Ballast Water Management

With Owner’s Perspective

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Why Ballast Water Management?

- ***Shipping moves over 80% of the world's commodities***
- ***Transfers approximately three to five billion tonnes of ballast water internationally every year.***
- ***Ballast water also poses a serious ecological, economic and health threat through the transfer of invasive aquatic species inadvertently carried in it.***

Background – Ballast Water Management

- ***BWM will enter into force on 8th September 2017.***
- ***As of 25th March 2017, there are 54 Contracting States to the Convention representing 53.4% of the world's global tonnage.***
- ***The United States (US) is not a State Party to the Convention.***
- ***The USCG testing standards have been considered more robust than IMO Guidelines for the approval of BWM systems.***

IMO BWM Convention

- ✧ ***All ships will have to carry a ballast water record book and an international BWM certificate.***

- ✧ ***Eventually, most ships will need to install BWTS by first renewal of (IOPP) certificate after the Convention enters into force on 8th September 2017 (as prescribed in IMO Assembly Resolution A.1088 (28)).***

- ✧ ***After EIF, ships' Ballast Water Record Books must record all relevant information related to ballasting/deballasting operation.***

IMO Approval of Ballast Water Management Systems

- ***During the Convention development process, considerable efforts were made to formulate appropriate standards for BWM, namely the D-1 and D-2 standard.***

- ***For D-1, Ships performing ballast water exchange are required with an efficiency of 95 per cent volumetric exchange and,***

- ***Ships using a BWM system are required to meet the D-2 standard that sets agreed maximum numbers of viable organisms by size per unit of volume that may be discharged in a ships' ballast water when a ship is de-ballasting.***

- ***The IMO comprehensively revised the G8 Guidelines at the MEPC 70 meeting in October 2016.***

- ***Ship-owners installed BWM system before 28th October 2016 will not be required to replace them that is approved in accordance with the previous 2016 G8 Guidelines.***

- ***Ship-owners who install a BWM system between 8th September 2017 and 28th October 2020 can install either the previous version of the G8 Guidelines or the updated 2016 G8 Guidelines.***

- ***However, ship-owners who install a BWM system after 28th October 2020 will have to install a system approved in accordance with the 2016 G8 Guidelines.***

USCG BWM Regulations

The USCG amended its Regulations on BWM in March 2012 to manage ballast in one of the following ways:

- ***A US type approved BWM;***
- ***Temporary use of BWMS accepted by the Coast Guard as an alternate management system (AMS)(5-year limitation);***
- ***Use and discharge ballast water obtained exclusively from a US public water system;***
- ***Discharge of ballast water to a reception facility, and***
- ***No discharge of unmanaged ballast water inside 12 nm***

- ***On 2nd December 2016, the USCG announced the approval of the first USCG type approved BWM system, Optimarin's BWM system.***

- ***On 23rd December 2016, two more BWM systems: Alfa Laval's Pure Ballast 3 and Ocean Saver's MKII.***

- ***All three systems also have IMO type approval.***

- ***The USCG have advised that now that USCG type-approved BWM systems are available, requesting an extension from the USCG must provide an explicit statement supported by documentary evidence and explicit reasons for why the installation of a type-approved system is not possible.***

- ***Any owner wishes to apply should use the amended extension application spreadsheet. This has recently been modified to review each application independently.***

- ***Batch applications are no longer be accepted and a separate application must be submitted for each ship.***

- ***Vessels can continue to comply with the USCG BWM Regulations by the alternative methods.***

	Ballast water capacity	Date constructed	Compliance date
New vessels	*All*	*On or after 1 December, 2013*	*On delivery*
	Less than 1,500m^3	*Before 1 December, 2013*	*First scheduled drydocking after 1 January, 2016*
Existing vessels	*1,500 – 5,000m^3*	*Before 1 December, 2013*	*First scheduled drydocking after 1 January, 2014*
	Greater than 5,000m^3	*Before 1 December, 2013*	*First scheduled drydocking after 1 January, 2016*

Table 2 – The USCG compliance schedule

Ballast water treatment standards

- ***The BWM Convention standard specifies measurement of 'viable' organisms, while the USCG specifies measurement of 'living' organisms.***

Organism category	Regulation
Plankton, >50 µm in minimum dimensions	<10 cells/m^3
Plankton, 10-50 µm	<10 cells/ml
Toxicogenic Vibrio cholera (O1 and O139)	<1 colony forming unit (cfu)/100ml or less than 1cfu/g (wet weight)
Escherichia coli	<250 cfu/100ml
Intestinal Enterococci	<100cfu/100ml

Table 3 – The IMO D-2 standard for discharged ballast water

Ballast Water Management Plans

All ships of 400 gt and above will be required to have on board an approved ship-specific BWMP and a Ballast Water Record Book to comply with the Convention.

- ***assist the ship complying with international regulations to minimise the risk of transfer of harmful aquatic organisms and pathogens in ships' ballast water and associated sediments.***
- ***identify the ship's Ballast Water Management Officer.***
- ***consider ship safety elements, provide information to PSC officers on the ship's ballast handling system and confirm that ballast water management can be effectively planned.***
- ***include training on BWM operational practices.***
- ***be written in the working language of the ship.***

Port state control

Once the BWM Convention enters into force, ships may be subject to inspections by port states to determine whether they comply with the BWM Convention's requirements. These inspections are limited to:

- *Verifying certification*
- *Inspecting the ballast water record book*
- *Sampling ballast water in accordance with the IMO's guidelines.*

How to comply

Planning for compliance

1. *Understand your obligations under the BWM Convention and other national and local regulations*

Under the BWM Convention, you will need to:

- ***ensure all ballast discharges comply with regulation D-1 or D-2, i.e., that ballast is exchanged or treated: this obligation applies to ballast discharges both at sea and in port***
- ***ensure the procedures in the Ballast Water Management Plan are followed at all times***
- ***keep proper records in the Ballast Water Record Book***
- ***operate and maintain ballast water treatment systems in accordance with the manufacturer's instructions.***

2. *Review current shipboard ballast tank, pumping and piping arrangements*

- ***Different water types should not be mixed and should only be discharged in accordance with the appropriate regulations.***
- ***No sampling should take place during stripping operations.***

3.<u>Develop a Ballast Water Management Plan</u>

4.<u>Select and install a ballast water treatment system</u>

5.<u>Develop training for ships' staff and ensure they are adequately trained in BWM operations</u>

6.***Develop a final Ballast Water Management Plan and submit for approval***

7.***Survey and certification***

- ***arrange for an initial survey of the ship for issue of an International Ballast Water Management Certificate or Certificate of Compliance.***

8. *Understand your obligations under the USCG regulations*

- ***Ballast water exchange will only be allowed until the implementation deadlines for treatment systems.***

- ***To use potable water (from the North American municipal system). However, the ballast tanks must be cleaned of any sediments before this application.***

- ***The USCG also requires: a Ballast Water Management Plan; clean ballast tanks free from sediments; and a report which is to be submitted to the US Authorities 24 hours before arriving at a US port.***

Achieving compliance in service

1. ***Manage ballast water and sediments in accordance with the Ballast Water Management Plan***

- ***Make sure that records of ballasting operations and sediment management are properly recorded in the Ballast Water Record Book.***

2. ***Keep the Ballast Water Management Plan and Ballast Water Record Book up to date***

- ***Carry out periodic reviews of the Ballast Water Management Plan and update it as necessary.***

3. ***Ensure required surveys are carried out within the permitted range dates***

4. *Operate and maintain equipment in accordance with the manufacturer's instructions*

5. *Monitor the treatment system's performance*

- ✧ ***Having the system serviced and checked by the manufacturer on a regular basis will help to ensure the system continues to function as designed and certified.***

6. *Manage ballast water and sediments in accordance with USCG requirements if they apply to you*

- ✧ ***Make sure that records of ballasting operations and sediment management are properly recorded in the Ballast Water Record Book.***

OVERVIEW OF DIFFERENT TECHNOLOGIES

There are a wide variety of treatment options for ballast water. Technologies are briefly described in the following.

ELECTROLYSIS

Electrolysis systems run all or part of the ballast water through electrolysis chambers which generate an active substance (a disinfectant) that breaks down the cell membranes of aquatic organisms. There are two types: inline and side stream.
With inline electrolysis systems, the entire ballast stream is passed through electrolysis chambers.

Side stream electrolysis systems may combine elec-trolysis with a filter, where a small portion of ballast water flow is led through the electrolysis chamber where disinfectants are generated and returned to the main ballast flow.

The active substances, hypochlorite and hypobromite, are produced through oxidation of seawater in the electrolysis chamber. Besides hypochlorite and hypobromite, electrolysis can produce H_2 gas, which must be handled on board the ship. The amount of active substance generated is dependent on the amount of the salinity level of the water. The oxidation reaction of seawater is also temperature dependent; the reaction does not create the disinfectant at effective levels below approximately 15°C. The water must be heated, hence the higher energy consumption.

In water with high organic content, the system has to produce more disinfectants, creating higher levels of toxic by-products. The IMO Convention stipulates a limit of remaining disinfectants for the outgoing ballast water. It may therefore be necessary to neutralize harmful by-products prior to release, should the IMO limit be exceeded.

Side stream electrolysis can provide a solution to problems caused by fresh water or low salinity by storing salt water in an aft peak tank used for producing hypochlorite for the treatment process. Side stream water can also be heated in cold temperatures.

The active substances and the H_2 generated during electrolysis mean that electrolysis systems must be equipped with additional safety procedures and training for the crew.

UV

UV systems generally utilize filters and ultraviolet light (UV). UV light kills or inactivates organisms by disrupting their DNA, leaving them unable to perform vital cellular functions. The efficiency of systems using UV light depends on total suspended solids (TSS) and the opacity of the water. High levels of TSS or colour will cause a decrease in the UV transmittance level. Consequently, the UV intensity will have to be increased, resulting in an increase in power consumption and a considerable decrease in lamp life. If the water cannot transmit the UV light,

ELECTROLYSIS, IN-LINE AND S STREAM

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- On-board d[illegible]
- Efficient
- 1-way treatment
- Can handle large capacities

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- Salinity dependent [illegible]
- Temperature dependent
- More complex [illegible]to instal, control and maintain
- Hydrogen gas production

UV

+

- Easy installation [illegible]etrofit
- Minimal safety issues
- Independent of s[illegible]y and temperature

−

- Dependent on water transmittance > 40-60%
- Power consumption
- 2-way treatment
- Typically installed [illegible]maller capacities

then the UV cannot disinfect efficiently because the organisms may be shielded from the UV light.

A filter will be advantageous in waters with high levels of particulate and organic matter, as a large proportion of organisms will be filtered out before processing. Filters which automatically back flush when a certain pressure drop is exceeded may seriously reduce the flow rate and increase the energy consumption in water with a high sediment content.

UV systems do not form any harmful by-products, and the process is principally independent of the temperature and salinity (however, the UV transmittance is not). The process may have relatively high energy demand in such cases.

OZONATION

Ozonation systems generate ozone (O_3) from ambient air. Ozone is injected into the incoming ballast water to oxidize and neutralize aquatic species. Ozone reacts with other chemicals that occur naturally in seawater to form hypobromous acid and hypobromide ion. These are effective disinfectants. Where ships take on fresh water as ballast (eg, ports located in lakes or rivers), brominated compounds are not formed and the ozone alone acts as disinfectant.

Waters with high particulate and organic matter require higher doses of ozone to ensure sufficient disinfection. Salinity and temperature are not obvious factors affecting the efficiency of BWTS employing ozonation. However, longer holding time may be required. Both ozone and hypobromous acid disintegrate extremely rapidly. Ozone disintegrates significantly slower in freshwater than in seawater. Residual by-products will be measured according to IMO acceptable limits and neutralized prior to release. Ozone is known to induce break- down of tank coatings and accelerate corrosion. However, little experience data has been established with regard to the use of ozone in ballast water tanks. Since ozone is toxic, additional safety measures and crew training are necessary.

CHEMICAL INJECTION

Chemical injection systems are often used in combination with filtration. A chemical solution is injected into the ballast water to ensure disinfection. The disinfectant may be liquid or granular and is often similar to the disinfectant used in domestic water treatment plants. Chemicals may successfully treat ballast water under various conditions and are not affected by salinity of the ballast water. Some systems require neutralization prior to discharge.

Chemicals used are trademarked, and supply might be limited to specific ports. The chemicals must be stored on board in closed containers and are highly toxic. Hence, the use of chemicals requires implementation of strict safety provisions and crew training (recharge, however, is often done by the supplier).

Due to chemicals supply, chemical injection systems may have higher operational costs than other systems utilizing other technologies.

Holding time may be affected by temperature. The efficiency of chemical processes depends on many factors, including temperature. A chemical reaction may have a slower reaction rate in colder water.

Limitations can be assessed through review of product information and test results provided by manufacturer.

OZONATION

+	−
Good for disinfecting tanks that have been used for local operations No filter	Complex system to is, control and maintain Highly toxic

CHEMICAL INJECTION

+	−
Good for infrequent users Good for disinfecting tanks that have been used for local operations	Complex system to is, control and maintain Highly toxic

TRADING PATTERN CHALLENGES

- ***BWTS technologies may face challenges in specific water conditions, "Approval of a system, however, does not ensure that a given system will work on all vessels or in all situations". If the system fails during ballast intake, sequential water exchange with treatment when out of port may be an option. shipowners will need to notify the port state if they need to perform sequential exchange.***

- ***Turbidity, opacity, temperature and salinity level of the intake water are challenges to which the treatment system is subjected.***

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Selecting a treatment system

When selecting a treatment system, you need to consider:

- ***the ship type***
- ***the ship's operating profile***
- ***the maximum and minimum ballasting and de-ballasting rates***
- ***ballast capacity***
- ***the space required (foot print and volume)***
- ***the flexibility of location of system components***
- ***the effects of pressure drop***
- ***integration with existing systems***
- ***whether it is certified intrinsically safe***
- ***power availability***
- ***health and safety***
- ***the effects on tank structure/coatings***
- ***the availability of consumables, spares and support (servicing)***
- ***additional crew workload***
- ***crew training***
- ***capital and operating cost***
- ***system availability and delivery time.***

Following information to be provided during the offer:

- *sufficient capacity to meet the ship’s maximum ballast flow rates*
- *the system’s power consumption and any other electrical requirements*
- *the types of technology employed in the system*
- *the chemicals required and their consumption rates*
- *health and safety considerations in terms of working environment, handling and storage of chemicals*
- *protection systems for normal and emergency operation*
- *training requirements*
- *the work plan for supply to ship, installation, commissioning and test*
- *a statement of the effect on ballast tank coatings*
- *details of pressure drops and the effect that the introduction of the treatment equipment will have on ballast pump suction and delivery performance.*

Additional considerations

Owners/operators should carry out the following engineering checks:

- *Ensure the additional power requirements.*
- *Check that treatment easily integrated into existing ballast systems.*
- *Check the suitability of control requirements, including alarms and protective devices.*
- *Conduct a review of integration with existing machinery controls.*
- *Assess ease of maintenance, calibration and ballast water sampling.*
- *Assess the need for venting or other measures for compartments where active substances (chemical or otherwise) are stored or at risk of escape.*
- *Review manufacturers' maintenance requirements*
- *Ensure pneumatic tank gauges might be affected by inerting of ballast tanks*
- *In some cases, separate ballast water systems may be required for 'gas safe' and 'gas dangerous' zones.*

Installing ballast water treatment systems – general considerations

- ***Consideration must be given to any risks that the installation and operation of the system may introduce on board the ship and how these risks can be mitigated.***

- ***Risks include the storage of chemicals required for the operation of the system and by-products generated by the system.***

- ***The system should have a type approval certificate***

- ***To ensure that the ship's sea water ballast system remains operational in the event of a ballast water treatment system failure or emergency, a suitable by-pass which can be remotely and manually controlled is to be installed.***

Costs

- ***The biggest operating cost for most systems is power, and for large power consumers (electrolytic, UV and advanced oxidation processes) availability of shipboard power will be a factor.***

- ***For chemical dosing systems, required power is low but chemical costs may be a major factor.***

Cost data is not provided within this guide. However, when selecting a system, care should be taken in interpreting the cost information since there may be variation in the way underlying costs are calculated between suppliers. In general (except for the few technologies that use stored chemicals and the gas injection units that use fossil fuel) opex should be based on the power required to operate the process (e.g., UV radiation, electrolysis or ozonation).

Initial key aspects

Vessel type and characteristics. Trading pattern.
Ballast capacity and flow rate requirements.

Technical and operational considerations

Time required for treatment to be effective. Ballast and treatment pumping rates.
Ballast system characteristics (for example, the number of independent systems on board oil tankers).
Health and safety.
In-service requirements.
Explosion proof equipment (for oil tankers, for example). Power requirements and onboard systems.
Effects on tank coatings and corrosion considerations. Controls and alarms.
Space constraints.

Treatment options

Combination filtration and treatment.

Chemical options such as chlorination, ozone, deoxygenation and peracetic acid.
Mechanical means such as cavitation. UV radiation.
Ultrasonic.

Vendor selection and specification reviews

Vendor experience in supplying similar systems. Equipment approvals.
Commercial considerations.

Installation planning

At sea or dry docking considerations for existing ships. Inclusion in build specifications for new builds.

Figure 6 – Steps to selecting a treatment system

Thank you