ships that operate on specific routes for a log period. A detailed risk assessment has to be made up and submitted to IMO for each individual vessel on a particular route.

This ballast water conference at Europort 2011 is organized by the EU Interreg IVb 'North Sea Ballast Water Opportunity' Project. In this project, over 40 partners and sub-partners are cooperating to prepare different groups of stakeholders in the North Sea Region for the upcoming consequences of the BWMC when it comes into force. At that moment, an enormous number of existing ships have to get an efficient ballast water treatment installation fitted on board and the port state control authorities have to be able to check in an efficient manner and without undue delay of the ship that these installations are operating according to their specifications (Compliance Monitoring & Enforcement). To achieve this, governmental policy makers from different countries, marine research institutes, major ports, shipping organizations, NGO's, vendors developing ballast water treatment systems (BWTS) and developers of equipment for Compliance Monitoring and Enforcement have joined forces in the NSBWO project. An overview of our activities is presented on the website www.northseaballast.eu. The project will continue to the end of 2013.

The majority of BWTS contain a first treatment step where particles are taken out from the incoming water by means of centrifugation or filtration. The second step is meant to kill the great majority of the remaining organisms mainly by either physical treatment (e.g. UV light), of by use of active substances (e.g. electro-chlorination) or a combination of both. All systems have to be tested in accordance with the Guideline G8, whilst systems making use of active substances also have to comply with the Procedure G9.

We have world-wide about 10 recognized test-sites where the land-based tests are carried out. NIOZ is one of those and is located on the island of Texel, on the border between North Sea and Dutch Wadden Sea. NIOZ performs tests at different levels of maturity of BWTS, beginning with feasibility studies (e.g. filter tests), followed by 'proof of concept' studies and land-based tests as part of the procedure to obtain the official Type Approval from a National Authority.

After land-based testing, installations must also be tested on board ships; this usually occurs when an installation has proven its value under land-based conditions. The entire certification procedure can take up to about two years.

[1]: Economic Assessment for Ballast Water Management: A Guideline. GloBallast Monograph Series No.19 (2010). GEF-UNDP-IMO GloBallast Partnerships and IUCN ISSN 1680-3078.
[2]: http://maps.grida.no/go/graphic/invasive-species-in-the-marine-environment-problem-regions
[3]: http://www.nobanis.org/species%20alert_11%20new%20marine%20species%20in%20NL.asp

# 12 RISE AND FALL. LITERATURE REVIEW OF DRIVERS OF INTRODUCTIONS OF NON-INDIGENOUS SPECIES MEDIATED BY BALLAST WATER AND FRAMEWORKS FOR REDUCING OCCURRENCE AND IMPACT OF NEW SPECIES INTRODUCTIONS.

**Ruurd van der Meer, University of Groningen**

**Abstract**

Ship's ballast water contains a great amount of species that can pose risks to the ecosystem where it is discharged. Shipping is therefore an important vector of non-indigenous species introductions. Ballast water mediated introductions find their pathway along the global network of shipping. In this network ports are regarded as nodes. Ports can be sources or recipients of new introductions or act as stepping stones. The shipping network predicts and describes the pattern of new species introductions. The introduction of non-indigenous species in ecosystems can lead to negative impacts on ecology, economy and health. Members of the International Maritime Organization agreed on the Ballast Water Management Convention in 2004 to reduce negative impacts of introduction of non-indigenous species. The intention of IMO is to introduce ballast water management to ensure ships only discharge a limited amount species in the recipient area according to defined standards. Ships that cannot comply with the requirement to meet the defined standards can be exempted of performing BWM. Ships that are exempted must undertake a ballast water introduction risk assessment. Risk in the ballast water issue is the risk of introduction and establishing of a species in a recipient area (or outside its native range).

**Introduction**

The introduction of non-indigenous species in ecosystems can lead to negative impacts on ecology, economy and health (Anil et al., 2002; Rodíguez-Labajos, Binimelis, & Monterroso, 2009). A big driver of new species introductions in marine ecosystems is shipping (Carlton & Geller, 1993). Ships translocate organisms over the world via on-board ballast water. Introduction of new species takes place along the global network of shipping. The impact of ballast water mediated introductions can occur on ecological scale by affecting biodiversity and ecosystem functioning, on economical scale when harming fisheries and on human health scale, by introduction of pathogenic viruses and bacteria (Anil et al., 2002; Dahlstrom et al., 2011).

This paper reviews the way marine non-indigenous species are introduced and the potential measures for reducing the risk of new introductions of marine non-indigenous species that can have harmful impacts. The shipping route network plays an important role in the mechanism of species translocation over the globe (Kaluza et al., 2010; Keller et al., 2011)]. The ecological conditions at the nodes of this network are important in predicting new introductions. Risk assessment can be used as framework for measures to reduce the risk of new introductions. In risk assessment the shipping network is described, as well as the natural conditions at the ports and the properties of species that are being translocated around the globe.

**Shipping as introduction driver of non-indigenous species**

1.1 Ballast water necessity for shipping

Shipping is of great importance for the world economy due to its efficiency (IMO, 2009a). This efficiency is reached, because ships can carry large quantities of goods at a relative low energy demand. It accounts for 90 percent of all global trade.

Loading and unloading of cargo are essential operations of ships. During this ships take in or discharge ballast. Ballasting is done for stability reasons to preserve a positive momentum by keeping the centre of gravity as low as possible and to ensure a ship will not break in two (bending moments and sheer forces) (Clark, 2002; Dokkum van, 2003). Another reason is to give vessels sufficient draft to enhance the working performance of the propeller and the rudder, for the efficiency of the propeller and the rudder increases when these are at a sufficiently water depth. When the forward draft is too small a ship will start slamming on the waves in bad weather conditions which leads to damage to the ship's construction (Anil et al., 2002; Clark, 2002).

Ballasting and de-ballasting operations are daily shipboard operations. Because ballast operations are so frequently performed it is very practical to use outboard water as ballast medium. In a ship special tanks are allocated for carrying water as ballast. These tanks often have large capacities, because huge weight is required for effective ballasting.

1.2 Shipping as driving force

Rodríguez-Labajos and colleagues (2009) studied the driving forces of introductions of organisms in places that are not their natural habitats. These are mostly induced by human activities and shipping is a major driving force of introduction of new species in marine environments. Westphal et al. (2008) concludes from a stochastic study on the introduction of new species, using a regression tree, that the degree of international trade is the best predictor of new introductions at a certain location.

Shipping is a driver due to its use of outboard water (Carlton & Geller, 1993). Outboard water used for ballasting contains all kind of matter of the place where a ship has loaded ballast water. A significant part of this matter consists of organisms that are small enough to pass the ballast pump suction and the ballast pump suction filter (Carlton & Geller, 1993). Carlton (1999) found 7000 - 10 000 different species are taken up by a ship in its ballast water. Types of organisms that are found in ship's ballast water are marine bacteria and viruses, zooplankton, phytoplankton and all kind of organisms in larval states including fishes, crustaceans, echinoderms and molluscs (Gregg et al., 2009).

1.3 Impacts of species introductions

The organisms that do not die during the voyage and are able to survive in the natural conditions of the recipient environment might thrive in the recipient area. These species can compete to species naturally occurring here. Some of the introduced non-indigenous marine species have negative impacts on ecological, economic and social scale (Dahlstrom et al., 2011). According Anil et al. (2002) these bring undesirable unbalances to the recipient ecosystem. Food webs get affected which may lead to biodiversity degradation. Biodiversity provides a large number of goods and services for sustaining life on earth and is an indication for the health of ecosystems and the services ecosystems deliver to human and nature (CBD, 2010). Affected ecosystems can have negative impacts on for example food and fuel provisions, the moderation of floods, droughts, temperature extremes and the forces of wind. An example of biodiversity affection on economical scale is the impact on aquaculture industries (Hewitt &

Campbell, 2007). The productivity of these industries decreases by competition and predation between the industry's target species and the introduced species. Other forms of economic damage occurs when, for example, installations that use marine waters (e.g. for cooling purposes) are affected by new species that settle near warm cooling water outlets. Among the bacteria and viruses that are present in discharged ballast water are pathogens such as Vibrio cholerae and Escherichia coli (Gregg et al., 2009). Algae can be affective to human health too (algal blooms) (Anil et al., 2002). The overall estimated costs of the damage by ballast water introduced non-indigenous species are $120 billion in the US alone (Westphal et al., 2008), in Europe €11.4 billion (found in EU's IEEP project).

In this review article the more neutral terms species introduction or non-indigenous will be used, although this article deals with the negative impacts non-indigenous species can have. Literature often uses the term (alien) invasive species for species introduction. Bioinvasion is a term often used as well (Anil et al., 2002; Drake & Lodge, 2004; Hewitt & Campbell, 2007). These terms appear negative biased. Not all introduced species survive successfully or have negative effects. Sometimes a new introduced species will fill a new niche in an ecosystem and might therefore not be harmful at all. Another reason for using these neutral terms for the problem of species translocation is to come to a more consistent terminology for the problem to cover all issues of new species introductions, as suggested by Dahlstrom et al. (2011).

## 2. Shipping network

The routing network formed by shipping plays an important role in describing the pattern of the introduction of non-indigenous species. The network of global shipping describes the links between the world's ports and the frequency ships sail on the links between ports. So the pattern of new introductions can be described by the global network of shipping (GNS). By understanding this network the risk of new introductions can be mapped and risk reducing measures can be designed. Kaluza et al. (2009) state that "predictions based on the real network are informative for international policy decisions concerning stability of worldwide trade and for reducing the risks of bioinvasion."

These researchers made an extensive study to the GNS. This study was based on real ship journeys in order to construct the actual GNS by which species can get translocated (figure 2.1 shows the network construction). They concluded that the GNS possesses a "small world properties" and that there is a broad degree and weight distribution. This means the ports in the network are densely interconnected, but some ports are only lightly connected to other ports and some ports are heavily connected. Broad weight distribution means that the cargo capacity differs widely on the links between ports. This is also what Keller et al. (2011) found in their study to the linkages between ports on the Great Lakes and other world ports. They found out that despite the Great Lakes are only a small fraction of global shipping, the Lakes are closely connected to all other ports and thus to species living in the other ports. Species that are translocated along the GNS can have a natural occurrence in ballast water loading ports, or are introduced in the loading ports and originate from other ports. Consequently, ports are stepping stones for species introductions. Once a species is introduced in a certain port, it can be spread from that port to other places, which makes them "highly cosmopolitan" (Westphal et al., 2008).

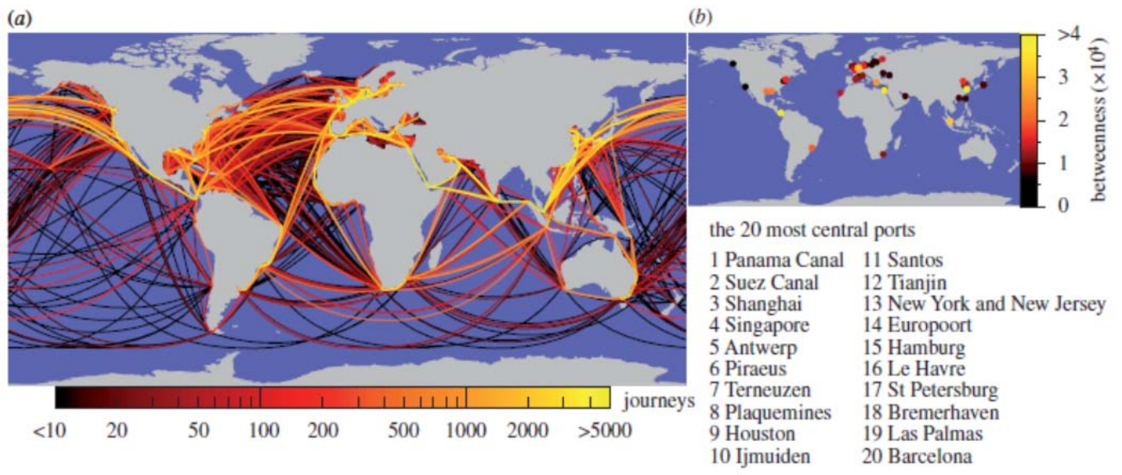



Figure 1. Routes, ports and betweenness centralities in the GCSN. (*a*) The trajectories of all cargo ships bigger than 10 000 GT during 2007. The colour scale indicates the number of journeys along each route. Ships are assumed to travel along the shortest (geodesic) paths on water. (*b*) A map of the 50 ports of highest betweenness centrality and a ranked list of the 20 most central ports.

**Figure 2.1; globel network of shipping analysed by Kaluza et al. (2009) (Retrieved from Kaluza et al. (2009)) -**

Kaluza et al. (2009) found that the GNS is unequally distributed. Ships often sail in loaded conditions to a port at which no cargo is available. The vessel needs to set sail to another port to be able to load and has to sail in ballast condition. If the network was more evenly distributed, less ballast water would be required.

A factor of importance in the success of spread along the GNS is the probable similarity in conditions between ports (Gollasch & Leppäkoski, 2007; Keller et al., 2011). If conditions are similar the chance of survival in a new place will be higher (see section 5.2.2).

Concluding, GNS in combination with the natural environmental conditions at the nodes of the network act as a mechanism in the introduction of non-indigenous species. The GNS can be valuable in designing measures to reduce the introduction risks.

## 3. Ballast water introduction prevention policies

### 3.1 IMO convention to ballast water

In order to reduce the risk of new introductions of non-indigenous species by ship's ballast water the IMO (International Maritime Organization) adopted the International Convention for the Control and Management of Ship's Ballast Water and Sediments (IMO, 2004), in literature called Ballast Water Management Convention, or BWMC. BWMC aims "to continue the development of safer and more effective Ballast Water Management (BWM) options that will result in continued prevention, minimization and ultimate elimination of the transfer of harmful aquatic organisms and pathogens."

In the early 1990s guidelines regarding ballast water were developed with the aim to prevent new species introductions. It became clear that full prevention could not be reached and guidelines were developed to minimize ballast water mediated introductions (Gollasch et al., 2007). After several major non-indigenous species introductions by ballast water had occured the IMO started working on a mandatory set of regulations. This resulted in the BWMC. The convention has not come into force yet (June 2011), although it was adopted in 2004 (IMO, 2009b). The BWMC shall enter into force 12 months after the date 30 countries signed the convention (Gollasch et al., 2007). Now this is done by 28 countries. Dahlstrom and colleagues (2011) indicate that international legislation is not legally binding by it selves. Countries have to undersign this individually, which "often is a process facing significant barriers". This is due to the difficulty of the process, lack of capability or lack of recourses (Dahlstrom et al., 2011).

3.2 Ballast water management as IMO measure

Emphasis of the BWMC is on the on-board management of ballast water to meet the standards of regulation D-1 or D-2 to ensure an as low as possible concentration of non-indigenous species will enter the ecosystem of a ballast water recipient port. The standard of regulation D-1 is reached by exchanging coastal water by ocean water. This is based on the premises that oceanic organisms are unable to survive in riverine, estuarine and coastal conditions and that ocean water is far less densely populated by marine organism then riverine, estuarine or coastal water (due to the abundance of nutrients) (Simard et al., 2011).

The standard of regulation D-2 is reached by treating ballast water. D-2 requires that discharged ballast water contains:

**- Table 3.1**; ballast water standard of regulation D-2 (retrieved from Tsolaki & Diamadopoulos (2009)) -

| Organism | Regulation of discharge ballast water |
|---|---|
| Phytoplankton/zooplankton $\geq$ 50 µm | $<$10 viable organisms per $m^3$ |
| Phytoplankton/zooplankton 10–50 µm | $<$10 viable organisms per mL |
| Toxicogenic Vibrio *cholera* (O1 and O139) | $<$1 cfu* per 100 mL |
| *Escherichia coli* | $<$250 cfu* per 100 mL |
| *Intestinal enterococci* | $<$100 cfu* per 100 mL |

* cfu = colony forming unit

The exchange of ballast water to meet regulation D-1 is seen as an interim solution (David & Gollasch, 2008). In the starting phase ships can choose which standard they follow, but eventually all have to meet standard D-2. The time of phasing in the standard of D-2 depends on ship's age and ballast water capacity (Gollasch et al., 2007; Simard et al., 2011).

*3.3 National measures*

Some (clusters of) countries already implemented or designed frameworks of prevention, reduction and management of new introductions (Hewitt & Campbell, 2007). Examples of countries that set frameworks are Australia, New Zealand and the United States (Dahlstrom et al., 2011; Hewitt & Campbell, 2007). According to Hewitt and Campbell (2007) these frameworks "are categorised under the term biosecurity and typically follow the quarantine principles: prevention of the entry and border surveillance for pests and diseases, short-term response, and long-term control of established pests", which are worked out in sets of regulations for Australia and New Zealand. The monitoring on potential new species introductions is very strict. This is not surprising as these two countries have a large amount of endemic species living in isolated ecosystems. Endemic species fill in very specific niches and make ecosystems vulnerable to new species introductions (Westphal et al., 2008).

### *3.4 European measures*

The European Union is leaning on the member states in implementing the IMO BWMC framework and puts the responsibility of reducing the risk of new species introductions to the individual members (David & Gollasch, 2008). This is laid down in the EU Marine Strategy Directive where member states have to "take necessary measures to achieve or maintain good environmental status in the marine environment" (EU, 2008). In the EU's framework of maritime policy, an integrating policy of the whole European maritime cluster, the issue of ballast water is not specifically mentioned (David & Gollasch, 2008). Olenin et al. (2010) also state that the EU did not define measures of reducing new species introductions, although new recommendations for policy options have been made.

### *3.5 Regional measures*

On regional level more developments in designing frameworks for reducing invasion risks by ballast water mediation are apparent (Dahlstrom et al., 2011; David & Gollasch, 2008). Frameworks within Europe are HELCOM, OSPAR and the Barcelona Convention, outside Europe the Arctic Treaty System, the NAFTA, APEC and SPREP. These regional policies are protection measures for shared trade and coasts and implementation is often voluntary.

## 4. Options for ballast water management

According to policies the on-board management of ballast water is believed to be the best option of reducing the risk of new species introductions. In the BWMC this is elaborated in regulation B-3. At the moment the BWMC will come into force ships have to ensure that the standards of regulation D-1 or D-2 are met. First ships have to comply with D-1, using BWE, and after certain years with D-2, using (on-board) treatment systems (Gregg et al., 2009). BWM treatment options can be distinguished in several groups: mechanical/physical treatment, active substance (chemical) treatment and combined treatment (Gregg et al., 2009).

### *4.1 Ballast water exchange*

Ships performing BWE must at least exchange 95 volumetric percent of the ballast water on board with oceanic water (IMO, 2004). This can either be done by emptying the tanks and refill the tanks with ocean water or by flushing through. Using this latter method three times the volume of the tanks must be pumped through (Endresen et al., 2004).

BWE is an interim solution. It is regarded as a first step towards the strict D-2 standard, but there is criticism about the performance of this method. Endresen et al. (2004) summed up the criticism on the BWE method. BWE is only allowed to perform more than 200 nautical miles off the coast and with 200 meters or more water depth (regulation B-4 (IMO, 2004)). Most of the maritime traffic takes place within the 200 nautical mile zone even on longer voyages (e.g. from NW-Europe to the Mediterranean, N-Africa or to ports in the Middle East). To meet this criticism ships may perform BWE up to 50 nm off the coast (with at least 200 m water depth) when they have permission from the flag state and the coastal state in whose water the ship will perform BWE. However, even with this permit ships often cannot comply with this regulation.

Another criticism is that the sediments at the bottom of the ballast tanks are not being changed. Sediment from the bottom of a port is pumped in with the ballast water and is difficult to remove during de-ballasting, due to the lay-out of the ship's ballast system. In sediment significant amount of species live (Gregg et al., 2009). These organisms will stay on board during BWE and will not be affected.

Seen from shipboard operations' perspective BWE is often unable to perform. Ships might lose stability, bending moments might be exceeded and by flushing through a too high overpressure in the ballast tank might be created. Weather conditions and sea state determine the possibility to exchange ballast water.

Simard and colleagues (2011) conducted a study of the efficacy of BWE using two methods (flow through and a form of empty-refill) on a voyage from Rotterdam to Canada. They found that flow through is most effective for removing microplankton and that empty-refill is more effective or even effective in removing zooplankton. But when they compared the results of the tanks in which the water was exchanged with control tanks that were not exchanged only 29 - 40 percent was removed of the initial microplankton and 23 - 54 percent of zooplankton. This shows that BWE is not sufficiently effective. BWE used as a method of BWM has to be temporarily and interim to make it possible for ships to implement more effective BWM options for reaching standard D-2.

### *4.2 Ballast water treatment options*

To meet the standard of D-2 the ballast water must be treated (Tsolaki & Diamadopoulos, 2010). Several techniques have been developed as ballast water treatment (BWT) options. BWT systems must be used during ballasting and de-ballasting (Gregg et al., 2009) or when the ship is en-route. BWT systems have to be installed on board, which could be a problem, because these treatment systems can be very expensive to buy, but also expensive to store on board, due to the lack of space and to extra maintenance requirements. BWT systems often have to be installed in a combination with another BWT system. Often a system alone cannot meet the D-2 standard due to limitations of the water or the vessel (Gregg et al., 2009).

BWT systems are based on physical/mechanical treatment or of active substance (chemical) treatment. Gregg et al. (2009) and Tsolaki and Diamadopoulos (2009) made extensive reviews of all kinds of techniques that are available for BWT and give the advantages and disadvantages of these techniques. Here only the major (dis)advantages will be discussed.

#### *4.2.1 Physical/mechanical treatment*

Mechanical treatment includes filtration and cyclonical separation, both principles based on particle size (Gregg et al., 2009). Removed organisms are returned directly to the water outboard the vessel, so they which will not have any environmental effect. This also counts for physical treatment options such as heat or radiation (Ultra Violet light) options, where only the physical properties of the water or organisms are changed. The high capital costs of some techniques are disadvantages of this kind of treatments. A ship's construction or type of cargo may not allow some techniques to be installed or to be used on board.

#### *4.2.2 Active substances*

The use of active substances (chemicals acting as oxidants, disinfectants or as biocides) as treatment is often very successful, but has environmental limitations, "since large amounts of treated water will be released into ports around the world" (Gregg et al., 2009) and leftovers of the treatment chemicals may be present and the water will be contaminated. Safety for ship and crew is also a limitation in the use of active substances.

*4.3 Limitations to ballast water treatment*

A serious limiting factor in the use of BWT systems is the amount of ballast water that must be treated and the high flow rate at which a vessel is (de-)ballasting. This makes some treatment options unable to treat all the organisms (Gregg et al., 2009). There are some designs of a ballast-free ship, but these are in an experimental phase and not widely available yet (see Gregg et al., 2009; Kotinis & Parsons, 2010).

*4.4 Ballast water management approval*

Only systems that are capable of reaching the standard of regulation D-2 get approval to be used on board (Gollasch et al., 2007; Tsolaki & Diamadopoulos, 2010). Before a treatment system gets a Type Approval and Final Approval, the strict guidelines of the BWMC G8 and G9 need to be followed and land-based and ship-board tests need to be done. The duration of the test can be as long as six months and much effort and costs are required in this process. There are even stricter regulations to follow if active substances are used as BWT.

But although the cost of getting approved may be high, Gollasch et al. (2007) conclude in a critical review of the BWMC "that an appropriate cost/benefit analysis would reveal that funds used to achieve the aims of the BWMC would be well spent, assuming that new biological invasions showing economic impacts are considerable reduced".

## 5. Ballast water risk assessment as reduction framework

*5.1 Risk assessment application*

In reducing the probability of non-indigenous species introductions as result of ballast water management the risk of a new introduction will be reduced as well. Assessing the magnitude of risks of species introduction will be helpful in determining the way of managing the on board ballast water policy of a ship. Dahlstrom et al. (2011) say that using risk assessment in the ballast water issue "provides tools to determine the probability and the impacts, accordingly prioritize use of limited resources, and thereby reduce the risk of species entering, establishing, spreading and having impacts" and is required "for trade-related biosecurity measures". According Endresen et al. (2004) risk assessments show "where most effort should be expended on mitigations and control strategies". Thus, an assessment of the risk of the introduction of a non-indigenous species is necessary in determining in how ballast water should be managed and in which places.

Ballast water risk assessment might be of special importance in situations where no treatment systems are on board and ballast water cannot be exchanged (Barry et al., 2008). The risk of a new introduction when using BWE or BWT systems is regarded as low or as acceptable and no further assessment is required. In some situations ballast water cannot be treated or exchanged. The situations were ballast water cannot be exchanged are short voyages, when ships operate in (semi)-enclosed seas (Barry et al., 2008) or situations of an emergency where ships need to get rid of untreated ballast water (Teles & Saito, 2009). The BWMC grants ships exemptions to these regulations if these cannot comply with the BWMC requirements. Ballast water risk assessments must be performed in these cases (Barry et al., 2008; IMO, 2004). Vessels that are exempted are allowed to discharge untreated ballast water in areas where the risk of new introductions is as low as possible.

Studies using risk assessment so far used this framework to find out what the risk of a new species introduction would be in a specific port or area visited by ships from all over the world (Gollasch & Leppäkoski, 2007; Keller et al., 2011) to determine what places of the world pose a threat to the specified port when ships arrive from these places. These studies are based on the environmental similarities between the recipient ports and ports in other places of the world. Teles & Saito (2009) performed a case study to find a place to de-ballast in a Brazilian bay with the lowest introduction risk based on a geographical analysis of the area.

### *5.2 Ballast water risk assessment methods*

The methods that can be used to assess ballast water risk are based on species-specific properties or based on environmental similarity (environmental matching) between the ports of ballast water loading and discharge (Barry et al., 2008). Barry and colleagues (2008) made an overview of the risk assessment in the ballast water issue, discussing the species-specific method and environmental similarity method.

#### *5.2.1 Species-specific risk assessment*

Species-specific risk assessment deals with the risk a particular species delivers to a recipient ecosystem, taking the characteristics of a species in consideration. Barry et al. define two approaches in this method. The first is based on the native distribution of a species "to assess species survival in the recipient range". The second is based on the species' physiological tolerances and life history to assess the chance of survival in the recipient ecosystem. A criticism to the first approach is "that it is not useful for prediction, because a species' native range may also be constraint by biotic interaction". The second approach might be a solution for the problem of the first by "more characterizing the species response to the recipient ecosystem". A disadvantage of applying species-specific risk assessment is that it requires a lot of data, because ballast water contains not just one organism that might be introduced and conducting a risk assessment may take a lot of effort and time.

#### *5.2.2 Environmental similarity risk assessment*

The environmental matching method of risk assessing does not focus on organisms that could be present in ballast water, but compares the natural conditions of a place of loading ballast water with the natural conditions of the place where the water is discharged. No target-species information is required. This method is based on the premise that organisms adapted to certain natural conditions cannot or poorly survive dissimilar natural conditions in another place (Barry et al., 2008). Salinity and water temperature are the main parameters used in this method. If the similarity is high between the loading and discharge areas the risk of introduction is regarded as high, if the similarity is low the risk will be low.

Disadvantage of this method is that it elaborates not much about the lack of condition-success relationships (Barry et al., 2008). This method also neglects species with wide environmental tolerances.

#### *5.2.3 Other aspects of risk assessment*

Gollasch and Leppäkoski (2007) argued that the duration of the voyage is of importance with respect to ballast water risk assessment. They argue that the number of organisms in ballast water declines over time and that the biggest decrease takes place during the first three days of a voyage. After ten days only few species remained alive. This means that time is an additional factor in a risk analysis of new species introductions. Further factors are the volume of ballast water that is brought to a recipient area and the frequency a ship visits that place (Drake & Lodge, 2004; Gollasch & Leppäkoski, 2007). More water of one port to another port will increase the amount of number of organisms and will increase the risk. Besides the similarities between two ports and/or the properties of species, time, volume and visit frequency are required in a qualitative ballast water risk assessment of introductions of non-indigenous species.

## 6. Conclusion

Ship's ballast water contains a great amount of species that can pose risks to the place discharge. Shipping is therefore an important vector of non-indigenous species introductions (Keller et al., 2011). These introductions find their pathway along the global network of shipping. In this network ports are regarded as nodes; ports are sources or recipients of new introductions or act as stepping stones. The network predicts and describes the pattern of new species introductions. The intention of IMO's BWMC is to introduce ballast water management to ensure ships only discharge a limited amount species in the recipient area according to defined standards. Ships that cannot comply with the requirement to meet the defined standards can be exempted of performing BWM. Ships that are exempted must undertake a ballast water introduction risk assessment. Risk in the ballast water issue is the risk of introduction and establishing of a species in a recipient area (or outside its native range) (Barry et al., 2008).

## 7. Discussion

Until now, ballast water risk assessment studies have been performed to see which ships from which direction pose risk of introduction of new species to specified ports as an exploration of the introduction pathway (Gollasch & Leppäkoski, 2007) or of the difference between parts of the world using branches of the GNS (Keller et al., 2011). These studies can act as frameworks to port authorities for designing measures to reduce the risk of introduction by ship coming from high risk areas and have a rather pure-scientific perspective.

No study has been performed about how ballast water risk assessments can be helpful in granting treatment exemptions based on routes of individual ships. Route-based ballast water risk assessment may help in determining whether or not to install BWT options on ships in cases exemptions can be granted and will make clear how risk assessment can be properly used for granting exemptions of BWM. In Europe many ships only sail on the North Sea or Baltic area and some on specific routes within these areas. These ships cannot perform BWE. The owners of these ships until now did not invest in treatment systems, because they argue an area such as the North Sea are one ecological zone and these measures might not be necessary[24]. What they argue can be discussed critically, for example the haline waters of the North Sea can act as barrier for fresh water species from the river Rhine to migrate to fresh waters in the UK (Gollasch & Leppäkoski, 2007). It will be helpful for ship owners to develop a risk assessment framework on which they base decisions of putting treatment options on ships sailing specific routes or not. Although this way of ballast water risk assessment has not yet being performed, studies already emphasized on the aspect that individual ships are responsible for new species introductions (Drake & Lodge, 2004; Gollasch & Leppäkoski, 2007; Keller et al., 2011).

With knowledge about a route (of the GNS) a ship sails: the origin of the ballast water on board, the natural conditions between the load and discharge areas and the geographical conditions of the discharge area (Teles & Saito, 2009), route-specific risk assessments of the risks ships sailing that route will make clear if there is a possibility of getting exempted. Ship owners can base their ballast water policy on this approach of ballast water risk assessment.

---

[24] found after discussion with technical departments of ship owners (reference of author)

**References**


Anil, A. C., Venkat, K., Sawant, S. S., Dileepkumar, M., Dhargalkar, V. K., Ramaiah, N., et al. (2002). Marine bioinvasion: Concern for ecology and shipping. *Current Science, 83*(3), 214-218.

Barry, S. C., Hayes, K. R., Hewitt, C. L., Behrens, H. L., Dragsund, E., & Bakke, S. M. (2008). Ballast water risk assessment: Principles, processes, and methods. *ICES Journal of Marine Science, 65*(2), 121.

Carlton, J. T. (1999). The scale and ecological consequences of biological invasions in the world's oceans. In O. Sandlund, P. Schrei & Å. Viken (Eds.), *Invasive species and biodiversity management* (pp. 195-212). Dordrecht: Kluwer.

Carlton, J. T., & Geller, J. B. (1993). Ecological roulette: The global transport on nonindigenous marine organisms. *Science, 261*, 78-82.

CBD. (2010). *Value of Biodiversity and Ecosystem Services*. Retrieved July 19, 2011, from http://www.cbd.int/2010/biodiversity

Clark, I. C. (2002). *The management of merchant ship stability, trim and strength* (1st ed.). London: The Nautical Institute.

Dahlstrom, A., Hewitt, C. L., & Campbell, M. L. (2011). A review of international, regional and national biosecurity risk assessment frameworks. *Marine Policy, 35*(2), 208-217.

David, M., & Gollasch, S. (2008). EU shipping in the dawn of managing the ballast water issue. *Marine Pollution Bulletin, 56*(12), 1966-1972.

Dokkum van, K. (2003). *Ship knowledge* (1st ed.). Enkhuizen: Dokmar.

Drake, J. M., & Lodge, D. M. (2004). Global hot spots of biological invasions: Evaluating options for ballast-water management. *Proceedings of the Royal Society B: Biological Sciences, 271*(1539), 575-580.

Endresen, O., Behrens, H. L., Brynestad, S., Andersen, A. B., & Skjong, R. (2004). Challenges in global ballast water management. *Marine Pollution Bulletin, 48*(7-8), 615-623.

EU. (2008). Marine strategy framework directive. *Directive 2008/56/EC,*

Gollasch, S., David, M., Voigt, M., Dragsund, E., Hewitt, C., & Fukuyo, Y. (2007). Critical review of the IMO international convention on the management of ships' ballast water and sediments. *Harmful Algae, 6*(4), 585-600.

Gollasch, S., & Leppäkoski, E. (2007). Risk assessment and management scenarios for ballast water mediated species introductions into the baltic sea. *Aquatic Invasions, 2*(4), 313-340.

Gregg, M., Rigby, G., & Hallegraeff, G. M. (2009). Review of two decades of progress in the development of management options for reducing or eradicating phytoplankton, zooplankton and bacteria in ship's ballast water. *Aquatic Invasions, 4*(3), 521-565.

Hewitt, C. L., & Campbell, M. L. (2007). Mechanisms for the prevention of marine bioinvasions for better biosecurity. *Marine Pollution Bulletin, 55*(7-9), 395-401.

IMO. (2004). *International convention for the control and management of ship's ballast water and sediments* (1st ed.). London: International Maritime Organization.

IMO. (2009a). *International shipping and world trade. facts and figures.* Retrieved June 09, 2011, from http://www.imo.org

IMO. (2009b). *Status of conventions.* Retrieved June 16, 2011, from http://www.imo.org

Kaluza, P., Kölzsch, A., Gastner, M. T., & Blasius, B. (2010). The complex network of global cargo ship movements. *Journal of the Royal Society Interface, 7*(48), 1093-1103.

Keller, R. P., Drake, J. M., Drew, M. B., & Lodge, D. M. (2011). Linking environmental conditions and ship movements to estimate invasive species transport across the global shipping network. *Diversity and Distributions, 17*(1), 93-102.

Kotinis, M., & Parsons, M. G. (2010). Hydrodynamics of the ballast-free ship revisited. *Journal of Ship Production, 26*(4), 301-310.

Olenin, S., Alemany, F., Cardoso, C., Gollasch, S., Goulletguer, P., Lehtiniemi, M., et al. (2010). *Marine strategy framework directive task group 2 report non-indigenous species*. Copenhagen: ICES.

Rodíguez-Labajos, B., Binimelis, R., & Monterroso, I. (2009). Multi-level driving forces of biological invasions. *Ecological Economics, 69*(1), 63-75.

Simard, N., Plourde, S., Gilbert, M., & Gollasch, S. (2011). Nett efficacy of open ocean ballast water exchange on plankton communities. *Journal of Plankton Research, 0*(0), 1-18.

Teles, L. J. S., & Saito, H. S. (2009). Ballast water and sustainability: Identification of areas for unballasting by geoprocessing—case study in todos os santos bay, brazil. *Pan-American Journal of Aquatic Sciences, 4*(3), 283.

Tsolaki, E., & Diamadopoulos, E. (2010). Technologies for ballast water treatment: A review. *Journal of Chemical Technology and Biotechnology, 85*(1), 19-32.

Westphal, M. I., Browne, M., MacKinnon, K., & Noble, I. (2008). The link between international trade and the global distribution of invasive alien species. *Biological Invasions, 10*(4), 391-398.

# 13 HYDE MARINE — HYDE GUARDIAN BALLAST WATER TREATMENT SYSTEM

**Tom Mackey, Hyde Marine**

The Hyde Guardian (HG) is a Type Approved BW Treatment system that was tested at NIOZ in 2008 on behalf of the UK MCA and Lloyds Register. The HG is a proven, simple, safe and effective solution to meet the IMO BWM Convention and US Coast Guard requirements. Well over 150 systems have already been sold with capacities from 60 to 2500 m3/hr. Hyde is a market leader in operating experience with type approved systems working aboard ship since 2003.

Hyde's BW history began in 1996 as an engineering sub-contractor for BWM R&D programs on the US & Canadian Great Lakes. The main program was called the Great Lakes Ballast Water Technology Demonstration Project. In 2000 Hyde entered the market with a developmental system and delivered 5 systems in 2000 and 2001 – 3 on cruise ships and one each on a container ship and a parcel tanker.

When the BWMC performance standards were first disclosed during 2002, Hyde updated the system based on these new standards and from the many lessons learned from the first 5 installations. The Hyde Guardian emerged in 2003 and the first installation was aboard the cruise ship, Coral Princess in June of 2003. That system has now been operating without problems for more than 8 years and was the first IMO type approved BWM system in operation. A second system was installed also aboard a cruise ship, the Celebrity MERCURY, in 2006. It too has operated successfully since installation and has now been renamed Mein Schiff 2 and transferred to a new cruise fleet in Germany.

The Hyde Guardian was chosen by the UK Royal Navy in 2008. A total of 6 Hyde Guardian systems – three for each of its two new Queen Elizabeth Class Aircraft Carriers were delivered at the end of 2008. The carriers are still under construction in the UK.

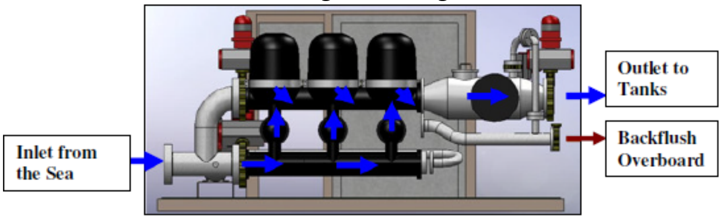
Hyde Marine was the first BWT system manufacturer to become involved with the USCG STEP program. The Coral Princess was the first ship accepted into the STEP Program in 2008 and the Celebrity Mercury was accepted in 2010.

IMO Type Approval for the HG was received from MCA in the UK in collaboration with Lloyds Register in April 2009. Land based testing was conducted at NIOZ in The Netherlands and shipboard testing aboard the Coral Princess by scientists from the University of Maryland. Since then Hyde has received type approvals from ABS, LR, and The Russian Registry of Shipping. Other Class type approvals have been applied for and certificates have been received from several governments.

The diagram below shows how the system works with two stages – filtration and UV disinfection. No chemicals or other active substances are used. It is a simple and safe system with reliable and proven performance. The

Guardian is a fully automatic treatment process with filtration and UV disinfection during ballasting and with the filter automatically by-passed and just the UV treatment during de-ballasting, to ensure that all organisms are killed or inactive before discharge.

***During Ballasting***




***During De-Ballasting***

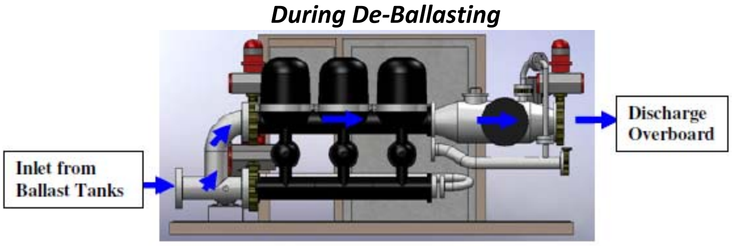



**Figure 1:** Hyde GUARDIAN operates automatically, behind the scenes, during both ballasting and de-ballasting operations.

Hyde received its first order for a tanker application in early 2010. The 10 ship order required locating the system in a hazardous area – the pump room. The electrical controls are located in the engine room. These ships are Suezmax, 154,000DWT Crude Oil Carriers, built for a Greek owner, ALMI Tankers, at DSME in Korea.

Hyde has received orders for well over 150 BWT systems for more than 100 ships with many additional orders well underway. The capacities range from 60 to 5450 m3/hr per ship. Approximately 30 systems are fully operational, several of them retrofits, with more coming into service on a regular basis.

The pictures below show the installation of 4 x Model SF700 filters for one of two Ex-Proof 2500m3/hr BWT systems in the pump room of the Suezmax tanker new building. Retrofitting aboard tankers and other high ballast water flow rate systems will, of course, present an even more difficult challenge and require careful planning, increased modularity, and engineering flexibility.

**Figure 2:** Model HG 2500 Filters - Pump Room installation aboard a Suexmax Tanker

Model HG 2500 UV Reactors - Pump Room installation aboard a Suexmax Tanker

All ship owners will have to comply with the upcoming BWM regulations. The IMO BWM Convention is expected to be ratified by the end of 2011 or early 2012 and will come into force 12 months after ratification. Certain port states may introduce regulations even more demanding than IMO. New buildings with keels laid during 2009 and later will have to have a type approved system installed and operating when the ship is delivered. Existing ships will have to comply by 2016, many before that. Selecting a safe, practical, robust and reliable ballast water management solution should be the highest priority.

Hyde Marine's philosophy has been to take the simplest and most direct technical approach in the design and selection of components to deliver the most reliable ballast water management system on the market.

# 14 ERMA FIRST — BALLAST WATER TREATMENT SYSTEM

**Konstantinos Stampedakis, ERMA FIRST**

### 1. ERMA FIRST Ballast Water Treatment System Overview

The ERMA FIRST BWTS is an integrated, autonomous and modular treatment system for ballast water, based on electro-chlorination, jointly developed by a group of scientists and engineers with a long lasting experience in the design and production of equipment for ship-generated liquid waste treatment. The treatment process includes two distinctive stages, a primary one, that enables the separation of coarser suspended materials and relatively larger living organisms in ballast water and a secondary one, in which electrolytic disinfection takes place to meet the required biological efficacy standard for treated ballast water as stipulated in the Convention.

At the primary stage of the process, removal of material with size larger than 50 μm is accomplished by means of an advanced cyclonic separator made from frictionless material. To prevent blocking of the separator from large particles that might pass though the sea chests and strainers of the vessel, a 200 μm self cleaning basket filter has been installed prior to the separator.

Electrolysis of ballast water to producing in situ up to 10 mg/L of free active chlorine constitutes the second stage of treatment which takes place during ballasting. The products of this process flow into the ballast tanks of the vessel, so that the residual oxidants disinfect any harmful organisms taken onboard. Integral components of the system are the control and monitoring equipment that ensure its proper operation as well as the neutralization process of treated ballast water prior to its eventual discharge into the sea.

The operational status of the system is continuously monitored at a central data logger, located into the central control panel of the system. Data logging includes the operation status of the system, operation, flow and temperature at the electrolytic cell, pressure difference across the self-cleaned filter and the cyclonic separator, the operational status of the neutralizing agent dosing pump as well as the chlorine level of the system. The control panel can be positioned into the cargo control room of the vessel.

### 2. ERMA FIRST BWTS OPERATION

The ERMA FIRST BWTS is an autonomous fully automatic operational unit. The system has two different operational modes, one during ballasting and one during the discharge of treated ballast water, de-ballasting. The two operation modes are described in the following paragraphs.

#### Mode one: Ballasting

During ballasting, ballast water will pass through the 200 μm pre-filter and then into the cyclonic separator. The rich in sediments and coarse material underflow stream from the latter will return back into the sea via a drain line. The overflow will enter the electrolytic cell. A flow sensor, installed upstream of the cell will provide a signal to the cell through the PLC of the system to apply DC current to the electrodes in order to initiate the electrochemical process and the production of the Active Substances. A free chorine sensor (TRO sensor), located downstream of the cell, monitors the free chlorine concentration.

The production rate of the Active Substances is continuously tuned, to the ballast flow rate and the measurement of the free chlorine at the sensor. Depending on the flow rate and the free chlorine measurement, the voltage at the cell changes in order to maintain the pre-set free chorine concentration. The electrolytic cell of the system has been specifically designed to produce the identified Active Substances at temperatures as low as 5oC and water salinity > 3.0 PSU. The ability of the cell to produce free chlorine in such conditions is based on the special coating material of its electrodes, and also to its design that enables sufficient contact time of chlorides in the water stream with the electrodes, thus providing enough contact time to convert into Active Substances.

Similarly, the electrolytic cell of the system can operate effectively in salinities above 32 PSU, due to the fact that water of such salinity results to high electrical resistance and thus the PLC of the system will adjust the voltage at the electrodes in such manner in order to keep the production of free chlorine at the pre-set values.
The whole unit is current driven controlled by the chlorine sensor arranging for the set concentration and current applies to the electrodes result in a specific amount of active substance production.
By monitoring the operating Amperes on the electrodes of the cell and adjusting the applied voltage, the PLC of the system ensures a constant production rate of Active Substances in an extended salinity and temperature range. Note that, e.g. in cases of emergency, the ballast water management system can be by passed using the appropriate valve arrangement.

**Operation mode two: Deballasting**

During de-ballasting, neutralization of the total residual oxidants takes place by adding aqueous solution sodium bisulphite solution (38% w/w). At this mode the pre-filtering equipment, the cyclonic separator and the electrolytic cell of the system are by-passed with the exception of the free chlorine sensor.

# 15 BALPURE® ELECTROLYTIC DISINFECTION BALLAST WATER TREATMENT SYSTEM OFFERS SLIP STREAM APPROACH WITH SIGNIFICANT ADVANTAGES

**Bill Burroughs, Severn Trent De Nora**

Shipowners and managers, suddenly having to pick their way through a maze of complex new legislation, unfamiliar technologies and competing claims from manufacturers can be a serious undertaking. While electrolytic ballast water disinfection systems share the same basic chemistry for electrolyzing seawater, commercially available electrolytic disinfection technologies differ significantly. Understanding the technical and commercial performance criteria of the various electrolytic ballast water treatment technologies is critical to the equipment selection process and ensuring that a proven, effective and reliable technology is selected to meet regulatory requirements.

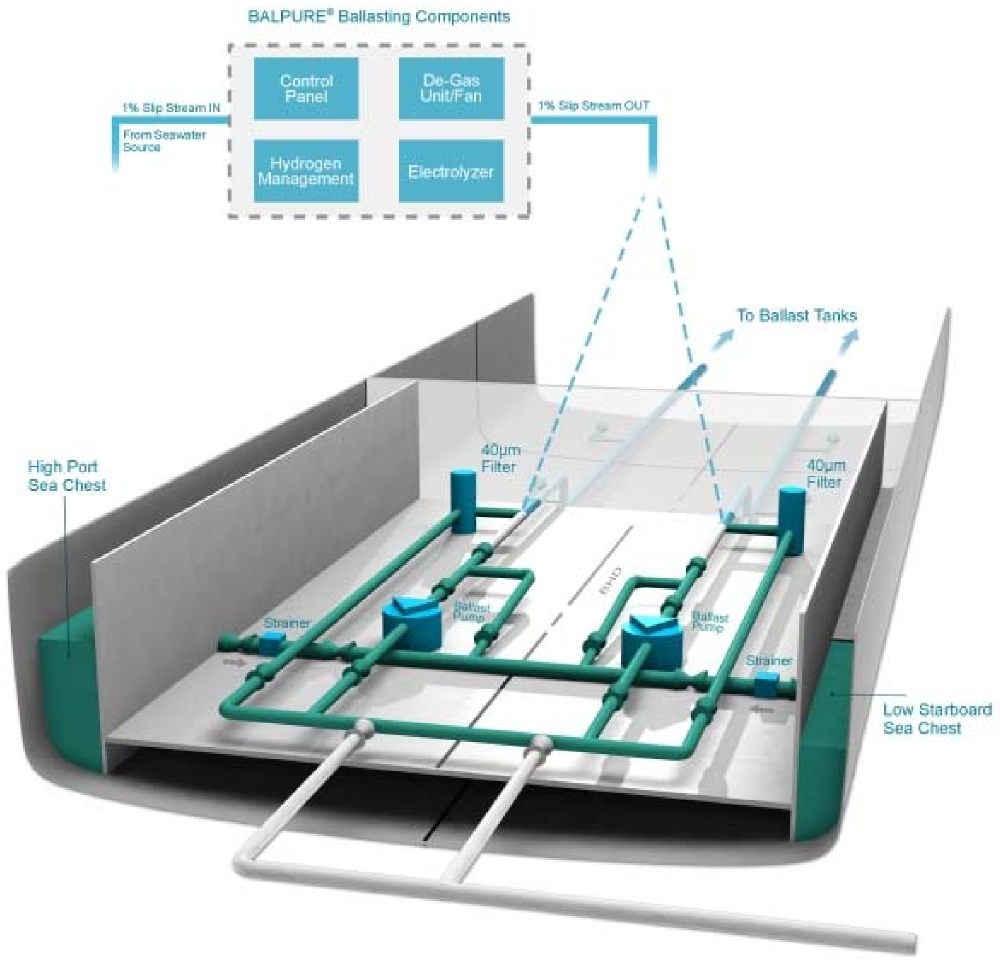
In addition to selecting a ballast water treatment solution able to meet regulatory requirements, it is also important to adopt a technology with proven efficacy and most suited for application-specific requirements such as ballast water flow rate and hazardous area rating requirements.

**Electrolytic disinfection, benefits of the slip stream approach**

Installation flexibility of an electrolytic ballast water treatment design is determined by its placement in-line with the main ballast system or its ability to treat a portion of the ballast water volume to achieve discharge standards.

Electrolytic ballast water treatment systems typically pass the entire ballast stream through the electrolytic cells. The Type-Approved BALPURE® ballast water treatment system from Severn Trent De Nora diverts a small side stream from the main ballast line. A slip stream approach allows the unit itself to make use of available existing locations remote from the main ballast line and gives the naval architect, marine engineer or yard flexibility over how the unit is located on board the vessel.

Rather than treat the whole volume of ballast water, the BALPURE slip stream approach feeds a percentage of total volume into the electrolytic system to generate a disinfectant within the electrolysers. The BALPURE system uses approximately one percent of the total ballast water volume to generate a disinfection solution on site with electricity and available seawater.




**BALPURE® Ballasting Process**

The disinfectants are then reintroduced to the main ballast flow downstream of the pumps. These active compounds, by now diluted 100 times to a very low concentration, protect against regrowth in the tanks during the vessel's passage and are neutralized back to their original state on discharge.
Another major advantage of the slip stream approach is on vessels with pump rooms. For example, the BALPURE system can be installed in the engine room or in other available spaces. This capability avoids taking up precious space in the pump room, negating expensive modifications and removing the need for the unit to meet the complex and expensive ATEX rules governing hazardous cargo areas. The only component of the BALPURE system that is required for placement in the ballast line is the self-cleaning filter (ATEX rated if required).

This slip stream design also means that multiple remote tanks or circuits can be dosed simultaneously such as the aft peak tank which, often being on a separate circuit can otherwise require its own ballast water treatment system to meet IMO rules.

**Slip stream treatment approach reduces power requirements and energy consumption**
Power requirements of ballast water treatment systems have concerned the shipping industry from the onset of regulatory discussions. The slip stream treatment approach, coupled with only having to treat

during the uptake of the ballasting cycle allows a ballast water treatment system to offer significantly reduced power requirements compared to competing technologies– ensuring low operational costs.
A typical BALPURE installation capable of treating 5000 m³ per hour of ballast water, under normal operating conditions with a dose rate of 6-8 ppm, will draw under 200kW. If higher than typical concentrations of chlorine residual are required for dosing, the power draw will increase, but only minimally. Maintenance too has been kept to a minimum with few wear parts and 100% redundancy on most critical components. The routine maintenance schedule calls for only two man hours per month, even on the largest unit, and is made simpler because the unit is not installed in the main ballast line.

**Slip stream treatment approach allows for a flexible and remote installation**
While most electrolytic ballast water treatment systems use a skid-mounted modular design to achieve a small footprint, a sub-assembly component design can allow for more flexible installation when coupled with a slip stream treatment approach.

Several sub-assemblies that together make up a BALPURE system can in turn be remotely mounted from each other, including on multiple decks – allowing small available spaces to be used in the engine room or other locations. This sub-assembly component design makes for much simpler loading of the ballast water treatment system components into the vessel in the yard, at the dockside or even at sea in preparation for installation and commissioning.

In the first quarter of 2008, a BALPURE ballast water treatment system was installed for testing on SeaRiver Maritime, Inc.'s S/R AMERICAN PROGRESS, a 46,000-dwt, double-hull product tanker. The double-hull tank ship arrangement has 14 cargo tanks and two slop tanks with a total ballast capacity of 19,000 cubic meters. The ballast is handled by two ballast pumps, each rated at 975 cubic meters per hour. For this installation, the BALPURE system was separated into six components and installed down a hatch less than 1.5 m x 1.5 m. Components were fitted into existing spaces spread over three decks, eliminating the requirement to relocate other ship equipment.

The operating and capital cost savings results of scaling up the BALPURE system to accommodate higher ballast water flow rates can be significant especially when company to other ballast water treatment system methods that simply replicate their base model design in order to treat increased flow rates, leading to an inefficient use of space and increased costs and system complexity.
BALPURE can scale up production of the disinfectant by simply increasing the size and number of plates in each electrolyser.

**Electrolytic disinfection and tank coatings**
Effective corrosion control in ballast water tanks is one of the most important features in determining a ship's effective lifespan. When evaluating a ballast water treatment system, ship builders and owners should also review the effect the system will have on the overall vessel and if there is a potential for impact on corrosion-protecting coatings in the ballast tanks. Third-party corrosion testing against the IMO MEPC 59/2/16 recommendations is a must for every viable ballast water treatment system.
A corrosion testing program undertaken by GL Noble Denton for the BALPURE system was successfully completed in March 2011. The testing proved the BALPURE system has no effect on coated steel, naval bronze and Cu-Ni alloys. Testing proved an insignificant effect on bare steel – so small that the acceleration of corrosion due to the presence of free chlorine has minimal practical implications in ballast

tanks. Therefore, the BALPURE ballast water treatment system will not impact the life expectancy of a ship.

**BALPURE® Skid-mounted system**

All electrolytic disinfection treatment systems are not equal
A slip stream electrolytic disinfection system is among the safest, most cost-effective ballast water treatment technology available to prevent the transfer of non-indigenous species. The Type-Approved BALPURE system was rigorously tested over eight years with results surpassing IMO D-2 standards by over ten-fold. Evaluating the BALPURE electrolytic disinfection system will enable ship owners and managers to eliminate the headache of navigating the maze of ballast water legislation and competing claims from manufacturers.

For more information, visit www.balpure.com.

**Maker: -** **COLDHARBOUR MARINE LTD**

**Equipment: -** GLD™ Ballast Water Treatment System

**Contact details: -**

sales@coldharbourmarine.com

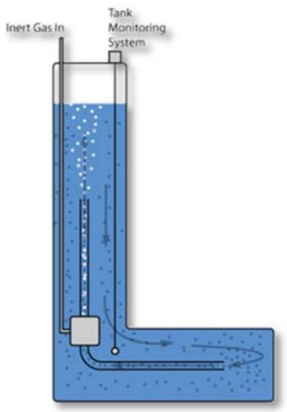
24 The Village, Maisies Way South Normanton
Derbyshire, DE55 2DS United Kingdom
Tel:- +44 (0) 1629 888386
Fax: - +44 (0) 1629 888385

Web: - www.coldharbourmarine.com

**Treatment Name: -** **Coldharbour GLD™ Ballast Water Treatment**

**IMO Treatment Type: -** **G8**

**Treatment Methodology: -**




"In Tank" during ballast voyage. Utilises Coldharbour Sea Guardian™ marine Inert Gas Generator (IGG) with ultra-low oxygen output of 0.2% $O_2$, linked to a patented shock wave Gas Lift Diffuser (GLD™).

The diffusion of $CO_2$ in ballast water: (a) reduces the oxygen levels in the seawater, which in turn induces Hypoxia within aerobic organisms, whilst it also (b) reduces the pH level to approx. 5.8, which kills anaerobic organisms by Hypercapnia. The shock wave element within the GLD is used to kill enteric and other bacteria.

**Estimated Footprint: -**

Footprint is based upon using a Coldharbour Sea Guardian™ ultra-low oxygen Inert Gas Generator (IGG) and is dependent on the total volume of ballast water to be treated and the minimum ballasted voyage time typically available to the vessel. For example, for a ULCC with (say) a minimum 12 day ballast voyage the footprint will be:

- 3.25$m^2$ for IGG fuel pumps mounted, plus
- Approx. 3$m^2$ for additional skid mounted blowers and compressors

The simple rule is that each 1$m^3$ of water requires 1$m^3$ of ultra-low oxygen inert gas for treatment. Therefore, for ships with typically shorter ballast legs, reductions in treatment times can be achieved by increasing the size of the IGG so that more gas is available in less time.

**Power consumptions: -** Typical peak power consumption on VLCC installation <400kW

| | |
|---|---|
| **Estimated Capex equipment: -** | 2.25mil US $, based on a ULCC* |
| **Estimated Capex installation: -** | This largely depends on the pricing levels of the shipyard that will undertake the installation. Based on UK prices, the installation cost is approx. 1.0mil US $ for a ULCC. |
| **Estimated Opex: -** | see attached last sheet<br>* When the Coldharbour Sea Guardian™ IGG is installed for BWT it can also be used for cargo blanketing top up, thereby saving the cost of an additional IGG. |
| **Explosion Proof: -** | Yes (no installation of equipment is required in hazardous areas, such as the pump room) |
| **Tank Coating Impact: -** | Studies conducted by two major paint suppliers have reported no impact on the tank coatings. In fact the system offers a significant improvement in corrosion control within the ballast tanks, particularly if the operator opts to use the optional inerting of the ballast tanks when empty. |
| **Ballast treatment capacity: -** | **Unlimited:** the size of the ballast pumps, which usually is one of the limiting factors for other systems on the market, is irrelevant to Coldharbours system, as the treatment of the ballast water takes place in the ballast tank during the ballast voyage. |
| **Pressure Drop: -** | **Nil:** There are no changes to ballast pumps/ballast lines. |
| **Performance Standard / U.S.C.G Compliance: -** | • Coldharbour plans to achieve compliance with the IMO, and New York B.W. regulations. Accordingly a modified B.W. treatment schedule may apply to ensure compliance with stricter regulations. This will not, however, affect the vessel's normal turn around in port scheduling because the treatment of the ballast water takes place in tank during the voyage.<br>• Extensive studies by accredited marine environmental scientists have proved that ballast water treated through the Coldharbour GLD™ BWT system is safe for immediate discharge, with zero environmental impact.<br>• A re-aeration cycle prior to de-ballasting is available to the operator should future changes to regulation require it. The Coldharbour system can achieve this without the need for upgrades or modifications. |
| **System Approval: -** | Basic pre-test qualification has been conducted by **Plymouth Marine Laboratories**, UK.<br>Land based testing is in progress at **NIOZ,** Netherlands under **UK MCA ,** under the supervision of **Lloyd's Register**.<br>Shipboard testing to be conducted during 1st half 2012 |

**Positive Benefits of the Coldharbour GLD™ Ballast Water Treatment system: -**

- Gravity ballasting/de-ballasting is unaffected.
- Maintains normal ships turn around schedule with no disruptions.
- Operates on existing power generation capacity with no upgrade required.
- Uses electrical power during off peak times.
- Unlimited treatment capacity.
- Uses known technologies and on-board skill sets.
- Is based on reliable technology with no moving parts in tank.
- Larger / higher pressure ballast pumps are not required.
- No upgrade to ballast piping is required, as there is no pressure drop.
- The Coldharbour IGG can be used for both ballast water treatment and cargo tank blanketing.
- The system will ensure that ballast water is always treated to the required standards of any port visited.
- The Coldharbour IGG is reliable and easy to maintain with no filters or spray nozzles or demister pads to clean.
- The BWT system has low maintenance costs.
- No requirement for installation of equipment in hazardous areas, such as the pump room.
- Large filters with consumables are not required.
- Can be retrofitted within normal repair periods.
- Can be retrofitted during a loaded voyage.
- Significantly reduces ballast tank corrosion.
- No active substances used (IMO G8 System).

# 16 FULFILLING THE NEED FOR HIGH FLOW CAPACITY BW TREATMENT SYSTEMS

**Tom Perlich, Ecochlor Inc. - USA**

**Abstract**

There are a many options for ship owners and ship builders with regard to ballast water treatment (BWT) systems and technologies. The number of choices has increased dramatically over the last 2 years, just in time for the implementation of the International Maritime Organization (IMO) Ballast Water Convention.

Although there are alternatives for small and moderate size vessels, few technologies are capable of treating high ballast water flow rates utilized by large bulkers and tankers. Ecochlor's BWT technology is especially suited for these vessels and this is the primary market for the organization. This paper will discuss the considerations that limit some competing BWT technologies.

**Introduction**

Depending on the source, the number of legitimate ballast water treatment technologies either on the market or close to the market ranges from 30 to more than 50. Each year, the IMO / Marine Environment Protection Committee (MEPC) is flooded with new BWT system applications for approval and this is expected to continue for some time.

The large range of technologies have one thing in common: they are all capable of treating low ballast water flow rates. The BWT system approvals are based on low flow rate (250 cubic meters per hour ($m^3$/hr)) testing. This ensures the technology's ability to satisfy a minimum performance standard at this rate. However, as flow rates increase by 2X, 10X, 20X or even up to 40X, how difficult is it to meet those same performance standards? How much more difficult is it to overcome challenging conditions? How difficult is it to meet a *higher* performance standard?

This paper will highlight several of the challenges facing legitimate BWT systems and how the Ecochlor® BWT System has the ability to easily, effectively and reliably meet and greatly exceed the IMO Regulation D2 Ballast Water Performance Standard.

**Discussion**

It is the author's belief that a portfolio of technologies will be available to the industry based on the maximum ballast water flow rate. Determining the maximum ballast water flow rate is more than simply looking at the rated capacity of the ballast water pump(s). A ballast water pump with a pumping capacity of 1000 $m^3$/hr means that the pump is guaranteed by the maker to pump at least 1000 $m^3$/hr against a maximum head pressure. This is typically seen when filling wing tanks. Therefore, when the pump sees no head pressure (e.g. while filling empty ballast tanks) the maximum flow rate will greatly exceed the ballast pump's rated capacity. It should also be understood that depending on a vessel's draft, gravity filling of ballast tanks can also reach maximum ballast water flow rates that exceed the rated pump capacities.

Therefore, the differentiation of the ballast water market based on maximum flow rates can be segmented in the following way:

| BWT System | Maximum BW Flow |
| --- | --- |
| Small | < 500 $m^3$/hr |
| Medium | 500 – 1500 $m^3$/hr |
| High | 1500 – 3000 $m^3$/hr |
| Very High | >3000 $m^3$/hr |

As BWT systems attempt to increase treatment capacity there are 3 major considerations: footprint, power and complexity. The importance of each consideration grows exponentially as ballast water flow rates get higher.

**Footprint**

Many BWT systems have been Type Approved in a modular configuration. This means that in order to increase the overall system's capacity, additional modules are added. Although this has a benefit for simplicity, it does force the system to grow in footprint size. For example, a system that has been Type Approved for 250 $m^3$/hr and an overall footprint of X, will have an overall footprint of 4X for 1000 $m^3$/hr and an overall footprint of 8X for 2000 $m^3$/hr.

**Power**

The vast majority of BWTSs being proposed and approved utilize fossil fuel generated electricity to provide the methodology to treat ballast water. This electricity is either used to generate ultraviolet (UV) light or to generate an oxidant (chlorine / bromine / ozone) in sea water. Power requirements grow in a linear manner and can increase beyond the amount of excess electric generation capacity available on the vessel. This is compounded by the fact that ballasting takes place during cargo operations where the majority of the electric power is already being utilized.

**Complexity**

The electro-chlorination technologies are limited by temperature and salinity of the source water. As the temperature drops below 15°C the efficiency of the reactions are adversely affected. Changing the source water temperature is possible and even practical for low ballast water flow rates but it becomes unrealistic as the ballast water flow rates increase. Simply put, trying to increase the temperature of 100 $m^3$/hr is completely different than trying to increase the water temperature of 3000 $m^3$/hr or more. Similarly, analyzing, quantifying and adjusting the salinity of the source water can also be problematic. Can it be done? Of course it can, but it becomes much more challenging with higher ballast water flow rates.

**Ecochlor's BWT Methodology**

Ecochlor's technology generates a dilute solution of chlorine dioxide as the active substance for treatment of the ballast water. The chlorine dioxide is injected into the incoming ballast water after a filtration stage. Treatment is only on the incoming ballast water, and no treatment or neutralization is needed on ballast water discharge.

Ecochlor's treatment is completely effective, and land-based and shipboard testing proves this even to the most sceptical critic under challenging water conditions. There is no need for any R&D efforts to satisfy performance standards more restrictive than the IMO. Ecochlor systems perform at these standards already.

**Ecochlor and Scale Up**

Ecochlor's BWT system is easily scalable. As seen below in Figure 1. the system does not grow in footprint like the modular systems. This allows the overall space required for "High" and "Very High" ballast water flow rates to be much smaller than the modular competitors.

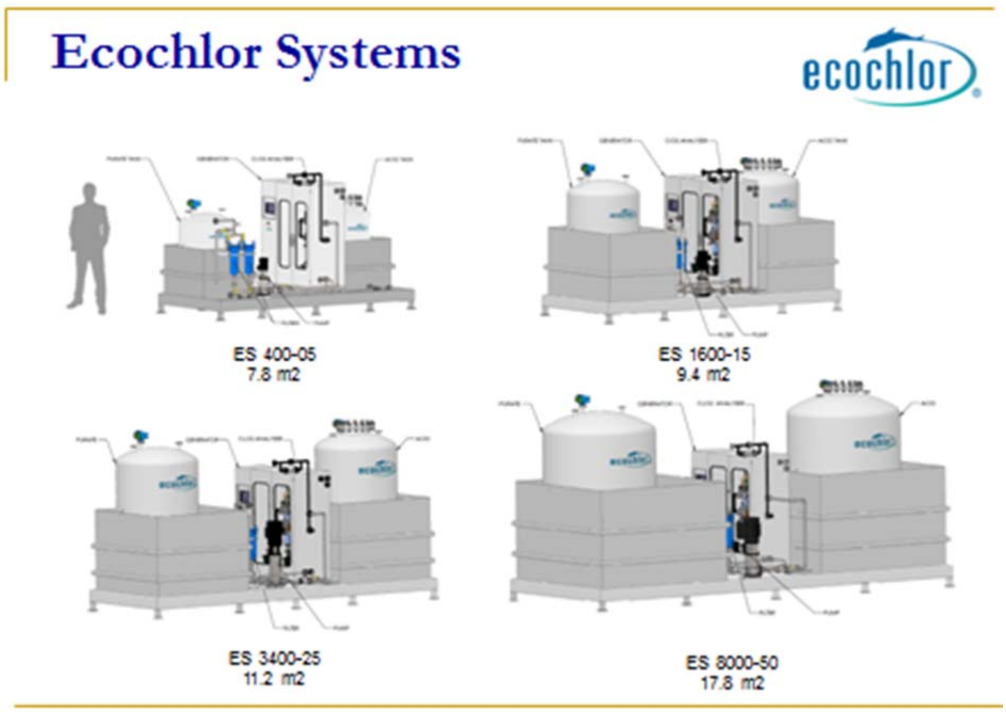



**Figure 1:** Scaled Ecochlor® BWT System Footprints

Regarding power, Ecochlor uses a small amount of chemicals to generate the active substance instead of large amounts of power. An Ecochlor system with a ballast water treatment capacity of 8000 $m^3$/hr requires less than 30 kW. This includes all support systems, filter operations (including cleaning) and the generation of the chlorine dioxide. The chemicals are available through our global network and the prices of the chemicals can be guaranteed over the life of the vessel. It is unlikely that any technology using high amounts of power can provide guarantees of the future price of electricity.
Also, there is no need to analyse, monitor or adjust the source water's temperature or salinity. The system has been operated successfully at 0°C and with a full range of salinity from seawater to fresh water.

**Conclusion**

Ship owners have many ballast water treatment options for "Small" and "Medium" size ballast water flow rates. However, as the flow rates increase, many technologies will have increased difficulty. The challenges are summarized in the footprint, power and complexity of the technology.
Ecochlor's unique treatment methodology allows a much smaller and simpler system at the "High" and "Very High" flow rates. There is no consideration with regard to temperature or salinity and a total power consumption of 30 kW for a VLCC or VLOC is trivial in comparison to the electricity based technologies.

## 17 MAHLE — BALLAST WATER TREATMENT SYSTEM "OPS"

**Birger Hahn, Mahle**

**Type Approval acc. IMO Guidelines for the MAHLE Ballast Water Treatment System "OPS" was granted in April 2011 by German Administration BSH.**

### Introduction

The Ocean Protection System "OPS" is a three-stage ballast water treatment system and operates in-line during uptake and discharge of ballast water. The system is based on well-known technologies from the industrial applications and combines mechanical and physical cleaning and disinfection principles.

While up-taking the ballast water flows sequential through two self-cleaning filter stages followed by one low pressure UV-irradiation (LP-UV) stage before it ends in the tanks. On the contrary during discharge all filters are bypassed and the ballast water is treated once again with high performance LP-UV.

Due to this two-way treatment-method the duration of the voyages is no longer a significant issue. That means as well that shortest holding times are sufficient to assure the compliance with the IMO D2-Standard at the discharge of ballast water.

### Land based test

The certification process according to the IMO G8 Guidelines for type approval testing is already under progress. In Spring 2009 **Land based test** trials were carried out successfully at the Royal Netherlands Institute for Sea Research (NIOZ), on the Island Texel in the Netherlands, in accordance with the required IMO D2 Standard and the G8 Guidelines (Resolution MEPC.174(58)).

In each of the official test run, the numbers of organism were well down below the IMO D2-Standard. The above average performance demonstrated that the OPS operates in a reliable and environmentally safe way of treating ballast water.

An additional G8 requirement to show that the discharge of ballast water is environmentally acceptable was also achieved during land based tests. At the same time miscellaneous eco-toxicological studies proved that no potentially toxic changes in chemistry occurred during the UV irradiation. The treated water did not contain any toxic or growth inhibiting substances nor were chemicals produced as a by-product.

### Shipboard tests

Currently the **Shipboard testing** is executed and several tests for mechanical functionality and biological effectiveness were accomplished successfully. Hereby a containerized OPS unit was installed on a 1100 TEU Container Feeder Vessel in one of the cargo holds. The container was delivered as a plug-and-play version especially designed for use as a retrofit unit. For this purpose only the BW piping system was adapted for the inlet- and outlet connections of the OPS, so that an exchange of the existing pump was not necessary.

A new and **fast installation method** with minimized welding reduced the complexity of integration significant whereby the installation workings could be executed within **5 days** without interrupting normal ship operations. All workings were supervised from ship´s classification society and approved thereafter.

**Advanced features & design**

The **fully automated** OPS can be completely integrated into the vessels ballast water control system. If any of the logged operating parameters of the BWTS are not within the acceptable and pre-determined tolerances, the **control system** will shut down the OPS and not allow untreated ballast water to pass. When the system is not in operation or in an improbable emergency case the pneumatically activated inlet- and outlet- butterfly valves separates the OPS from vessel´s ballast system.

Installations on-board ships with **hazardous areas** such as tankers can also be accomplished with the OPS. However there are limitations as to the location of the individual system components. By adapting some system components, it can be made into an explosion proof system, such as required for use on oil and gas carriers and chemical tankers.

The OPS will not cause **corrosion** of the vessel´s structure. The filtration step is a solid liquid-separation system only and the UV disinfection treatment does not change the treated water by any means. Official chemical water analysis during land bases testing approved that there is no effect on corrosion.

Additional advantages for ship owner and operators of **civil, marine and special vessels** are the low power consumption of the Ocean Protection System, low operation and maintenance costs, no need of chemicals, as a result

**Maximum safety for all involved.**

Besides the standard design as a skid-mounted unit the OPS is optional available as container system or in single components. The filtration system can be installed separately from the disinfection system. Both systems can be installed either vertically or horizontally as this has no effect on the operation or the efficiency of the system. This individual design for misc. flow rates and the fact of fast and low cost installation make the OPS for new buildings as well as for existing ships equally interesting.

# 18 HAMWORTHY — AQUARIUS BALLAST WATER TREATMENT SYSTEM

**Stelios Kyriacou, Hamworthy**

## INTRODUCTION

Hamworthy is a leading supplier of marine equipment for both the new build and retrofit market, across the full range of ship types in both marine and offshore sectors. Having a strong marine background in providing specialist systems and service support to meet performance standards in the rigours of a marine operating environment is our specialisation. Experience in supplying a full range of services from equipment supply only to full turnkey retrofit solutions, has established skills and a knowledge base covering the full range of needs in the ballast water market.

## THE DRIVER

The issue of the introduction of non-indigenous invasive species has been on the scientific horizon for several years. Many scientific studies have dealt with the environmental impact assessment of bio-invasions including research into the development of control, mitigation and combat strategies. In more recent years the issue of aquatic invasive species has received considerable attention and a strategy to address the problem has been developed. This has now been embodied in the 2004 IMO convention that calls for the management of ships' ballast water and sediments, as a means of addressing the issues associated with the ecological damage caused by the introduction of invasive species and the alleviation of the risk. This has originated from the recognition that ships' ballast water is a major and high-risk pathway for the transfer of aquatic species globally.

The long-term intent of the IMO convention is that all sea going ships designed to carry ballast water are fitted with ballast water treatment systems (BWT). This provides the means to deal with the aquatic organisms and pathogens that are carried in ballast water. In order to comply with the discharge standard stipulated in Regulation D-2, ballast water must be treated on uptake and/or discharge as applicable. The treatment mode is dictated by the disinfection process choice.

Scientific efforts and resources have focused onto the study of aquatic invasive species, their behaviour and the associated economic, environmental and human health impact. Globally many scientific marine and oceanographic institutes have focused their attention on the development of methods to evaluate the effectiveness of treatment technologies, sampling methodologies, formulation of appropriate test protocols, life viability and risk assessments.

The marine equipment sector on the other hand has focused its attention to the development of ballast water treatment equipment that meet the IMO convention, Regulation D2 discharge standard. Considerable R&D effort has been invested by the scientific community and technology companies. A number of sound technical solutions have been developed over the last few years and many ballast water treatment systems have been tested, certified and marketed.

## THE TECHNICAL CHALLENGE

Ballast Water treatment presents some significant technical challenges. BWT systems should be designed for installation on new build and existing vessels. The grand challenge is however related to the vast range of environmental and water conditions encountered globally. Water quality varies from location to location and is influenced by fresh water runoff, depth, seasonal variations, tides, temperature, wind direction and human activity (industrial and waste water effluents) to mention but a few factors.

**SUCCESS FACTORS**

It is therefore pertinent that BWT solutions recognise that

- ships operate globally where they encounter variable:
  - water quality
  - environmental conditions
  - salinity range from fresh to sea water (0 to 30+ PSU)
  - water temperature range 0°C to 30°C plus

The hardware design must

- be fit for purpose
  - safe and simple to operate
  - suitable for marine applications (e.g. vibration, humidity & temperature)
  - matching onboard constraints (both new build and retrofit)

**TECHNOLOGY LANDSCAPE**

In terms of technology there are a number of options as shown in Figure 1 below. In the majority of cases a two-stage approach to ballast water treatment is adopted where Stage-1 is a mechanical treatment step and Stage-2 comprises a physical or chemical treatment or a combination.

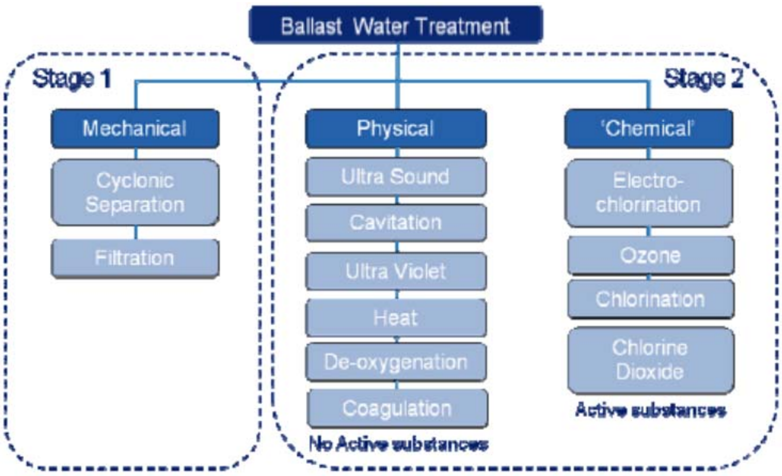



**Figure 1:** Technology Landscape

The IMO convention does not only call for ballast water management but also sediment management in accordance to Regulation B-5. The use of a filtration and/or separation treatment ensures the removal of sediments in addition to the elimination of large plankton and other particles suspended in ballast water. The resultant reduction in zoo- and phytoplankton density has the potential to reduce the burden on the disinfection treatment stage with obvious reductions in dose requirements (power and active substance demand).

No filtration or separation is an option. However, this allows uncontrollable uptake of organisms and sedimentary particles. Sediment build-up in ballast tanks provides a breading ground for microorganisms and bacteria that thrive in anaerobic conditions. Arguably no filtration or separation is against the spirit of the convention.

Separation systems using hydro-cyclones or cyclonic separation have been employed in some systems. Such devices introduce a high pressure drop in the piping system that frequently necessitates pump upgrade or installation of booster pumps, a CAPEX penalty. The separation efficiency is directly related to the flow rate and hence there is a limited scope to operate off design limits. Separation is undeniably dependent to particle density. In addition such devices operate with a fixed high percentage reflux and this directly impacts the duration of ballasting and hence OPEX.

Filters have an inherent flexibility to cater for varying loads. Back-washing or back-flushing filter types are well proven in the marine and offshore sectors. Filters offer a fixed 'screen' size and separation is based on particle size and not particle density. Back-flushing is activated according to screen cleanliness state and cleaning cycles are as long as conditions dictate. The use of filters as a Stage-1 process provides preconditioning treatment to the ballast water, removing suspended organic and inorganic matter and it is an essential step for any BWT making use of UV disinfection.

As shown in Figure 1, there are a number of methods that can be used as Stage-2 disinfection. Review of available systems indicates a polarisation in technology selection. The most popular disinfection processes are electro-chlorination and treatment based on low pressure or medium pressure UV, both combined with a Stage-1 treatment.

**HAMWORTHY AQUARIUS™**

AQUARIUS™ is the range of ballast water management systems (BWMS) developed by Hamworthy. It offers two distinct technical solutions as follows:


**AQUARIUS™-EC**, Figure 2. The system makes use of a two-stage approach. Stage-1 makes use of an automatic back washing filter. The filter removes particulates, sediments, zooplankton and phytoplankton over 40 micron. Automatic filter cleaning ensures and maintains filtration efficiency.

Stage-2 utilises the principle of side stream electrolysis to generate in situ the disinfectant. A small proportion of the ballast water (1-5%) of the total flow is diverted into the electrolysis unit where the specially designed electrolytic cells generate sodium hypochlorite from seawater. This side stream approach to electrolysis of seawater provides enhanced flexibility to the BWT system and allows the inclusion of design features to deal with the unfavourable conditions of low salinity and temperature. The low salinity condition is tackled by the use of a dedicated tank filled with seawater used to provide the feed water for the electrolysis system. Installation of a heat exchanger in the side stream enables the heating of the incoming feed water if required.

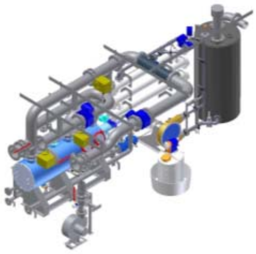


**Figure 2:** AQUARIUS™-EC Containerised Prototype

The sodium hypochlorite generated is pumped into the main ballast line, where it is mixed with filtered ballast water for efficient disinfection, and pumped into the ballast tanks. Ballast Water TRO concentration is monitored to ensure the correct hypochlorite dose. During discharge the filter is bypassed and residual concentration of TRO in treated ballast water is monitored before being discharged overboard.

If required, treated ballast water is neutralised by injecting sodium bisulphite into the main ballast line during discharge. Neutralisation effectiveness is continuously monitored to ensure compliance with MARPOL discharge limits.

AQUARIUS™-EC Features

Broad environmental operating envelope

Flexible side stream electrolysis configuration

- o No salinity limits
- o No temperature limits

In situ safe, sustainable and economical disinfectant generation

Efficient injection and dosing controls

Modular construction for

- o efficient use of space and power
- o easy integration with ship systems

Flexible up-scaling

Intelligent PLC control ensuring safe, automatic and economical operation

**AQUARIUS™-UV**, Figure 3. The system makes use of a two-stage approach. Stage-1 comprises an automatic back wash filter. During uptake ballast water passes through an automatic back washing filter. The filter removes particulates, sediments, zooplankton and phytoplankton over 40 micron. Automatic filter cleaning ensures and maintains filtration efficiency.
Filtered ballast water is directed into a disinfection chamber where medium pressure ultraviolet lamps, set in cross flow arrangement, deliver UV irradiation to achieve disinfection. Treated ballast water is then directed to the ballast tanks.

Lamps are fitted with an automatic wiper system, which prevents bio-fouling and controls the accumulation of deposits on lamp sleeves ensuring maximum performance at all times. UV light intensity is continuously monitored during system operation to ensure intensity is maintained and the desired dose for maximum treatment efficiency is achieved.

During discharge ballast water is pumped from the ballast tanks back through the UV disinfection chamber for final treatment before being discharged overboard. The filter is bypassed during discharge.

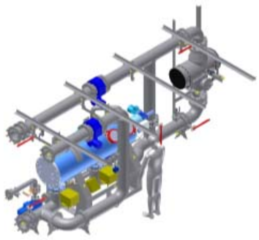


**Figure 3:** AQUARIUS™-UV Containerised Prototype

AQUARIUS™-UV Features

Broad environmental operating envelope

- o No salinity limits
- o No temperature limits

No minimum retention time

No active substances

Integrated antifouling control system (No CIP)

Modular construction for

- o efficient use of space and power
- o easy integration with ship systems

Flexible up-scaling

Intelligent PLC control ensuring safe, automatic and economical operation

**Typical module configurations**

**Figure 4:** AQUARIUS™ EC Assembly

**Figure 5:** AQUARIUS™ UV Assembly

**AQUARIUS™ offers the customer**

- Single source of supply with choice of technology
- Turnkey or equipment only supply
- Flexible up-scaling and adaptable installation/integration
- Intelligent control for safe and easy operation
- Low maintenance and life cycle costs
- Modular design with flow capacity to 6,000m3/hr (and higher)
- Optimised power and space utilisation

At Hamworthy, we pride ourselves in establishing strong partnerships with our customers. With over 30 years experience in marine water management, Hamworthy Water Systems are able to offer complete and comprehensive engineering support and technical expertise which cannot be rivalled by any other manufacturer.

With our ship profiling, evaluation and surveying capabilities together with system guidance and a choice of technology offerings, we are able to design a ballast water management system solution that meets your unique requirements.

Our engineering, installation and commissioning know-how, through life system support and worldwide technical support network ensures your confidence in us.

## 19 SUMMARY OF BALLAST WATER TREATMENT SYSTEMS

**Matej David,University of Ljubljana, Faculty of Maritime Studies and Transport**
**Stephan Gollasch, GoConsult**

### ABSTRACT
This contribution summarizes existing and developing ballast water treatment systems (BWTS). The diversity of systems is introduced by outlining the most common treatment technologies, range of treatment capacities and basic technical requirements. The availability of certified systems is also presented.

### INTRODUCTION
Ballast water management was addressed by the International Convention on the Management of Ships' Ballast Water and Sediments, London, 2004 (BWM Convention) (IMO, 2004). This instrument was prepared by the International Maritime Organization (IMO), the United Nations body to deal with shipping. The BWM Convention introduces two different protective regimes with a sequential implementation:

1. Ballast Water Exchange Standard (Regulation D-1) requiring ships to exchange a minimum of 95% ballast water volume;
2. Ballast Water Performance Standard (Regulation D-2) which requires that ballast water discharged has the number of viable organisms below specified limits.

*Regulation D-2 Ballast Water Performance Standard*

> *1 Ships conducting Ballast Water Management in accordance with this regulation shall discharge less than 10 viable organisms per cubic metre greater than or equal to 50 micrometres in minimum dimension and less than 10 viable organisms per millilitre less than 50 micrometres in minimum dimension and greater than or equal to 10 micrometres in minimum dimension; and discharge of the indicator microbes shall not exceed the specified concentrations described in paragraph 2.*
>
> *2 Indicator microbes, as a human health standard, shall include:*
>
> > *.1 Toxicogenic Vibrio cholerae (O1 and O139) with less than 1 colony forming unit (cfu) per 100 millilitres or less than 1 cfu per 1 gram (wet weight) zooplankton samples;*
> >
> > *.2 Escherichia coli less than 250 cfu per 100 millilitres;*
> >
> > *.3 Intestinal Enterococci less than 100 cfu per 100 milliliters.*

At present it is believed that the only way to achieve the discharge requirements of the D-2 standard is achievable with the installation of a ballast water treatment system (BWTS). The installation of BWTS triggers additional costs, and is not required as the BWM Convention is not yet into force. The BWM Convention will enter into force 12 months after the date on which not less than 30 States with combined merchant fleets of not less than 35% of the gross tonnage of the worlds' merchant shipping have either signed it without reservation. As reported on the IMO homepage, 30 States constituting 26,44 percent of the gross tonnage of the world merchant fleet have ratified the convention by 31 October 2011.[25]

The entry into force of the BWM Convention is an important driving force for ballast water treatment technology developments worldwide (David and Gollasch, 2008). As a result, it is expected that the development and implementation of these systems will now proceed at a greatly accelerated rate. The phase in of the D-2 standard was agreed at IMO according to ballast water capacity and ships age (see Figure 2).

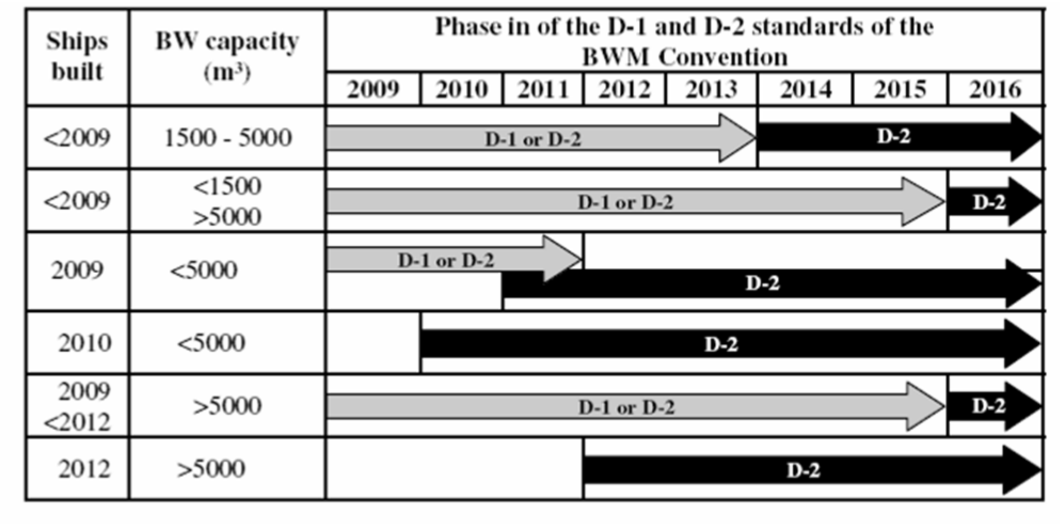



**Figure 2:** Phase-in of the ballast water performance standard (Regulation D-2) in relation to ballast water exchange standard (Regulation D-1) (Source David & Gollasch 2008).

#### BALLAST WATER TREATMENT SYSTEMS

There are many different treatment technologies available (Dobroski, et al. 2009, Gregg, et al. 2009 , ABS 2010, California State Lands Commission 2010, Lloyds Register 2011, Witherby Seamanship International 2011, authors experience in shipboard tests), and most of those were previously developed for municipal and other industrial applications. However, when applying those without modifications and improvements to the ballast water treatment purpose, none of these technologies have shown the capability to treat the ballast water to the level required by the BWM Convention D-2 standard.

Different manufacturers developed new systems to treat ballast water on vessels. By July 2011 information about 87 different systems was collected. Many of these systems are in the (early) development stage, hence information about some systems is limited or not available and therefore not included in other summaries of BWTS (Dobroski, et al. 2009, Gregg, et al. 2009, ABS 2010, California State Lands Commission 2010, Lloyds Register 2011, Witherby Seamanship International 2011).

#### BWTS TECHNOLOGIES AND THEIR APPLICATION ON VESSELS

Different vendors developed different BWTS combining different technologies. The systems (or part of these) are used in different stages of the ballasting process, i.e., at the uptake of ballast water, during the holding time of the ballast water in tanks during navigation, and/or at discharge.

---

[25] See www.imo.org, status of conventions.

Among the 87 manufacturers identified, 67 use some pre-treatment technology; 51 use filtration, others use different other methods to mechanically remove organisms or a combination of these as pre-treatment. As secondary treatment most systems (60) use some kind of an "Active Substance"[26]. The most frequently used active substance technique for treatment seems electrolysis/electrochlorination (25 systems), used as stand alone treatment method by 20 systems, or in combination with other techniques. In second place is UV (24 systems); and 16 of these systems use UV as the only treatment process, while 8 systems use UV in combination with one or more other techniques (i.e., $TiO_2$, ultrasound, ozonation, electrolysis, plasma). In total 20 BWTS use two or more treatment techniques in combination as the main treatment method, while 64 rely on one secondary treatment technique (no information for 3 BWTS).

### BWTS CAPACITIES AND INSTALLATION REQUIREMENTS

Different systems have different capacities and technical profiles, which are mainly related to the aspects of an appropriate capacity (i.e. flow rate) of the system related to the capacity of the ballast water system of a vessel, as well as the system footprint onboard and power consumption. System capacities range from 50 m3/h to more than 10.000 m3/h, while two manufacturers informed that their systems are (will be) able to treat 20.000 and more m3/h. In terms of footprint space requirements the systems could occupy from even less than 1 m2 and up 145 m2. Systems operate also with no electricity requirement, and others may consume up to 200 kW per 1000 m3/h.

### BWTS TESTING AND APPROVALS

All systems need to be type approved by a Flag state before being sold to a client. Systems that use Active Substances by the definition in the BWM Convention have to undergo a more thorough certification process and obtain Basic and Final Approval by IMO Marine Environment Protection Committee (MEPC). This process and the required data to show the environmental acceptability of such systems is described in the IMO G9 Guideline (IMO, 2005).

All systems are tested in a land-based setting with challenging water conditions, and at least three successful test cycles need to be undertaken onboard of commercial vessels to document the seaworthiness of the BWTS. These tests are addressed in the IMO G8 Guideline (IMO, 2008). At present systems are in different stages of testing and approval processes, while 16 were already type approved by different administrations.

### CONCLUSIONS

Currently it seems that the only possible method to meet the discharge requirements of the BWM Convention D-2 standard is by using a BWTS. The soon expected entry into force of the BWM Convention is an important driving force for treatment technology developments worldwide, hence after it enters into force, BWTS systems need to be installed on vessels.

There are many different treatment technologies available, however only a combination of different treatment technologies have shown the capability to treat the ballast water to the level required by the

[26] "Active Substance" means a substance or organism, including a virus or a fungus that has a general or specific action on or against Harmful Aquatic Organisms and Pathogens.

D-2 standard. Hence, vendors developed different BWTS combining different technologies as primary and secondary treatment.

Our review resulted in 87 BWTS manufacturers were identified. Most of the systems apply the treatment at the uptake of ballast water, and 39 systems treat the ballast water at uptake and discharge. In total 67 systems use pre-treatment technology (51 use filtration), others selected different methods or designed their BWTS with a combination of two or more pre-treatment steps. Most systems (60) make use of an active substance with the most frequently used technique being electrolysis/electrochlorination (25 systems). The second most commonly used technology is UV radiation (24 systems). The treatment capacities of most systems range from 50 m3/h to more than 10.000 m3/h. Two vendors announced a capacity of 20.000 m3/h and more. BWTS footprints occupy from even less than 1 m2 up to 145 m2 depending on their capacity and treatment technologies. Some BWTS operate with no electricity requirement, others may consume up to 200 kW per 1000 m3/ h.

All systems need to be type approved by a Flag state according to the IMO G8 Guideline before being sold to a client. In addition, BWTRS using Active Substances need to obtain Basic and Final Approval by IMO MEPC and the relevant procedure is described in the IMO G9 Guideline. At present systems are in different stages of testing and approval processes, while 16 completed the certification requirements and were already type approved by different administrations.

The BWM Convention is nearing the requirements of entry into force, hence this is prognosed for the year 2013. With this, BWTS production and shipyard capacities may become a challenge and possibly also a bottle neck to equip the more than 50,000 vessels (IMO, 2010) which may need to install such systems.

**ACKNOWLEDGEMENTS**

The research leading to these results has received funding from the European Community’s Seventh Framework Programme (FP7/2007-2013) under Grant Agreement No. 266445 for the project Vectors of Change in Oceans and Seas Marine Life, Impact on Economic Sectors (VECTORS).

**LITERATURE**

ABS (2010). Ballast Water Treatment Advisory. ABS, Houston, 48 pp.

California State Lands Commission (2010). Assessment of the Efficacy, Availability and Environmental Impacts of Ballast Water Treatment Systems for use in California Waters. 141 pp.

David, M., Gollasch, S. (2008). EU Shipping in the Dawn of Managing the Ballast Water Issue. *Mar. Pollut. Bull.*, vol. 56, no. 12, 1966-1972.

Dobroski, N., Scianni, C., Takata, L. & Falkner, M. (2009). October 2009 Update: Ballast Water Treatment Technologies for use in California Waters. Prepared By The California State Lands Commission, Marine Invasive Species Program. 19 pp.

Gregg, M., Rigby, G. & Hallegraeff, G.M. (2009). Review of two decades of progress in the development of management options for reducing or eradicating phytoplankton, zooplankton and bacteria in ship's ballast water. Aquatic Invasions, 4(3), 521-565.

IMO (2004). International Convention for the Control and Management of Ships' Ballast Water and Sediments. International Maritime Organization. 36 pp.

IMO (2005). Procedure for approval of ballast water management systems that make use of active substances (G9). International Maritime Organization. 14 pp.

IMO (2008). Guidelines for Approval of ballast water management systems (G8). International Maritime Organization. 28 pp.

IMO (2010). Information for examination and analysis of the applicable requirements for vessels described in regulation B-3.1, submitted by Japan to the Marine Environment Protection Committee, 61 session (MEPC 61/2/17), 23 July 2010. 4 pp.

Lloyds Register (2011). Ballast water treatment technology. Current status, June 2011. Lloyds Register, London. 18 pp.

Witherby Seamanship International (2011). Ballast Water Management 3rd Edition. Livingston, United Kingdom, 206 pp.

# 20 RETROFITTING: A CHALLENGE FOR OVER 60.000 SHIPS

## HOW TO SELECT AND INTEGRATE BALLAST-WATER-TREATMENT- SYSTEMS

**Gerd Hagemeister WINTER 3D-design**

**WINTER 3D-Design** in Luebeck, Germany -founded in 1968 – is specialised in engine room design for merchant ships, work ships, military ships and mega-yachts (the latter including decks-coordination).

It is unquestionable that BWT will be ratified by IMO. Since there will be an immense demand for retrofits we have already worked out procedures for the implementation of BWT-systems.

**WINTER 3D** did intensive studies on the various Ballast-Water-Treatment technologies, as there are:

*Mechanical:* Filtration, Cyclone separation, Electromechanical separation, Diaphragm filtration.
*Physical:* UV- treatment, Cavitation, Deoxygenation, Thermal treatment.
*Chemical:* Chemical biocides, Electrolytic chlorination, Active substances.
*Combinations* of the above treatment varieties.

Different situations on different ships require individual solutions for BWT.
**WINTER 3D** defined the procedure to find the suitable BWT system.

Aspects that have to be taken into account:

*Key aspects:* Shiptype, ballasting characteristics, trade aspects, BW- volume, flow rate requirements.
*Technical and operating aspects*: Time-interference with the regular operation, health and safety regulations, explosion protection, energy consumption, control and warning instruments, available space.
*Supplier selection:* Status of type approval, technical aspects, commercial conditions, experience with familiar suppliers.
*Work and risk estimation:* Smaller or bigger changes in engine rooms, system position outside of engine room (cargo deck etc.), engine room extension, pressure drop calculations, additional generator.
*Installation planning:* During dry docking, during ship operation.

**WINTER 3D** worked out an overview over the manufacturers:

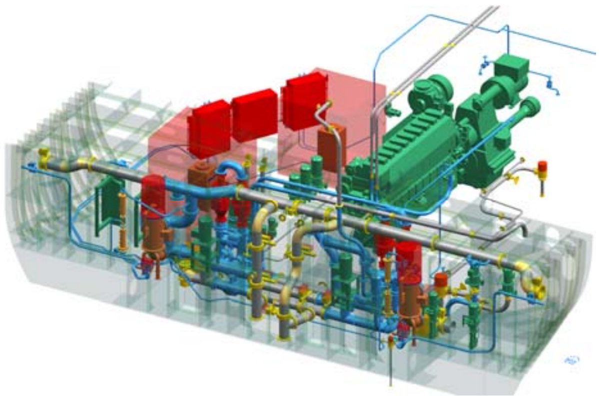
- approximately 14 manufacturers with type approval (September 2011)
- overall more than 40 manufacturers (including those without type approval)

The following theoretical retrofit samples show the complex procedure of implementation:

a) Installation planning <u>with</u> existing 3D design (UG NX and AC- Plant designer):

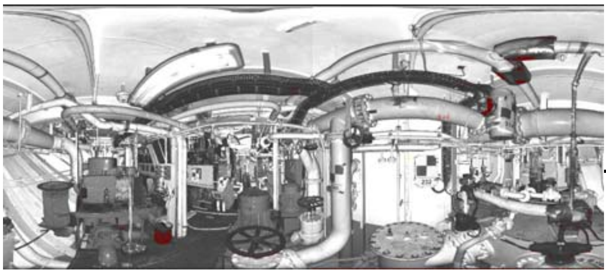
Filtration-cavitation-ozone, Filtration- UV, Filter- chemical, each of them for:

- MPV 6100 tdw with space reserve in engine room
- CV 900 TEU without space reserve

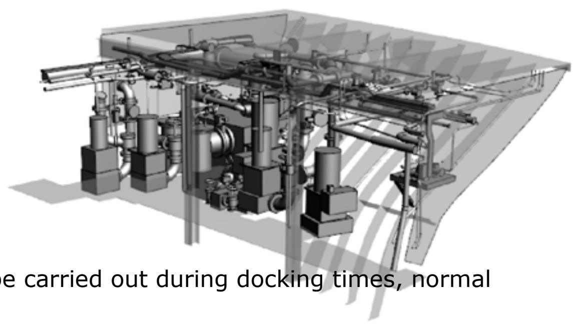


The Implementation into Ballast-Water diagrams and ER- arrangement plans are quite easy. The real challenge is to fit the equipment into the packed and space optimized engine rooms of existing vessels.

b) Installation planning without existing 3D design requires in addition:
As-built-documentation: Measurements and/ or Laserscanning generating 2D or 3D documentation during docking times, channel passages, normal trade or off- hire.



→



It has to be balanced weather installation should be carried out during docking times, normal trade or off- hire.

Summary:

To minimize risks, costs and disturbance of operating time it is necessary to prepare a detailed plan for retrofitting, including:

As-Built-documentation, installation plans for class approvals, energy balance, connections from sea cooling water lines and BW-lines, foundation drawings, pipe work and electrical integration.

Many ship owners underestimate the complexity, time and expenditure of such a project.
Due to limited time for the installation, limited equipment manufacturers, limited repair ship yards and a huge amount of ships there is no time to be wasted.
With 60.000 ships to be refitted within 6 years by 20 suppliers, each of them would have to deliver and install 1 BWT every other week.

## 21 BALLAST WATER TREATMENT – A SHIP-OWNER'S PERSPECTIVE

**Bart Boosman, Wagenborg Shipping**

Wagenborg owns a fleet of General Cargo Vessels, ranging from about 1800 to 20.000 ton deadweight. Implementing the BWMC will have a massive impact for ship-owners. Surviving in the present market means cost-cutting and the BWMC will not help in that respect. Nevertheless, Wagenborg started at an early stage to explore the treats, challenges and possibilities for the about 200 ships involved.

Shipping is a truly global affair! Therefore a uniform approach is needed and regulations should be globally accepted. New rules and regulations should apply to all parties involved to maintain the level playing field. On top of that, new rules and regulations should also have a realistic time frame. This is getting close now.

The best platform for development of rules and regulations is the IMO. Unfortunately, outside IMO also some organisations will make their own rules, like the US Coast Guard, the European Union and others. This patchwork of regulations is a nightmare and serious threat for ship-owners, willing to comply to the rules. All sorts of local regulations deviating from any international standard should be banned.

Therefore, Wagenborg hopes the BWT convention will be ratified soonest, and that adoption of the Convention will lead to an immediate end of the current plethora of 'local' regulations. The situation in the USA is particularly confusing; we still look forward to hear final legislation from the USA. We sincerely hope the US federal law, USCG and State laws can be combined and aligned with the present IMO BWMC standard.

Although the Convention is quite clear in most respects, we still see a number of open-ended issues that need to be resolved quickly:

- What if a vessel spends its entire life within a single biological zone (North Sea, Baltic, etcetera)?
  For a ship owner it is generally impossible to get permission for a short time (2 years?) only.
- A unified format in which to present the BWT data to PSC. Treatment manufacturers and PSC should work together on this issue. A CSN-file is not acceptable.

So far, the number of treatment units approved according to the Convention has steadily increased. As a consequence, prices have fallen dramatically compared to only a few years ago. This may change once the convention is ratified and deadlines are approaching, due to an increased demand and lack of production facility and yard capacity.

But this is not the only consideration. Not all treatment units are suitable for all applications. Considerations have to include:

- Fresh water operations (Great Lakes)
- Operations in ice conditions
- Operations in severely muddy conditions (e.g. tidal rivers)
- Acceptance of chemicals; risks for crew etc.

- Limitations on electrical power
- Limitations on space
- etcetera

It may be worth accepting less ballast pump capacity in order to save on treatment unit dimensions, consumption and/or investment.

**SHIP OWNERS: DO YOUR HOMEWORK!**

# 22 DECISION MATRIX BWTS

**Lourens van Fraeyenhove, Levien Faasse, Information Centre Sustainable Shortsea Shipping**

### Introduction

Two students of the Maritime Institute De Ruyter in Flushing developed a decision matrix as part of the study in the project for the Information Centre Sustainable Shortsea Shipping. For shipowners with a small staff, the BWMC can become a nightmare in terms of strategic decisions. In those cases, a decision matrix might be a helpful tool for a ship-owner to come from a long-list of potential all ballast water management systems (BWMS) suppliers to a short list of suitable systems.

### Why a decision matrix?

At this moment there is a large variety of ballast water management systems. There are over 51 systems. Some are already approved, and others are still waiting to be approved. But to make a choice for a system that suits with the ship and meets all the requirements of the shipping company is not so easy. This is why the NIOZ asked us to make a decision matrix, which makes a shortlist out of the entire list of systems.

### How is the decision matrix established?

In order to make the ballast matrix we had to do a lot of research. We needed to know what the requirements are for the shipping companies and what the manufactures of ballast water treatment systems could provide, because they are the ones ordering the systems. So we called 20 shipping companies to ask them what there criteria where.

The second step was to collect the criteria, which the shipping companies mentioned, of the BWTS. To do this we sent an E-mail to the manufactures with the question if they could sent us the information about their system. The information we requested consisted things such as capacity, footprint, required power, etc.

With the criteria from the shipping companies and the specifications of the manufactures we were able to make a decision matrix. With the criteria what the shipping companies founded most important and with the specifications of the manufactures we could make a good estimate of the variables in the systems to make sure the long list will become a shortlist at the end of the matrix.

### Working of the decision matrix

During the presentation we give some examples how the decision matrix works. So after the presentation it will be clear how the matrix works .

The date of publication of the decision matrix has not been made yet, but if you regularly contact the website www.NorthSeaBallast.eu we expect the programme will be available soon.

www.duurzaamschip.nl

## APPENDIX I: QUESTIONS AND ANSWERS FROM PANEL DISCUSSIONS BOTH DAYS

Q: Will there be sufficient systems available for all ships at ratification?
The general feeling is that there are a different sorts of systems for all applications available at the moment. Production numbers are still unknown, but the market will pick-up very quick when necessary. A bottle neck might be the availability of yard capacity. 3D Mapping and proper preparation might be helpful in this respect.

Q: Are there many systems installed already?
A: It is not very clear how much installations have been installed so far. One ship owner indicates that they will install systems on all their new-buildings. Manufacturers have the impression that most ship owners are slowly catching up.

Q: Do systems have to be explosion proof?
A manufacturer indicates that explosion proof is not a problem.

Q: For large vessels there are no solutions yet. Will the date of implementation change accordingly?
A: There are as yet no new rules made for the large vessels to be built after 2012; it is not clear whether this will be done in the future. The dates for larger vessels will not change as there are sufficient suitable treatment systems available.

Q: Is there harmonisation amongst the classification societies?
A: There is not yet harmonisation between class societies, but there is an intention to achieve further harmonisation in the near future. Further details are not available at the moment.

Q: Do ballast water tanks have to be cleaned at installation of a BWT system?
A: Although it is at present not required to clean or strip ballast water tanks before a BWTS is installed on a vessel it is highly advisable for your own safety.

Q: Is there information about Basic- and Final approvals of BWT systems?
A: All the information of the GESAMP-BWWG is available at the respective national administrations, including the advice on approval to MEPC.

Q: Do new-building vessels have to comply with the BWMC already?
A: Once the BWMC is ratified, vessels have to comply with the rules accordingly. This also includes new-buildings and ships that are going to be built in the near future, regardless the date of ratification. There is no period of grace as such.
The national administration and Port State Control will check the vessels. When they do not comply, those parties have to decide how to act and on which grounds.

Q: Will it be helpful to design ships with a specific ballast water capacity?
A: The ultimate solution will be a ship without ballast water. However, this does not seem to be very realistic yet. But it might be helpful to reduce the capacity to less than 5000 m3.
Q: If gey water is stored in ballast water tanks, does this have to comply to the BWMC?
A: If grey water is stored in ballast tanks, the water at discharge had to comply with the D2 standard, although it is not stated as such anywhere.

Q: Are there rules for the use of ultrasonic devices?
A: Noise pollution, although not generally known to be a potential side effect of BWTS, should be taken into account as well. Marine pollution can also be caused by discharging energy into the environment (Convention for Law of the Sea), hence ultrasound should be considered for environmental acceptability.

Q: Is there a tool for ship owners to assist with applications for exemptions?
A: BSH works out under OSPAR and HELCOM a tool which helps to identify risks between specified ports. This might be helpful in the future as decision tool for instance for exemptions. It gives an indication of comparable water as to ecological conditions.

Q: Is there a simple programme that calculates when a particular vessel has to comply?
A: This is not developed yet, but might be an idea for the NSBWO project. Further reference is made to the decision matrix on BWM systems from the Information centre sustainable short sea shipping. One should always check for what purpose one needs a certified system. When calling at harbours that have a high load of suspended sediment in the water, you need to know whether your system can cope.

Q: Will the BWMC be changed at short notice and do we than need other equipment?
A: The BWMC is not a living document, as was a concern of ship owners. Only if the Convention has entered into force this can be amended. This is a time-consuming process, as it requires a political decision trajectory. It is important to check what needs to be adapted and when. Convention itself is not a living document. The Annexes are more flexible when scientific developments so indicate. Also after gaining experience, BWT systems may need updates after a certain period.

Q: Will there be different regimes in the United States of America?
A: Some U.S. States develop their own BW requirements, which are stricter than the IMO standards, for instance Michigan and New York. For ship owners in particular it is important to check what all U.S. States and possibly other countries are doing at present.

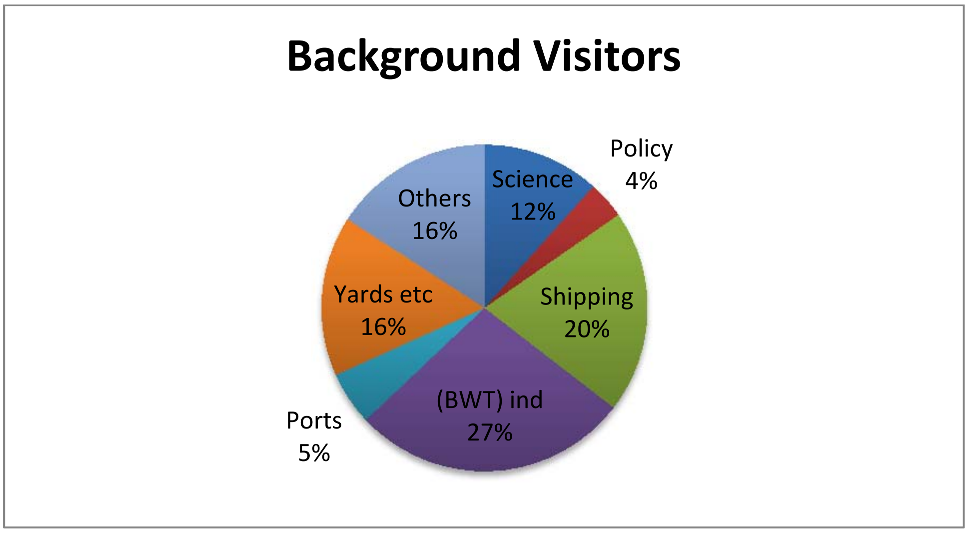
Q: After a while on board, can re-growth happen in ballast water tanks?
A: The regrowth of organisms has been observed after treatment with BWTS in testing conditions and in the laboratory. Survivars are mainly the so called "hard bugs". Cato ten Hallers notes that, once a BW discharge has entered the natural aquatic environment, the conditions may be quite different from those in a ballast water tank, where it is dark and no nutrients are available. Most organisms die during a long trip, especially with anoxic conditions in a ballast water tank, while it depends on the conditions in the BW receiving environment whether the few organisms that survive can regrow. The regrowth behaviour in a discharge environment needs further research.

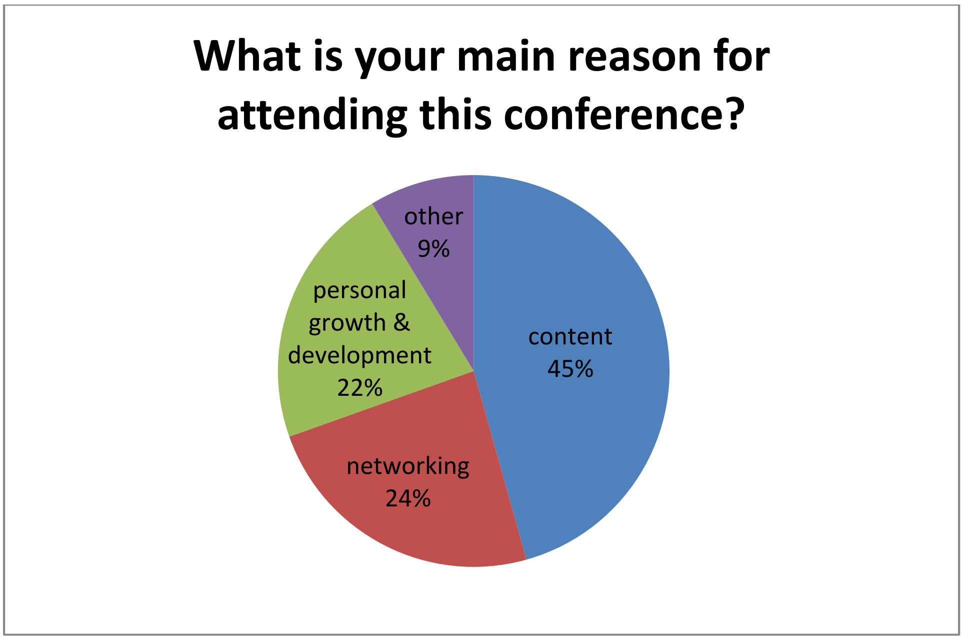
Q: If a ship is found non-compliant, will it be detained?

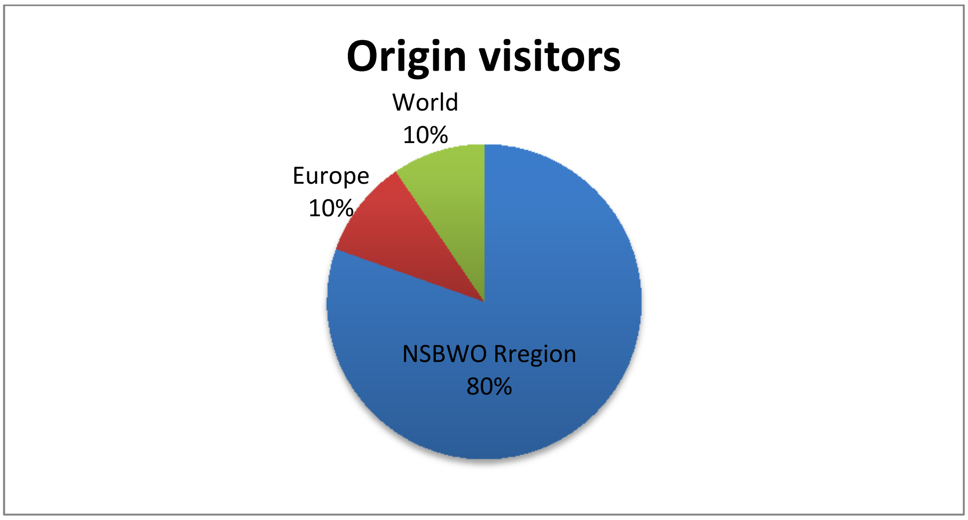
A: EMSA indicates that when a ship is not in compliance, it is not allowed to discharge, but it is allowed to leave port. Harmonisation between ports states is needed as well, so as to prevent that a ship is in compliance in one harbour, and yet fails in another.
Q: Can ships be exempted from BWT systems?
A: Dick Brus explains that when ships only travel one route, there is potential for exemptions, for instance for ferries. In particular in regions like the North Sea. Several national administrations do investigating what expemption strategy would be feasible. Worldwide such is not the case yet.

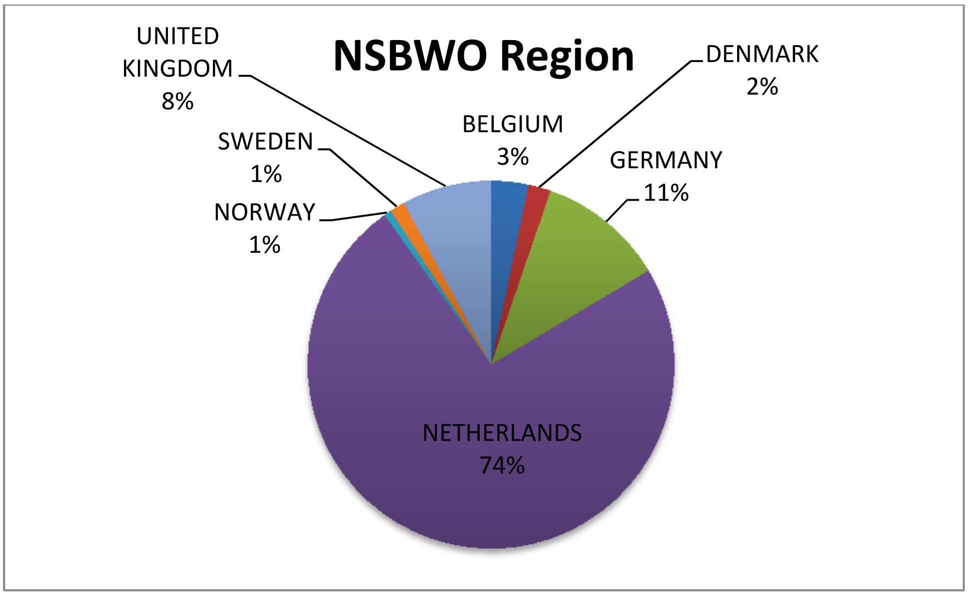
Q: Will it help to rus a system at maximum capacity?
A: To the question whether it would be a problem if a ship owner would overdose a BWTS, to be on the safe side, and if so, how this can be controlled. Eleonora Panella replied that Port State control is still in progress, and has not yet made decisive statements. She recognised the relevance of such issue. Cato ten Hallers then added that, once a system is certified, one has to dose as specified in the certificate, otherwise one uses a new system with a deviating dose and would hence need a new type approval certificate.

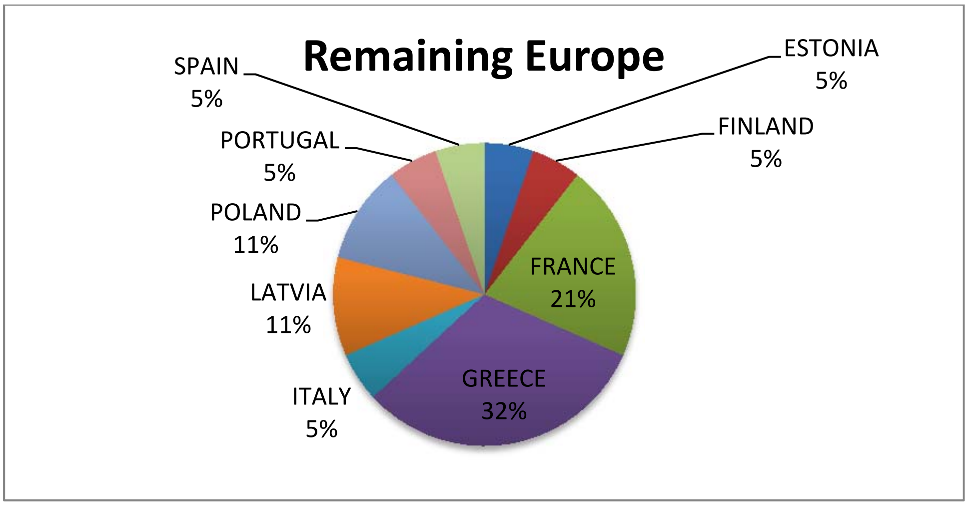
## APPENDIX II: TO EXECUTIVE SUMMARY

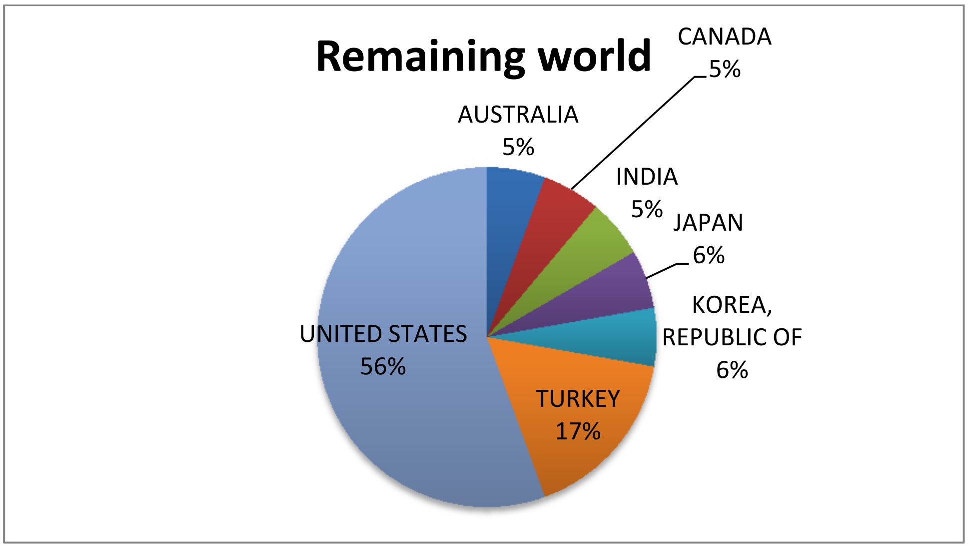



Origin visitors
World
10%
Europe
10%
NSBWO Rregion
80%


NSBWO Region
UNITED
KINGDOM
8%
DENMARK
2%
BELGIUM
3%
SWEDEN
1%
GERMANY
11%
NORWAY
1%
NETHERLANDS
74%


Remaining Europe
SPAIN
5%
ESTONIA
5%
PORTUGAL
5%
FINLAND
5%
POLAND
11%
FRANCE
21%
LATVIA
11%
GREECE
32%
ITALY
5%


Remaining world
CANADA
5%
AUSTRALIA
5%
INDIA
5%
JAPAN
6%
KOREA,
REPUBLIC OF
6%
UNITED STATES
56%
TURKEY
17%

## APPENDIX III: QUESTION AND TOPICS WHICH, IF APPROPRIATE, SPEAKERS MAY WISH TO ADDRESS OR COMMENT UPON IN THEIR PRESENTATIONS

This is in random order

- Indicate how your aims/work/expertise/organisation relate to the context of the North Sea Ballast Water Opportunity project.
- Demarcate what really matters and what is not, although sometimes assumed to be (such as ‘fairy tales’).
- Guidance to help replacing the present feeling of insecurity on the BWMC and its implementation into curiosity about what more is going on/is or will become available/present and future options and windows of opportunities.
- Options you may have identified for enhancing progress in the process of implementing the BWMC, or for enhancing the process itself.
- Clarity about the responsibilities in implementing the BWMC from your perspective.
- If a window of access to your expertise would be relevant, views on what window that would be, where to found and how best/most easily accessed.
- Views on optimising communication between your field of expertise/perspective and the shipping world
- Views on the future of your work in relation to the NSBWO project and beyond.

## APPENDIX IV: PARTICIPANTS LIST

| First Name | Last Name | Company |
|---|---|---|
| **Rutger** | Aalders | Damen Shipyards Bergum |
| **Nadia** | Abboud | Severn Trent Services |
| **Benoit** | Adam | federal public service mobility and transport |
| **Ahmet** | ALKAN | Gesad |
| **Kaspar** | Anderson | Ministry of the Environment |
| **Felicia** | Arenoe | NIOZ |
| **Vincent** | Avontuur | Bureau Veritas |
| **Gabriel** | Baes | SBM Offshore |
| **Goran** | Bakalar | MH Systems |
| **Serdar** | Bal | SafeTMade Marine Product LtCo. |
| **Jurrien** | Baretta | Goltens Green Technologies |
| **Roger** | Bernat | AZUD |
| **Soner** | Bicer | BETA ENGINEERING LTD. |
| **Alicja** | Biliñska | NIOZ / Evers + Manders Subsidieadviseurs BV |
| **Vidjay** | Birdja | Magneto special anodes |
| **René** | Bonhof | J.Bekkers Co. B.V. |
| **Jan** | Boon | NIOZ |
| **Bart** | Boosman | Wagenborg Shipping B.V. |
| **Natasja** | Bouman | Defence Materiel Organisation |
| **Dick** | Brus | Ministry of Infrastructure an the Environment |
| **Etienne** | Brutel De La Rivière | Flemano BV |
| **Willem** | Buijs | Kronios / Hatenboer-Water BV |
| **Valerio** | Cardetta | Filtrex |
| **Charlene** | Ceresola | BIO-UV |
| **Ole** | Christensen | Bawat |
| **James** | Clarkson | Hamworthy |
| **Bill** | Cochrane | Riviera Maritime Media |
| **Martin** | Conway | Royal Institution of Naval Architects |
| **Jg** | Copier | Min. v. Defensie |
| **John** | Dahlkvist | Grontmij Marine |
| **Maurice** | De Gier | MacArtney Benelux BV |
| **Mark** | De Lange | Cofely West Industrie bv |
| **Marten** | De Vries | KNVTS |
| **Joris** | De Weert | Ovizio Imaging Systems |
| **Rob** | Den Heijer | Green Award |
| **Andy** | Dittmer | Mariso |
| **Leonard** | Dobber | HAL |
| **Holger** | Elies | OPTIMARIN AS |
| **Emmanuel Makia** | Etongo | Nature group plc |
| **Michael** | Evans | Wilhelmsen Technical Solutions |
| **Michael** | Evans | Wilhelmsen Technical Solutions |

| | | |
|---|---|---|
| **Levien** | Faasse | Maritiem Instituut de ruyter |
| **Hans** | Flipsen | Evers + Manders Subsidiadviseurs |
| | Fredriksson | Marine Safety Consultancy |
| **Henrik** | Friedenberger | RWO GmbH - Marine Water Technology |
| **Frank** | Fuhr | KiTe Aquatic Resources Consulting |
| **Eveline** | Garritsen | NIOZ |
| **Ingrid** | Gerards | Ship Building |
| **Jo** | Giles | Riviera Maritime Media |
| **ROBIN** | GOATLEY | ADMANTHOS |
| **Stephan** | Gollasch | GoConsult |
| **Lenze** | Grooten | Van Oord |
| **Rinus** | Haakman | Dockwise B.V. |
| **Gerd** | Hagemeister | WINTER 3D-Konstruktions GmbH |
| | Hahn | MAHLE Industriefiltration GmbH |
| **Ernst Roger** | Halvorsen | Ditech as |
| **Margriet** | Hartman | Royal Haskoning |
| | Harts | MIR |
| **Anne** | Hazelzet | Alfa Laval Benelux BV |
| **Jos** | Heuvelmans | Boskalis |
| | Hoek | Holland Ship Service |
| **Gunter** | Höffer | HEAT Nord GmbH |
| **Mari-Helena** | Hoikka | Lloyd's Register EMEA |
| **Jes** | Hojlund | MacArtney |
| **Kees** | Hoogendijk | Hoogendijk Scheepselectro BV |
| **Dirk** | Hoogendijk | Hoogendijk Scheepselectro |
| **David** | Hughes | Magneto special anodes |
| **Jan** | Hummer | Bawat |
| **Pieter** | Huyskens | Damen Shipyards |
| **Eva** | Immler | NIOZ |
| **Akshay** | Jain | Vedam Design & Technical Consultancy Pvt Ltd |
| | Janssen | Allseas Engineering BV |
| **Leon** | Janssen | bestUV |
| **Roelof** | Jorritsma | Bright Spark BV |
| **Stefan** | Kacan | Fed. Maritime and Hydrographic Agency |
| **Johann** | Kasten | ITC Management B.V |
| **Erik** | Keurntjes | MAGNETO special anodes B.V. |
| **Marcel** | Kints | MacArtney Benelux BV |
| | Klaassen | Siemens Nederland |
| | Klasens | Koninklijke Wagenborg |
| **Gert** | Kleijer | All Pumps Holland BV |
| **Stefan** | Kools | Grontmij (AquaSense) |
| | Krull | Hyde Marine |
| **Ellen** | Kuipers | Waddenvereniging |
| **Gray** | Kurosawa | Port Enterprise Co., Ltd. |
| **Stelios** | Kyriacou | Hamworthy |
| **Ludovic** | Laffineur | Royal Belgian Shipowners Association |

| | | |
|---|---|---|
| **Réjean** | Lanteigne | Laurentian Pilotage Authority |
| **Haechang** | Lee | JETRO SEOUL |
| **Jeong** | Lee | KLC MARINE |
| **Viola** | Liebich | NIOZ |
| **Jan** | Linders | private |
| **Ellen** | Loeven | Huisman Itrec |
| **Alex** | Loudon | Guido Perla & Associates, Inc. |
| **François-Xavier** | Louis | Dragages-Ports |
| **Piet** | Luijk | Haven Amsterdam |
| **Tjitse** | Lupgens | Lloyds Register |
| | Mackey | Hyde Marine |
| **Kamila** | Malek | RMS Duisburg |
| **Austra** | Mangusa | LATVIAN MARITIME ACADEMY |
| **Nikolaos** | Marantidis | Siemens Nederland N.V. Bruinhof Marine |
| **Andrew** | Marshall | Coldharbour Marine Ltd |
| **Jolanda** | Matthijssen | Cofely West Industrie BV |
| **Billy** | Mccracken | Ruysch Technical Agencies Holland BV |
| **Juergen** | Meier | Evonik Industries AG |
| **Gabriela** | Misiak | Jaga Consultancy |
| **Jekaterina** | Mjackova | Latvian Maritime academy |
| **Teresa** | Monzon | Gemeentelijk Havenbedrijf Antwerpen |
| **Kishore** | Navani | Baird Publications |
| **ERNESTO** | NIARCHOS | DAMEN SCHELDE HELLAS |
| **Alexandros** | Niarchos | Damen Schelde Marine Services |
| **Xander** | Nienhuis | NHL Hogeschool |
| **Rob** | Noordam | Defensie Materieel Organisatie |
| **Killian** | O'Brien | Academy of European Law |
| **Lars** | Olsson | Wärtsilä Water Solutions |
| | Overgaauw | N-Sea |
| **John** | Paine | A&P GROUP |
| **Eleonora** | Panella | emsa |
| **Daniel** | Park | Panasia |
| **Ilias** | Patoucheas | SIEMENS AE |
| **Gillian** | Peden | Ruysch Technical Agencies Holland BV |
| **Louis** | Peperzak | NIOZ |
| **Tom** | Perlich | Ecochlor Inc. |
| **Dario** | Pirjak | Atlanship |
| **Jan-Willem** | Ploeg | Management Facilities Group |
| **Maurits** | Prinssen | Port of Rotterdam |
| **Amy** | Qu | Ruysch Technical Agencies Holland BV |
| **Ramon** | Ranschaert | offshore |
| **Karin** | Ree | University of Groningen |
| **Geert Jan** | Reinders | Groningen Seaports |
| **Christian** | Robeson | Bureau Veritas |
| **Martin** | Rotbarth | HEAT Nord GmbH |
| **Bäckman** | Rotork Sweden AB | GM |

| | | |
|---|---|---|
| **Leo** | Salazar | Blue Fish Chemicals & Consultants |
| **Douglas** | Schneider | World Shipping Council |
| **Matthijs** | Schuiten | Damen Shipyards |
| **Peter** | Sintmaartensdijk | jhp metaal |
| **Andre** | Smit | NIOZ |
| **Panos** | Smyroglou | COLDHARBOUR MARINE LTD |
| **Andrea** | Sneekes | IMARES, Wageningen UR |
| **Josje** | Snoek | NIOZ |
| | Stamidis | SIEMENS GREECE |
| **Konstantinos** | Stampedakis | ERMA FIRST |
| **Peter Paul** | Stehouwer | NIOZ |
| **Gregor** | Struzik | RMS Duisburg |
| **Michael** | Stuhr | MAHLE Industriefiltration GmbH |
| **Maurice** | Tax | Bright Spark |
| **Cato C.** | Ten Hallers-Tjabbes | NIOZ/CaTO Marine Ecosystems |
| **Zunino** | Thomas | BioUV |
| **Joe** | Thomas | Hamworthy Water Systems Ltd |
| **Jan** | Tilman | Van Oord Dredging & Marine Contractors |
| **Klaas** | Timmermans | NIOZ |
| | Todd | Hyde Marine |
| **Kai** | Truempler | Federal Maritime and Hydrographic Agency |
| **Stephen** | Valentine | IHS Fairplay |
| **Mathijs** | Van De Ketterij | Kotug Int. |
| **Peter** | Van Den Dries | Havenbedrijf Antwerpen |
| **Johann Van Der** | Van Der Geest | JB van der Geest Groningen BV |
| **Tom** | Van Der Have | Food and Consumer Goods Safety |
| **Leonard** | Van Der Kaaden | Huisman Equipment |
| **Ruurd** | Van Der Meer | NIOZ/Universitiy of Groningen |
| **Isabel** | Van Der Star | NIOZ |
| **Welmoed** | Van Der Vegt | KooleTanktransport B.V. |
| **Lourens** | Van Fraeijenhove | Maritiem Instituut de ruyter |
| **Sjors** | Van Gaalen | bestUV |
| **Ron** | Van Gelder | Port of Rotterdam Authority |
| **Edward** | Van Kesteren | Arnesco BV |
| **Lies** | Van Nieuwerburgh | Royal Haskoning |
| | Van Noordt | Management Facilities Group |
| **Jan** | Van Overloop | Marship Engineering |
| **Martijn** | Van Poppelen | Koole Tanktransport BV |
| | Van Schellen | maritime Instituut De Ruyter |
| **Cees** | Van Slooten | NIOZ |
| **Jan** | Van Soest | Jumbo shipping |
| **Bram** | Van Weerdenburg | CytoBuoy b.v. |
| **Dirk** | Vandermeersch | Abis Shipping |
| **Marcel** | Veldhuis | MES |
| **Eija** | Velin | University of Turku, Centre for Maritime studies |

| | | |
|---|---|---|
| **Peter** | Velthuis | Velthuis |
| **Ton** | Verwijmeren | Koole Tank Transport |
| **Marieke** | Vloemans | NIOZ |
| **Matthias** | Voigt | Cathelco GmbH |
| **Theo** | Vollaard | Atlantic Marine and Offfshore |
| **Jan** | Voulon | Havenbedrijf Rotterdam |
| | Weiss | Hyde Marine |
| **Mark** | Wells | Coldharbour Marine Ltd |
| **Roel** | Werkman | Scheepvaart |
| **Renate** | Westendorf | havenbedrijf |
| **Jaap** | Witte | Nioz |
| **Andreas** | Zink | Institute for Environmental and Technology Law, University of Trier |

## APPENDIX V: PROGRAMME

**BWM policies: implementation and what the maritime world is facing**

Tuesday November 8, 2011 (13:00 – 17:45)

| | | | |
|---|---|---|---|
| 1. | Dick Brus | Ministry of Infrastructure and the Environment | Introduction |
| 2. | Kai Trümpler | Federal Maritime and Hydrographic Agency (BSH) | Obligations of the BWMC and consequences for ships |
| 3. | Doug Schneider | World Shipping Council | Understanding the United States Ballast Water Regulations & Requirements |
| 4. | Killian O'Brien | Academy of European law, Trier | The Phasing-In and Application of Certain Standards regarding obligatory BWM systems on board ships |
| 5. | Tjiste Lupgens | Lloyd's Register | BWMS Certification; type approval. The process and the role of Class |
| 6. | Jurrien Baretta | Goltens Green Technologies | Ballast Water Management Systems on Ship-board - Challenges in installation |
| 7. | Jan Linders | GESAMP-BWWG chairman | Environmental Acceptability under Procedure (G9) |
| 8. | Cato ten Hallers | CaTO Marine Ecosystems | Environmental Acceptability (G8) |
| 9. | Eleonora Panella | European Maritime Safety Agency (EMSA) | Harmonization in compliance control; what does it entail: regulations and responsibility |

**Implementing the BWM Convention; what are the options and how could it be facilitated**

Wednesday November 9, 2011 (10:30 – 15:30)

| | | | |
|---|---|---|---|
| 10. | Jan Boon | NIOZ | Introduction |
| 11. | Ruurd van der Meer | Groningen University | Review of the ballast water issue |
| 12. | Ballast Water Treatment Systems - different technologies | | |
| a. | Thomas Mackey | Hyde Marine | UV-system, medium pressure |
| b. | Konstantinos Stampedakis | Erma First | Electro-chlorination with hydrocyclone |
| c. | Nadia Abboud | Severn Trent De Nora | Hydro-chlorine system |
| d. | Andrew Marshall | Cold Harbour | Inert gas system |
| e. | Tom Perlich | Ecochlor | Chlorine-Dioxide system |
| f. | Birger Hahn | Mahle | UV-system, low pressure |
| g. | Stelios Kyriacou | Hamworthy | UV-system, medium pressure and Electro-chlorination system |
| 13. | Stephan Gollash | GoConsult | Summary of Ballast Water Treatment Systems |
| 14. | Gerd Hagemeister | Winter 3D design | Retrofitting: a challenge for over 60.000 ships |
| 15. | Bart Boosman | Wagenborg Shipping | Experience from a ship owner |
| 16. | Laurens van Fraeyenhove & Levien Faasse | Information centre sustainable short sea shipping | Decision Matrix on BWM Systems |

North Sea Ballast Water

European Union The European Regional Development Fund

The Interreg IVB North Sea Region Programme

*Investing in the future by working together for a sustainable and competitive region*