Technical Report

Ballast Water Convention and Ballast Water Treatment Systems - Guidance on procurement, installation, operation and certification
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1 INTRODUCTION

1.1 THE PROBLEM

Since the introduction of steel ships around 120 years ago, water has been used as ballast to stabilize ships at sea. Ballast water is pumped-in to maintain safe operating conditions throughout a voyage. This practice reduces stress on the hull, provides transverse stability, improves propulsion and manoeuvrability, and compensates for weight lost due to fuel and water consumption.

While ballast water is essential for safe and efficient modern shipping operations, it may pose serious ecological, economic and health problems due to the multitude of marine species carried in ships’ ballast water. These include bacteria, microbes, small invertebrates, eggs, cysts and larvae of various species. The transferred species may survive to establish a reproductive population in the host environment, becoming invasive, out-competing native species and multiplying into pest proportions.

Scientists first recognized the signs of an alien species introduction after a mass occurrence of the Asian phytoplankton algae Odontella (Biddulphia sinensis) in the North Sea in 1903. But it was not until the 1970s that the scientific community began reviewing the problem in detail. In the late 1980s, Canada and Australia were among countries experiencing particular problems with invasive species, and they brought their concerns to the attention of IMO’s Marine Environment Protection Committee (MEPC).

The problem of invasive species in ships’ ballast water is largely due to the expanded trade and traffic volume over the last few decades and since the volumes of seaborne trade continue to increase the problem may not yet have reached its peak. The effects in many areas of the world have been devastating. Quantitative data show the rate of bio-invasions is continuing to increase at an alarming rate and new areas are being invaded all the time.

The spread of invasive species is now recognized as one of the greatest threats to the ecological and the economic well-being of the planet. These species are causing enormous damage to biodiversity and the valuable natural riches of the earth upon which we depend. Direct and indirect health effects are becoming increasingly serious and the damage to environment is often irreversible.

Some examples of aquatic bio-invasions causing major impact can be found in the following picture. It should be noted, however, that there are hundreds of other serious invasions which have been or are in the process of being recorded around the world.
1.2 THE RESPONSE
Preventing the transfer of invasive species and coordinating a timely and effective response to invasions requires cooperation and collaboration among governments, economic sectors, non-governmental organizations.

IMO has been at the front of the international effort by taking the lead in addressing the transfer of aquatic invasive species (AIS) through shipping. In 1991 the MEPC adopted Guidelines for preventing the introduction of unwanted organisms and pathogens from ships’ ballast water and sediment discharges (MEPC resolution 50(31)); while the United Nations Conference on Environment and Development (UNCED), held in Rio de Janeiro in 1992, recognized the issue as a major international concern.

In November 1993, the IMO Assembly adopted resolution A.774(18) based on the 1991 Guidelines requesting the MEPC and the MSC to keep the Guidelines under review with a view to
developing internationally applicable, legally-binding provisions. While continuing its work towards the development of an international treaty, the Organization adopted, in November 1997, resolution A.868(20) - Guidelines for the control and management of ships' ballast water to minimize the transfer of harmful aquatic organisms and pathogens - inviting its Member States to use these new guidelines when addressing the issue of IAS.

After more than 14 years of complex negotiations between IMO Member States, the International Convention for the Control and Management of Ships' Ballast Water and Sediments (BWM Convention) was adopted by consensus at a Diplomatic Conference held at IMO Headquarters in London on 13 February 2004.

Figure 1.2: cover of the International Convention for the Control and Management of Ships' Ballast Water and Sediments

The Convention will require all ships to implement a Ballast Water and Sediments Management Plan. All ships will have to carry a Ballast Water Record Book and will be required to carry out ballast water management procedures to a given standard. Parties to the Convention are given the option to take additional measures which are subject to criteria set out in the Convention and to IMO guidelines.

Several articles and regulations of the BWM Convention refer to guidelines to be developed by the Organization and Conference resolution 1 invites IMO to develop these guidelines as a matter of urgency and adopt them as soon as practicable and, in any case, before the entry into force of the Convention, with a view to facilitate global and uniform implementation of the instrument.

The MEPC, at its fifty-first session in April 2004, approved a programme for the development of guidelines and procedures for uniform implementation of the BWM Convention, listed in Conference resolution 1 including additional guidance required but not listed in the resolution. The programme was further expanded at the fifty-third session of the MEPC in July 2005 to develop and adopt 14 sets of Guidelines.
The Convention will enter into force 12 months after ratification by 30 States, representing 35 per cent of world merchant shipping tonnage. As of today, 38 States have ratified the Convention, representing 30.38% of world merchant shipping tonnage with Argentina, Belgium and Germany due to submit their instruments of ratification in the near future.
2 REGULATORY BACKGROUND

2.1 INTERNATIONAL CONVENTION FOR THE CONTROL AND MANAGEMENT OF SHIPS’ BALLAST WATER AND SEDIMENTS, 2004

2.1.1 The Convention

The BWM Convention will apply to ships flying the flag of a Party except:

1. ships not designed or constructed to carry ballast water;
2. ships operating exclusively in waters under the jurisdiction of a Party, unless the party determines that the discharge of ballast water from such ships would impair or damage their environment;
3. warships, naval auxiliary or other ships owned or operated by a Party;
4. ships with permanent ballast water not subject to discharge.

Exemptions from the management of ballast water may be granted to ships on voyages between specified ports or operated exclusively between specified ports or locations when ballast water is not mixed other than between these ports or locations. These exemptions shall be effective for a period not exceeding five years, subject to intermediate review. Moreover, BWM.2/Circ.32, dated 8 August 2011, specifies that provisions of the Convention are not applicable to the water in the hopper area of hopper dredgers.

Ships to which the Convention applies will be required to carry on board the following:

1. a “Ballast Water Management Plan” approved by the Administration, detailing safety procedures and actions to be taken to implement the ballast water management requirements;
2. a “Ballast Water Record Book” for the recording of each operation concerning ballast water management;
3. an “International Ballast Water Management Certificate” (for ships of 400 gross tonnage and above excluding floating platforms, FSUs and FPSOs) with a five year validity and subject to annual, intermediate and renewal surveys.

Port State Controls will be authorized to inspect ships verifying:

1. validity of the certificate;
2. presence on board of documents required by the Convention;
3. compliance with the requirements of the Convention of the ballast water carried on board, performing samples.

For the management of ballast water, two main standards are defined by the Convention:

1. D1: ballast water exchange with an efficiency of 95% volumetric exchange (for ships exchanging ballast water by the pumping through method, pumping through three times the volume of each ballast tank shall be considered equivalent);
2. D2: allowable limits on viable organisms in ballast water to be discharged, defined as maximum number and size per cubic meter (less than 10 viable organisms per cubic meter
greater than or equal to 50 micrometers in minimum dimension and less than 10 viable organisms per milliliter less than 50 micrometers in minimum dimension and greater than or equal to 10 micrometers in minimum dimension). Ballast water management, in compliance with the D-2 standard, will be performed by type approved systems. The application of the two above-mentioned standards will be required as follows:

1. **existing ships, constructed before 2009:**
   a. with a ballast water capacity between 1,500 and 5,000 cubic meters, inclusive, that at least meet the standard D1 shall conduct ballast water exchange from the date of entry into force of the Convention until 2014, after which they shall conduct ballast water management meeting at least the D-2 standard; **OR**
   b. with a ballast water capacity of less than 1,500 cubic meters and more than 5,000 cubic meters that at least meet the standard D1, shall conduct ballast water exchange from the date of entry into force of the Convention until 2016, after which they shall conduct ballast water management meeting at least the D-2 standard.

2. **new ships, constructed in or after 2009:**
   a. with a ballast water capacity of less than 5,000 cubic meters, shall conduct ballast water management meeting at least the D-2 standard; however, recognizing that a limited number of technologies will probably be available in January 2009 to meet the first implementation date of the D2 standard, Resolution A.1005(25) dated 29 November 2007 recommended that a ship constructed in 2009 and with a ballast water capacity of less than 5000 cubic meters be not required to comply with D-2 standard until its second annual survey, but no later than 31 December 2011.
   b. with a ballast water capacity of 5,000 cubic meters or more:
      i. if constructed in or after 2009 but before 2012 shall conduct ballast water exchange until 2016, after which they shall conduct ballast water management meeting at least the D-2 standard;
      ii. if constructed in or after 2012 shall conduct ballast water management meeting at least the D-2 standard.

Existing ships shall comply with the above-mentioned requirements not later than the first intermediate or renewal survey, whichever occurs earlier, after the anniversary date of delivery of the ship in the year of compliance with the applicable standard.

The expression “anniversary date of delivery of the ship” refers to year 2014 and 2016 indicated in 1.a, 1.b and 2.b.i. Consequently, ships with a ballast water capacity between 1500 m$^3$ and 5000 m$^3$, inclusive, are required to comply with the D-2 standard not later than the first intermediate or renewal survey, whichever occurs first, after the anniversary date of delivery of the ship in 2014; and ships with a ballast water capacity of less than 1500 m$^3$ or greater than 5000 m$^3$ are required to comply with D-2 standard not later than the first intermediate or renewal survey, whichever occurs first, after the anniversary date of delivery date of delivery of the ship in 2016 (BWM.2/Circ.29/Rev.1 dated 26 September 2011).

In the following timetable, that summarizes the above-mentioned requirements, BWC is to be read as the ballast water capacity of the ship, measured in cubic meters.
Ballast water exchange shall be conducted, whenever possible, at least 200 miles from the nearest land and in water at least 200 meters in depth. If the ship is not able to conduct ballast water exchange under these conditions, it should be conducted at 50 miles from the nearest land and in water at least 200 meters in depth. A ship shall not be required to deviate from its intended voyage, or delay the voyage, in order to comply with these requirements.

In particular sea areas, where the distance from the nearest land or the depth does not meet these parameters, the port State may designate sea areas where a ship may conduct ballast water exchange.

A ship shall not be required to conduct ballast water exchange if the master reasonably decides that such exchange may threaten the safety of the ship. In such cases, reasons shall be entered in the ballast water record book.

Ships involved in research programs approved by an Administration, to test and evaluate ballast water treatment technologies (D-2 standard), will not be requested to apply that standard until five years from the date on which the ship would otherwise be required to comply.

To date the following guidelines, guidance and procedures, referred to in the BWM Convention, are available:

1. G1 “Guidelines for sediment reception facilities”, adopted by Resolution MEPC.152(55) on 13 October 2006;
2.1.2 Revised implementation scheme of the IMO Ballast Water Management Convention

To ensure practical and clear implementation of the Convention once it enters into force, IMO agreed to modify the D-2 standard compliance schedule for ships constructed (keel laid) before the entry into force date of the Convention. The revised implementation scheme is summarized in the following table (IMO Resolution A.1088(28)):
Ballast Water Convention and Ballast Water Treatment Systems
Guidance on procurement, installation, operation and certification

<table>
<thead>
<tr>
<th>Date of Construction (C)</th>
<th>Ballast Water Capacity (m³) (B)</th>
<th>Mandatory D-2 Compliance (treatment)</th>
</tr>
</thead>
<tbody>
<tr>
<td>C&lt;2009</td>
<td>1500≤B≤5000</td>
<td>Anniversary Date of Delivery in 2014, or entry into force date, if it occurs later</td>
</tr>
<tr>
<td></td>
<td>B&lt;1500 or B&gt;5000</td>
<td>Anniversary Date of Delivery in 2016, or entry into force date, if it occurs later</td>
</tr>
<tr>
<td>2009≤C&lt;2012</td>
<td>B≥5000</td>
<td>Anniversary Date of Delivery in 2014, or entry into force date, if it occurs later</td>
</tr>
<tr>
<td>2009≤C&lt;Entry into force of the Convention</td>
<td>B&lt;5000</td>
<td>Entry into force date of the Convention</td>
</tr>
<tr>
<td>2012≤C&lt;Entry into force of the Convention</td>
<td>B≥5000</td>
<td></td>
</tr>
</tbody>
</table>

Figure 2.2: revised implementation scheme of the BWM introduced by A.1088(28)

In addition, IMO clarified that the “first renewal survey” after which ships shall comply with the D-2 standard, is the one associated with the International Oil Pollution Prevention (IOPP) Certificate. Ships constructed on or after the date of entry into force of the Convention, irrespective of their ballast water capacity, will be required to comply with Standard D-2 by the completion date of the construction.

2.1.3 Issuance of BWM certificates prior to the entry into force date of the Convention

The Marine Environment Protection Committee, at its 63rd session (February-March 2012), noted that the Convention allows no phase-in period for ships constructed prior to the entry into force of the Convention. This would result in all ships of 400 gross tonnage and above to have on board an approved Ballast Water Management Plan and be surveyed and certified immediately on the entry into force of the Convention.

To address this impracticality the Committee, at its 64th session, approved circular BWM.2/Circ.40 allowing Contracting Governments to the BWM Convention to issue International Ballast Water Management Certificates prior to entry into force of the Convention.

In this case it is to be annotated in the Certificate that the validity begins from the entry into force date of the Convention.

In addition to the above the Administration or any Organization recognized by it (RO) has to issue a statement to the shipowner indicating when the BWM Plan was received. Starting from this date, the ship will be allowed to trade for three months with an unapproved BWM Plan on board.

This provision will be useful for BWM Plan submitted to the relevant Administration/RO in the period close the entry into force date of the Convention.

Notwithstanding the above, it is recommended to prepare and to submit to RINA the BWM Plan as soon as possible, in order to avoid any possible problem due to the submission of a great number of plans in the very close period to the entry into force of the Convention.

2.1.4 Validity of ballast water management plans previously approved according to resolution A.868(20)

BWM.2/Circ.40 also address the matter of Ballast Water Management Plans approved in accordance with old resolution A.868(20) (November 1997).
According to the above circular, whilst the Guidelines adopted by MEPC.127(53) in 2005 and referenced in the BWM Convention have effectively superseded the Guidelines adopted by resolution A.868(20), for practical reasons the Ballast Water Management Plans approved in accordance with resolution A.868(20) will remain valid until the ship is required to install a ballast water treatment system (compliance with D-2 Standard).

2.1.5 Ballast water quality
Regulation D-2 of the Ballast Water Convention sets the standard that ballast water treatment systems must meet (Figure 2.3). Treatment systems must be tested and approved in accordance with the relevant IMO Guidelines.

<table>
<thead>
<tr>
<th>Organism category</th>
<th>Regulation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Plankton, &gt;50 μm in minimum dimension</td>
<td>&lt; 10 cells / m³</td>
</tr>
<tr>
<td>Plankton, 10-50 μm</td>
<td>&lt; 10 cells / ml</td>
</tr>
<tr>
<td>Toxicogenic Vibrio cholera (O1 and O139)</td>
<td>&lt; 1 cfu* / 100 ml or less than 1 cfu / g (wet weight)</td>
</tr>
<tr>
<td>Escherichia coli</td>
<td>&lt; 250 cfu* / 100 ml</td>
</tr>
<tr>
<td>Intestinal Enterococci</td>
<td>&lt; 100 cfu* / 100 ml</td>
</tr>
</tbody>
</table>

* colony forming unit

Figure 2.3: IMO ‘D2’ standards for discharged ballast water

2.1.6 The approval processes
Regulation D-3 of the BWM Convention requires that ballast water management systems used to comply with the Convention must be approved by the Administration taking into account the Guidelines for approval of ballast water management systems (G8). Approval consists of both shore-based testing of a production model, to confirm that the D-2 discharge standards are met; and shipboard testing, to confirm that the system works in service. Timescales are likely to be between six weeks and six months for the shore-based testing and six months for the ship-based testing.

In addition to the above mentioned requirement, Regulation D-3 also requires ballast water management systems which make use of active substances to be approved by IMO in accordance with the ‘Procedure for approval of ballast water management systems that make use of Active Substances (G9)’. Procedure (G9) consists of a two-tier process – Basic and Final Approval - to ensure that the ballast water management system does not pose unreasonable risk to the environment, human health, property or resources.

A technical group of experts has been established under the auspices of GESAMP to review the proposals submitted for approval of ballast water management systems that make use of Active...
Substances. The GESAMP Ballast Water Working Group (GESAMP-BWWG) reports to the Organization on whether such a proposal presents unreasonable risks in accordance with the criteria specified in the Procedure for approval of ballast water management systems that make use of Active Substances.

Flag Administrations will issue a Type Approval certificate in accordance with the aforementioned G8 guidelines once G9 approval has been granted by MEPC. If the process uses no active substances, the Flag Administration will issue a Type Approval certificate without the need for G9 approval.

A summary of the approval pathway for ballast water treatment systems can be found in the following Figure.

### Figure 2.4: Summary of the approval pathway for ballast water treatment systems

- **Systems using active substances**: Initial approval → Land-based testing → Shipboard trials → Final approval → Issue of type approval certificate
- **Systems not using active substances**: Initial approval → Land-based testing → Shipboard trials → Issue of type approval certificate

* Includes chemical disinfectants, e.g. chlorine, ClO₂, ozone

† Includes techniques not employing chemicals, e.g. deoxygenation, ultrasound

2.1.7 Available ballast water treatment systems

There is a limited number of approved ballast water treatment systems available, but there are many more manufacturers developing systems which will be submitted for test and approval in the near future.

At the time of writing, the complete list of systems making use of active substances which received type approval is given by BWM/Circ.34/Rev.2 (24th May 2013) together with systems which received basic and final approval.
3 TREATMENT PROCESSES

3.1 OVERVIEW
IMO defines ballast water treatment equipment as “…the equipment which mechanically, physically, chemically or biologically processes either singularly or in combination to remove, render harmless or avoid the uptake or discharge of harmful organisms or pathogens. Ballast water treatment equipment may operate at the uptake or discharge of ballast water, during the voyage, or at a combination of these events.”

The technologies used for treating ballast water are generally derived from municipal and other industrial applications. However, their use is constrained by key factors such as space, cost and efficacy (with respect to the IMO discharged ballast water standards).

There are two generic types of process technology used in ballast water treatment:
1. Solid-liquid separation and
2. Disinfection.

The following paragraphs provide a brief overview of their characteristics.

3.1.1 Solid-liquid separation
Solid-liquid separation is simply the separation of suspended solid material, including the larger suspended micro-organisms, from the ballast water, either by sedimentation (allowing the solids to settle out by virtue of their own weight) or by surface filtration (removal by straining, i.e. by virtue of the pores in the filtering material being smaller than the size of the particle or organism). All solid-liquid separation processes produce a waste stream containing the suspended solids. This waste stream comprises the backwash water from filtering operations or the underflow from hydrocyclone separation. These waste streams require appropriate management and during ballasting they can be safely discharged at the point where they were taken up.

On deballasting, the solid-liquid separation operation is generally bypassed.

3.1.2 Disinfection/Sterilization
Disinfection removes and/or inactivates microorganisms using one or more of the following methods:
- Chemical inactivation of the micro-organisms through either:
  - oxidising biocides – general disinfectants which act by destroying organic structures, such as cell membranes, or nucleic acids; or
  - non-oxidising biocides – these interfere with reproductive, neural, or metabolic functions of the organisms.
- Physico-chemical inactivation of the micro-organisms through processes such as UV light, heat or cavitation.
- Asphyxiation of the micro-organisms through deoxygenation.

All of these disinfection methods have been applied to ballast water treatment, with different products employing different unit processes. Most commercial systems comprise two or more stages of treatment with a solid-liquid separation stage being followed by disinfection (Figure 6), though some disinfection technologies are used in isolation. One ballast water treatment
technology also employs chemical enhancement (i.e., coagulation/flocculation) upstream of solid-liquid separation; another uses titanium dioxide ($\text{TiO}_2$) to intensify ultraviolet irradiation.

Figure 3.1: Summary of treatment options
3.2 PROCESSES

The range of system processes employed for ballast water treatment is shown in the following figure.

<table>
<thead>
<tr>
<th>Process</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Solid-liquid separation</strong></td>
<td></td>
</tr>
<tr>
<td>Filtration</td>
<td>Discs or fixed screens with automatic backwashing</td>
</tr>
<tr>
<td>Hydrocyclone</td>
<td>High velocity centrifugal rotation of water to separate particles</td>
</tr>
<tr>
<td>Coagulation</td>
<td>Optional pre-treatment prior to separation to aggregate particles and increase their size</td>
</tr>
<tr>
<td><strong>Chemical disinfection (oxidising biocides)</strong></td>
<td></td>
</tr>
<tr>
<td>Chlorination</td>
<td>Oxidising biocide that, diluted in water, destroys cell walls of micro-organisms</td>
</tr>
<tr>
<td>Electrochlorination</td>
<td>Creates oxidizing solution by employing direct current into water (electrolytic reaction)</td>
</tr>
<tr>
<td>Ozonation</td>
<td>Ozone gas is bubbled into the water which decomposes and reacts with other chemicals to kill micro-organisms</td>
</tr>
<tr>
<td>Chlorine dioxide</td>
<td>As chlorination</td>
</tr>
<tr>
<td>Peracetic acid and hydrogen peroxide</td>
<td>As chlorination</td>
</tr>
<tr>
<td><strong>Chemical disinfection (non-oxidising biocides)</strong></td>
<td></td>
</tr>
<tr>
<td>Metadione / Vitamin K</td>
<td>Metadione is toxic to invertebrates</td>
</tr>
<tr>
<td>Physical disinfection</td>
<td>Amalgam lamps surrounded by quartz sleeves produce UV light, which denatures the DNA of the micro-organisms and prevents it from reproducing</td>
</tr>
<tr>
<td>Ultraviolet (UV) irradiation</td>
<td>Reduces pressure of oxygen in space above the water with inert gas injection or by means of a vacuum to asphyxiate the micro-organisms</td>
</tr>
<tr>
<td>Deoxygenation</td>
<td>Induced by ultrasonic energy or gas injection. Disrupts the cell wall of organisms</td>
</tr>
<tr>
<td>Cavitation</td>
<td>Heat treatment of ballast water</td>
</tr>
<tr>
<td>Heat</td>
<td></td>
</tr>
</tbody>
</table>

Figure 3.2: Description of treatment options

Systems which employ active substances will treat on uptake only (with the exception of neutralisation prior to discharge) whereas other mechanical methods tend to treat on both uptake and discharge.

Figures 3.3, 3.4 and 3.5 illustrate the basis of the functionality of the ballast system with the treatment module.

Figure 3.6 reports an example of the installation of BWT system in a typical ballast system.
Ballast Water Convention and Ballast Water Treatment Systems
Guidance on procurement, installation, operation and certification

Figure 3.3: Ballast system functionality scheme with water treatment during ballasting operation

Figure 3.4: Ballast system functionality scheme with water treatment (single passage) during deballasting operation

Figure 3.5: Ballast system functionality scheme with water treatment (double passage) during deballasting operation
The installation of the BWT system mainly concerns modification of the design of the ballast system and its components. In particular:

- An increase of power of ballast pumps should be considered to overcome the pressure drop lost in the BWT system;
- The system may be redesigned and the scantling of the lines/valves could change for the higher design pressure of part of the system;
- Stripping system should be modified: this is not necessary for “single passage” systems.
## 4 COMPLIANCE WITH THE CONVENTION

The following table summarizes the requirements for compliance with the Ballast Water Convention:

<table>
<thead>
<tr>
<th>Requirement</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Type Approval certification for treatment systems</td>
<td>Ships will be required to install and use a ballast water treatment system that is approved by a flag Administration or a recognised organisation, and have a certificate indicating compliance with IMO resolution MEPC.174(58).</td>
</tr>
<tr>
<td>Approved Ballast Water Management Plan (BWMP)</td>
<td>Each ship will need to develop a Ballast Water Management Plan and have it approved by the flag administration or a recognised organisation. The plan should be developed in accordance with IMO resolution MEPC.127(53). The plans submitted for approval should include piping, electrical and control systems. In case the ship has on board a ballast water management plan previously approved according to resolution A.868(20), please refer to para 2.1.3.</td>
</tr>
<tr>
<td>Ballast Water Record Book</td>
<td>Each ship will need to have on board a Ballast Water Record Book containing the information required by the Convention, and in the required format (please refer to Appendix II of BWM/CONF/36). The Record Book may be in paper format or an electronic format approved by the administration.</td>
</tr>
<tr>
<td>Classification requirements for existing ships</td>
<td>To maintain a ship in class the operator needs to submit plans and information about the ballast water treatment system and its installation to the ship’s classification society. After these have been reviewed and approved, a class surveyor will survey the installation to confirm that it is in accordance with the approved plans.</td>
</tr>
</tbody>
</table>
| Certification and survey requirements             | After the Convention has entered into force, every ship over 400 gt will be required to undergo an initial survey and be issued with an International Ballast Water Management Certificate (IBWMC) (please refer also to para 2.1.2 “Issuance of BWM certificates prior to the entry into force date of the Convention”). The IBWMC will be valid for five years subject to annual and intermediate surveys. After five years, a renewal survey will be held and on successful completion of this survey, the IBWC will be reissued. The initial survey survey shall verify that the Ballast Water Management plan required by regulation B-1, the Ballast Water record book and any associated structure, equipment, systems, fitting, arrangements and material or processes comply fully with the requirements of this Convention. The annual intermediate and renewal surveys will confirm that:  
  • there have been no changes to the ballast water management arrangement since the last survey  
  • an approved BWMP is on board  
  • the ballast water record book has been maintained and has up to date entries  
  • the treatment system (if applicable) is in good condition and has been operated and maintained in accordance with the manufacturer’s instructions  
  • there are sufficient consumables and spares on board as recommended by the manufacturer.                                                                                   |

Figure 4.1: Requirements for compliance with the Ballast Water Convention
# Ballast Water Convention and Ballast Water Treatment Systems

Guidance on procurement, installation, operation and certification

## 5 RINA AUTHORIZATIONS

The following table summarizes, for each Flag having RINA classed ships, the activities that RINA is authorized to perform on behalf of the Flag. The first columns after the one of the flag (“Accession” column) indicates if that flag has ratified or not the BWM Convention.

<table>
<thead>
<tr>
<th>FLAG</th>
<th>Accession (Yes/No)</th>
<th>Authorization to issue ship related certificates (Initial/periodical/renewal surveys and issue of the relevant interim and full term certificates)</th>
<th>Authorization to issue Type Approval Certificates for ballast water treatment systems</th>
<th>None</th>
</tr>
</thead>
<tbody>
<tr>
<td>Italy</td>
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<td>x (full, for italian producers only)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Panama</td>
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<td></td>
<td>x</td>
<td></td>
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<tr>
<td>Malta</td>
<td>N</td>
<td>x (full)</td>
<td></td>
<td></td>
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<tr>
<td>Greece</td>
<td>N</td>
<td></td>
<td>x</td>
<td></td>
</tr>
<tr>
<td>Liberia</td>
<td>Y</td>
<td></td>
<td>x</td>
<td></td>
</tr>
<tr>
<td>Saint Vincent and the Grenadines</td>
<td>N</td>
<td>x (full)</td>
<td></td>
<td></td>
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<tr>
<td>Marshall Islands</td>
<td>Y</td>
<td>x (full)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Spain</td>
<td>Y</td>
<td>x (full)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Bahamas</td>
<td>N</td>
<td>x (full)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>United Arab Emirates</td>
<td>N</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Singapore</td>
<td>N</td>
<td>X (full)</td>
<td></td>
<td></td>
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<tr>
<td>Portugal</td>
<td>N</td>
<td></td>
<td>x</td>
<td></td>
</tr>
<tr>
<td>Indonesia</td>
<td>N</td>
<td>x (limited) MCA only authorises RINA to approve and issue type approval certificates of BWMS that comply with IMO Resolution MEPC.174(58)</td>
<td></td>
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</tr>
<tr>
<td>United Kingdom</td>
<td>N</td>
<td>x (full)</td>
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<tr>
<td>Argentina</td>
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<td>Netherlands</td>
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<tr>
<td>Hong Kong</td>
<td>N</td>
<td>x</td>
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<td>Saudi Arabia</td>
<td>N</td>
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<tr>
<td>Egypt</td>
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<td>Philippines</td>
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<tr>
<td>Cyprus</td>
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<td>Finland</td>
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<td>Sweden</td>
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## Ballast Water Convention and Ballast Water Treatment Systems

**Guidance on procurement, installation, operation and certification**

<table>
<thead>
<tr>
<th>FLAG</th>
<th>Accession (Yes/No)</th>
<th>Authorization to issue ship related certificates (Initial/periodical/renewal surveys and issue of the relevant interim and full term certificates)</th>
<th>Authorization to issue Type Approval Certificates for ballast water treatment systems</th>
<th>None</th>
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<td>Brazil</td>
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<td>Sierra Leone</td>
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<td>Gibraltar</td>
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<td>Isle of Man</td>
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<td>Denmark</td>
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<td>x (Statement prior to the entry into force and certificate when the Convention enters into force)</td>
<td>x (on a case by case basis, reference Agency is given)</td>
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</table>
### Ballast Water Convention and Ballast Water Treatment Systems

Guidance on procurement, installation, operation and certification

<table>
<thead>
<tr>
<th>FLAG</th>
<th>RINA classed ships (n.)</th>
<th>Accession (Yes/No)</th>
<th>Authorization to issue ship related certificates (initial/periodical/renewal surveys and issue of the relevant interim and full term certificates)</th>
<th>Authorization to issue Type Approval Certificates for ballast water treatment systems</th>
<th>None</th>
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<td>Venezuela</td>
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<td>Tanzania</td>
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<td>Kuwait</td>
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<td>x</td>
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<td>Russia</td>
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<td>Y</td>
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<td></td>
<td>x</td>
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<td>N</td>
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<td></td>
<td>x</td>
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<tr>
<td>Russia</td>
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<td>Viet Nam</td>
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<td>Cambodia</td>
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<td>N</td>
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</tr>
<tr>
<td>Sri Lanka</td>
<td>1</td>
<td>N</td>
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<td>x</td>
</tr>
</tbody>
</table>

Figure 4.1: Activities that RINA is authorized to perform on behalf of the Flag
6 BALLAST WATER TREATMENT SYSTEM : PROCUREMENT

6.1 STEPS TO SELECTING A TREATMENT SYSTEM

6.1.1 Initial key aspects
The following initial key aspects should be taken into account in the process of selecting an effective ballast water treatment system:

   a) Ship type and characteristics;
   b) Trading pattern;
   c) Ballast capacity and flow rate requirements

6.1.2 Technical and operational considerations
After having identified the key aspects listed in para 6.1.1. it is important to consider some important technical and operational parameters:

   a) Time required for treatment to be effective
   Non-oxidizing biocides include numerous chemicals that act by interfering with a necessary life function such as metabolism or reproduction. Because of the time needed for deactivation, non-oxidizing biocides may not be the best option for shorter voyages. On the other side oxidizing biocides (chlorine, bromine, and iodine) act by destroying cell membranes which leads to cell death and are able to treat ballast water in a short time.

   b) Ballast and treatment pumping rates
   All BWTS have a ‘total capacity rate’ (TCR). This indicates how many cubic meters of ballast water the system can process each hour. It is needed to choose a system with a TCR high enough to handle ship’s ballast capacity and operational pumping rate. As general principle a treatment equipment capacity greater than the ship’s ballast rate is suggested, in order to allow for an operating margin.

   c) Health and safety
   Whatever BWTS it’s going to be installed, training will be required on operating and maintaining the system, and health and safety aspects such as chemical handling. Training requirements will need to be included in the ballast water management plan required by the Convention.

   d) In-service requirements
   It is important to be able to keep the BWTS operational. If it stops working, the ship will be in contravention of the Convention and could face fines or detention. It is important to check that spares, consumables and servicing are readily available in all the areas where the ship is trading.

   e) Explosion proof equipment (for oil tankers, for example)
   If the ship is a tanker, and the system is going to be installed in a ‘gas dangerous area’ (i.e., in the cargo area), the system must be certified ‘gas safe’.

   f) Power requirements and onboard systems
   Some systems may have very high power requirements. It is suggested to check whether it is needed to run another generator when the system is in operation or even install an additional generator set. Another consideration is whether a spare breaker is available in the electrical distribution board to provide power to the BWTS. If not, it is needed to find an alternative solution.
g) Effects on tank coatings and corrosion considerations
Corrosion and coating degeneration are two potential effects that system substances and processes may have on tanks. It is important to get assurance from the system manufacturer that tanks will not be adversely affected.

h) Controls and alarms
It is advantageous to integrate the alarms and controls for the treatment system with those for the ballast pumping system, so that both can be operated from all control panels.

i) Space constraints
System footprints range from approximately 0.25 m² to 145 m², depending on their TCR. Some are single units while others can be installed as separate components. This may be useful if there is not a single space on board ship which is big enough or if access for bringing a single system on board is difficult.

6.1.3 Treatment options
As described in Section 3, different treatment options can be chosen to comply with the Convention’s requirements:
   a) Combination filtration and treatment.
   b) Chemical options such as chlorination, ozonation, deoxygenation and peracetic acid.
   c) Mechanical means such as cavitation.
   d) UV radiation.
   e) Ultrasounds.

A synthetic description of the main characteristics of the above mentioned options can be found in paragraph 3.2

6.1.4 Vendor selection, approvals and commercial considerations
The following aspects should be considered in the process of selecting the most reliable vendor:
   a) Vendor experience in supplying similar systems
   b) Equipment approvals
      As mentioned in paragraph 2.1.5, to install a BWTS on board a ship, it must be ‘type approved’ by the flag administration or a Recognised Organisation in accordance with the relevant IMO Guidelines. If the system uses an active substance, this will need to have received final approval from the IMO before type approval can be granted.
   c) Commercial considerations
      A BWTS is a big investment and could cost as much as $2,000,000 depending on the manufacturer. As for operating cost, it depends on the type of system and starts from as little as a few dollars per 1,000 m³ of treated water. Many system suppliers quote operating costs below $20 per 1,000 m³.

6.1.5 Installation planning
The installation planning differs for new and existing ships.
   a) Existing ships
      For existing ships it is needed to decide if the system will be fitted at sea or in drydock. If the latter, it is suggested to combine the retrofitting with a scheduled drydocking. Whether this is possible will depend on the ship’s survey schedule and how it aligns with the
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Convention compliance dates. It is also needed to make sure that the system can be delivered by the preferred time.

b) New ships
For new ships the installation is to be included in build specifications

6.2 PROCUREMENT SPECIFICATION
In order to select a suitable system, ship operators will need to prepare a Procurement Specification for potential suppliers, which details their technical requirements. The following table include the above mentioned information as well as the information that ship operators should require that suppliers include in their offer.

<table>
<thead>
<tr>
<th>Technical requirements of the ship</th>
<th>Importance</th>
<th>Information expected to be included in the suppliers’ offer</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ballast water pump flow rates that the treatment system will be required to cope with</td>
<td>Critical</td>
<td>Confirmation that their system has sufficient capacity to meet the ship’s maximum ballast flow rates</td>
</tr>
<tr>
<td>A copy of the ballast system pipework diagrams showing the connections, pumping capacities and valves</td>
<td>Critical</td>
<td>An estimate of the reduction in the ship’s ballasting rate following installation of the treatment system and a description of any mitigation measures. This should include details of pressure drops and the effect that the introduction of the treatment equipment will have on ballast pump suction and delivery performance.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Retention time: minimum time the ballast water has to be retain in tanks for safe discharge without neutralizer</td>
</tr>
<tr>
<td>Compartment details for the installation of treatment equipment and storage of consumable materials</td>
<td>Critical</td>
<td>Types of technology employed in the system.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Chemicals required and their consumption rates.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Health and safety considerations in terms of working environment, handling and storage of chemicals.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Protection systems for normal and emergency operation</td>
</tr>
<tr>
<td></td>
<td></td>
<td>EX restrictions: If the system can installed in hazardous areas, where required</td>
</tr>
<tr>
<td>Power supply availability and routing for control cabling</td>
<td>Critical</td>
<td>The system’s power consumption (excluding the ship’s fitted ballast pumps) and any other electrical requirements.</td>
</tr>
<tr>
<td>Certification requirements</td>
<td>Secondary</td>
<td>The work plan for supply to ship, installation, commissioning and test.</td>
</tr>
<tr>
<td>Details of the ballast tank coatings</td>
<td>Critical</td>
<td>A statement of the effect that the treated ballast water will have on ballast tank coatings, including copies of relevant studies that support such claims</td>
</tr>
</tbody>
</table>

Figure 6.1: Procurement Specification
Ballast Water Convention and Ballast Water Treatment Systems
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<table>
<thead>
<tr>
<th>Other Information that operators should consider when shortlisting potential suppliers</th>
<th>Importance</th>
</tr>
</thead>
</table>
| Costs:  
  - price of the equipment  
  - installation and commissioning costs  
  - estimated operating costs including consumables | Critical |
| Training requirements for system operation, calibration, monitoring and health and safety | Secondary |
| Maintenance requirements of the systems | Critical |
| Operating experience of the suppliers | Secondary |
| Any special docking requirements or ship modifications required for equipment installation. | Critical |

Figure 6.2: Other Information to be considered

6.3 ENGINEERING CHECKS
After technical data has been received from the suppliers, operators should carry out the following engineering checks:

c) Ensure that existing auxiliary generators and control systems can cope with the additional power requirements (for some systems it may be necessary to upgrade generators)

In general the installation onboard of the Ballast Water treatment system requires an increment of the electric power generation. The main contributions to the increase of electrical power are:

- Increase of electrical power required by ballast pumps
- Electrical power required by ballast water treatment system.

The increase of dimensions of diesel generators depends mainly on the ratio between ballast water pumps capacity and the electrical power required to be installed onboard in the hypothesis that no BWT system is fitted. The percentage of additional required electrical power increases proportionally to the above mentioned ratio.

In the worst situation it could be necessary to increase the number of diesel generators (e.g. case of Panamax Bulkcarrier gearless), in the remaining cases it could be necessary to change the type or the rating of diesel generators.

d) Check that treatment equipment can be easily integrated into existing ballast systems

The installation of the water treatment system can impact the number and the characteristics of ballast pumps. In fact the power of the pumps might be increased in order to cover the pressure drop of the treatment system.

e) Check the suitability of control requirements, including alarms and protective devices

Ballast water management systems should incorporate a visual alarm which is always activated whenever the BWMS is in operation for purposes of cleaning, calibration, or repair, and these events should be recorded by the control equipment. It is recommended that automatic ballast water treatment controls and alarms are integrated with, or located close to, the ship’s ballast water controls.
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f) Conduct a review of local versus remote operating systems and ease of integration with existing machinery controls

g) Assess ease of maintenance, calibration and ballast water sampling
Manufacturers’ maintenance requirements should be reviewed to confirm which activities the ship’s staff are required to perform, what spares and consumables would need to be carried, and what service requirements, if any, would have to be undertaken by the original equipment manufacturer (OEM).

h) Assess the need for venting or other measures for compartments where active substances (chemical or otherwise) are stored or at risk of escape.
Some systems generate chemicals during the treatment process, for others chemicals are required to be stored on board.
If chemicals are stored on board, the crew will require training on their use and handling.
Suitable storage space for chemicals and proper ventilation are of paramount importance. The Safety Data Sheet for chemicals to be stored on board need to be consulted and where necessary the appropriate fire protection and extinction arrangements will need to be installed. In the case of systems that generate chemicals during the treatment process, the crew will require training on the hazards associated with them.

Advice on the storage and handling of chemicals is contained in the IMO Circular: BWM.2/Circ.20 “Guidance to ensure safe handling and storage of chemicals and preparations used to treat ballast water and the development of safety procedures for risks to the ship and crew resulting from the treatment process”.

i) Assess how sediments will be managed.
Regulation B-5.1 of the Convention requires that all ships remove and dispose of sediments from spaces designated to carry ballast water in accordance with the Ballast Water Management Plans. Ship designers, shipbuilders, owners and operators should design and operate ships in order to minimize the retention of sediment. Guidance on the management of sediment is contained in the “Guidelines for ballast water management and development of ballast water management plans (G4)”. Reference should be made also to the “2012 Guidelines on design and construction to facilitate sediment control on ships (G12)” (resolution MEPC.209(63))

j) Ensure ballast tank gauging will not be affected by the ballast water treatment system (pneumatic tank gauges may be affected by inerting of ballast tanks).

k) Ensure that the ballast water treatment system arrangements maintain the separation of ballast tanks located within ‘gas safe’ and ‘gas dangerous’ zones
In some cases, separate ballast water systems may be required for each zone. Typically, this applies to oil and chemical tankers.
# 7 DOCUMENTATION TO BE SUBMITTED

## 7.1 SHIP PLANS AND OPERATIONAL MANUALS

Once identified the most appropriate ballast water treatment plant, Table 1 below shows the general ship plans and operational manuals that should be submitted for review/approval or information, as applicable. Specific documents that need to be placed onboard the ship for presentation to the RINA Surveyor at appropriate surveys are also annotated in the table.

Due to a wide range of treatment systems, RINA may require the submission of additional plans or supporting information as called for by the specific treatment system.

<table>
<thead>
<tr>
<th>Type of Ship Plans and Manuals</th>
<th>Additional Description</th>
<th>For Approval (AP) or Information (I)</th>
<th>Placed Onboard Ship for Survey (S)</th>
</tr>
</thead>
<tbody>
<tr>
<td>General arrangement drawings of the BWMS</td>
<td>Installation arrangement drawings on the ship including location and layout</td>
<td>AP</td>
<td>--</td>
</tr>
<tr>
<td>Arrangement and capacity of ballast tanks and pumps</td>
<td></td>
<td>I</td>
<td>--</td>
</tr>
<tr>
<td>Ballast piping system drawings</td>
<td>Layout, filling arrangement, and booklet of construction details of piping system</td>
<td>AP</td>
<td>--</td>
</tr>
<tr>
<td>Location of ballast water sampling facilities</td>
<td></td>
<td>AP</td>
<td>--</td>
</tr>
<tr>
<td>Electrical circuit drawings and main power cable drawings</td>
<td></td>
<td>AP</td>
<td>--</td>
</tr>
<tr>
<td>Power calculation document</td>
<td>Including electrical load analysis</td>
<td>AP</td>
<td>--</td>
</tr>
<tr>
<td>Control, monitoring and safety system documentation</td>
<td>Especially where the controls and monitoring of the BWMS have been connected to or integrated with the ship’s control and monitoring system(s)</td>
<td>AP</td>
<td>--</td>
</tr>
<tr>
<td>Local instrumentation arrangement plan</td>
<td></td>
<td>AP</td>
<td>--</td>
</tr>
<tr>
<td>Structural plans</td>
<td>Showing installation details of attachment, supports and foundations of principal components of the BWMS</td>
<td>AP</td>
<td>--</td>
</tr>
<tr>
<td>Hazardous area plan</td>
<td></td>
<td>AP</td>
<td>--</td>
</tr>
<tr>
<td>List of electrical equipment in hazardous area</td>
<td></td>
<td>I</td>
<td></td>
</tr>
<tr>
<td>Storage tanks and day tanks containing chemicals and preparations used to treat ballast water</td>
<td>Include complete piping details of filling, drain system, vents, drip trays, and safety precautions, etc.</td>
<td>AP</td>
<td>S</td>
</tr>
<tr>
<td>Safety documentation for hazardous chemicals</td>
<td>In recognized industry format, such as MSDS, CHRIS Code, Cole-Palmer</td>
<td>I</td>
<td>--</td>
</tr>
<tr>
<td>Leakage detection system and safety features associated with the generation of toxic or flammable gases</td>
<td>Safety features include sensor, alarms and shutdown settings, etc. together with proper suitable certification. Schematic plans detailing arrangement and location of sensor are to be provided</td>
<td>AP</td>
<td>S</td>
</tr>
</tbody>
</table>

Figure 7.1 (Part 1): general ship plans and operational manuals to be submitted for review/approval or information
Ballast Water Convention and Ballast Water Treatment Systems
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<table>
<thead>
<tr>
<th>Type of Ship Plans and Manuals</th>
<th>Additional Description</th>
<th>For Approval (AP) or Information (I)</th>
<th>Placed Onboard Ship for Survey (S)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Safety assessment documentation, where applicable</td>
<td>For BWMS that employs active substances and preparations; include arrangement, handling and safety plans of auxiliary systems for the treatment system, as applicable</td>
<td>AP</td>
<td>--</td>
</tr>
<tr>
<td>Ballast water management plan (BWMP)</td>
<td>BWMP is specific to the ship and in a standard format per G4 Guidelines</td>
<td>AP</td>
<td>S</td>
</tr>
<tr>
<td>BWMS operating and safety manual</td>
<td>Manual specific to the actual installation onboard the ship;</td>
<td>AP</td>
<td>S</td>
</tr>
<tr>
<td>Shipboard function test plan for sea or quay trial</td>
<td>Function test of the installed BWMS at the sea trial or quay trial in the presence of RINA Surveyor; function test plan per paragraph 5.1.9 of G8 Guidelines;</td>
<td>AP</td>
<td>--</td>
</tr>
<tr>
<td>Ballast water record book</td>
<td>Ballast water record book is specific to the ship</td>
<td>I</td>
<td>S</td>
</tr>
</tbody>
</table>

Figure 7.1 (Part 2): general ship plans and operational manuals to be submitted for review/approval or information

7.2 REQUIRED SPECIFIC CERTIFICATION AND DOCUMENTATION

The ballast water management system installed onboard shall be type-approved by an IMO Member State, and some specific certificates and documentation of the treatment system are to be provided for record, information or reference, as appropriate. The certificate/documentation requirements are shown in Table 2.

In accordance with the Convention, specific documents are to be retained onboard the ship for presentation or inspection at appropriate surveys.

<table>
<thead>
<tr>
<th>Type of Document for BWMS</th>
<th>Additional Description</th>
<th>For Record (R) or Information (I)</th>
<th>Placed Onboard Ship for Survey (S)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Type Approval Certificate of BWMS</td>
<td>G8 Guidelines, paragraph 8.1.1; Information for the Certificate is to include main particulars of BWMS, approved application, limiting conditions and others as stipulated in G8 Guidelines, Section 6</td>
<td>R</td>
<td>S</td>
</tr>
<tr>
<td>Results of test analysis for BWMS</td>
<td>Copy of test results showing the effectiveness and ability to meet IMO discharge standards per G8 Guidelines, paragraph 6.5.4</td>
<td>I</td>
<td>S</td>
</tr>
<tr>
<td>International Ballast Water Management Certificate (after entry into force)</td>
<td>In accordance with the Convention Regulation E-2</td>
<td>I</td>
<td>S</td>
</tr>
</tbody>
</table>

Figure 7.2 (Part 1): certificate/documentation requirements
<table>
<thead>
<tr>
<th>Type of Document for BWMS</th>
<th>Additional Description</th>
<th>For Record (R) or Information (I)</th>
<th>Placed Onboard Ship for Survey (S)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Type Approval Certificate of BWMS</td>
<td>G8 Guidelines, paragraph 8.1.1; Information for the Certificate is to include main particulars of BWMS, approved application, limiting conditions and others as stipulated in G8 Guidelines, Section 6</td>
<td>R</td>
<td>S</td>
</tr>
<tr>
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<td>I</td>
<td>S</td>
</tr>
<tr>
<td>International Ballast Water Management Certificate (after entry into force)</td>
<td>In accordance with the Convention Regulation E-2</td>
<td>I</td>
<td>S</td>
</tr>
<tr>
<td>Documentation verifying IMO Basic Approval of BWMS to G9 Guidelines, if applicable</td>
<td>In a suitable format: i.e., basic approval application and GESAMPBWWG review report, etc.</td>
<td>R</td>
<td>--</td>
</tr>
<tr>
<td>Documentation verifying IMO Final Approval of BWMS to G9 Guidelines, if applicable</td>
<td>In a suitable format: i.e., final approval application and GESAMPBWWG review report, etc.</td>
<td>R</td>
<td>--</td>
</tr>
<tr>
<td>Statement confirming BWMS type tested in accordance with the environmental testing specifications of the Convention</td>
<td>G8 Guidelines, paragraph 8.1.2; from the BWMS manufacturer</td>
<td>I</td>
<td>S</td>
</tr>
<tr>
<td>Equipment manuals for major components of BWMS</td>
<td>G8 Guidelines, paragraphs 5.1.1 and 8.1.3; manual should include equipment list and specifications; from the BWMS manufacturer</td>
<td>R</td>
<td>S</td>
</tr>
<tr>
<td>Operations and technical manual</td>
<td>Manual is specific to the ship and approved by the Administration per G8 Guidelines, paragraphs 8.1.4, 5.1.3-7; from the BWMS manufacturer</td>
<td>R</td>
<td>S</td>
</tr>
<tr>
<td>Installation specifications</td>
<td>G8 Guidelines, paragraphs 8.1.5 and 5.1.8; from the BWMS manufacturer</td>
<td>R</td>
<td>S</td>
</tr>
<tr>
<td>Installation commissioning Procedures</td>
<td>G8 Guidelines, paragraph 8.1.6; from the BWMS manufacturer</td>
<td>R</td>
<td>S</td>
</tr>
<tr>
<td>Initial calibration procedures</td>
<td>Guidelines, paragraph 8.1.7; from the BWMS manufacturer</td>
<td>I</td>
<td>S</td>
</tr>
<tr>
<td>Documentation relating to the environmental and public health effects of the BWMS</td>
<td>BWM.2/Circ.28, paragraph 3.1.13.7 and G8 Guidelines, Part 1, Section 1.6.4; BWMS manufacturer is to provide information to ship owner</td>
<td>I</td>
<td>--</td>
</tr>
<tr>
<td>Documentation relating to the corrosion effects of the BWMS on the ship’s tank coatings, steel plating or ballast water system</td>
<td>BWM.2/Circ.28, paragraph 3.1.13.2; BWMS manufacturer is to provide information to ship owner</td>
<td>I</td>
<td>--</td>
</tr>
</tbody>
</table>

Note: Where “R” is indicated, submission of the documentation to RINA is mandatory, as it will be used as reference for the engineering review.

Figure 7.2 (Part 2): certificate/documentation requirements
7.3 ENGINEERING REVIEW
Hull plans showing the foundation and attachments to ship’s structure for each component of the BWMS are to be submitted and approved. These plans are to clearly indicate the scantlings and details of welding.
Machinery plans showing the installation design of the BWMS on the ship including location, piping and electrical details/drawings, general arrangement and layout, installation and equipment plans are to be submitted and approved before proceeding with the installation. Plans are to include applicable arrangements for hazardous areas acceptable to RINA, if applicable.
8 SYSTEM RELATED AND INSTALLATION CRITERIA

8.1 GENERAL
In order to minimize the risk associated with the discharge of harmful aquatic invasive species resulting from ballast water transfers, the ballast water management system must be effective under the range of typical ship operating conditions without negatively impacting the safety of shipboard personnel or the ship or the environment into which the ballast water is discharged. Ballast water management systems must meet international protocols under various environmental conditions, aquatic organisms, flow rates, volumes, and retention times.

However, the Type approval of a system does not ensure that a given system will work on all ships or in all situations. The provisions in this Section address the supplementary classification requirements that apply when a ballast water management system is installed on board a ship.

As general rule, the ballast water management system (BWMS) must be designed, constructed and installed such that:

1. it is proven safe for the shipboard personnel and ship operations
2. it complies with the international regulations
3. it does not degrade the quality of local marine environments upon discharge.

8.2 COMMON CRITERIA
The design and installation of a ballast water management system is to comply with the following criteria:

1. The treatment rated capacity (TRC) is to be sufficient to meet the ship’s ballast capacity and normal ballast operations rate
2. Capable of operating effectively at the minimum discharge rate of the ballast pumps or stripping system
3. Capable of operating effectively with all connected ballast system pumps and eductors
4. Capable of effectively treating all ballast water regardless of tank location, size or structure
5. Provide for ballast flow to the furthermost tank at maximum capacity stated in the ship’s BWMS specification
6. Shall not adversely affect any parts, materials, equipment, structures or coatings
7. Shall not exceed the electrical generating capacity of the shipboard power supply under normal in port operating conditions
8. Shall not discharge hazardous vapors or byproducts to the atmosphere, other than as considered in the type approval of the BWMS
9. All parts of the BWMS are to be easily accessible for inspection and maintenance
10. Have suitable bypasses or overrides to protect the safety of the ship and personnel in the event of an emergency (See para 8.2.5.9 “Bypass arrangements”)
11. Comply with all requirements, restrictions and conditions identified in the type approval certificate issued by the IMO Member State.
8.2.1 BWMS Locations

8.2.1.1 General

1. A ballast water management system may be installed in various locations throughout a ship. The acceptability of the location and arrangements depend on the type of treatment system under consideration, the installation specifications and the type of ship involved. Each installation must be carefully evaluated to verify that potential safety concerns and pollution hazard issues are adequately addressed.

2. Regardless of the location, all BWMS installations shall be in accordance with all relevant requirements listed in this Guide, the RINA Rules and Guides, and international regulations, standards, guidelines and recommendations.

3. BWMS equipment enclosures may not be constructed on weather deck locations that will reduce the navigational bridge visibility.

4. New or retrofitted enclosed deckhouse is to comply with Part B of RINA Rules for structural requirements and deck openings.

5. For tankers transporting combustible, corrosive, or toxic cargo, the BWMS is required to comply with the criteria relevant to the cargo transported and the ship arrangements as specified in Common Structural Rules for Double Hull Oil Tankers and Part E of RINA Rules.

8.2.1.2 Locations of BWMS not involving hazardous areas

Ballast water management systems that do not serve ballast tanks considered to be hazardous may be installed in the following locations, unless specifically prohibited due to the treatment method involved:

1. Machinery space or engine room
2. Void spaces with or without direct access or adjacent to the machinery room
3. Dedicated enclosure

8.2.1.3 Locations of BWMS involving hazardous areas or with process creating a hazard

Unless the system configuration, arrangements, locations and isolation arrangements have been specifically accepted by RINA, ballast water management systems that serve ballast tanks considered to be hazardous are to be installed in a void space, weather deck enclosure, or enclosed compartment on the cargo deck, complying the below compartment criteria. In addition, treatment systems that are prohibited from being installed in areas such as typical machinery space due to the treatment method involved (e.g., treatment process creating a hazard) are to be installed in a void space, weather deck enclosure, or enclosed compartment on the cargo deck, complying the below compartment criteria:

1. Determined to be suitable for the service intended
2. Treated as “other machinery spaces” with respect to the fire protection
3. Positioned outside of any combustible, corrosive, toxic, or hazardous areas unless specifically approved
4. Arranged with no direct access to accommodation spaces, service space, machinery space, control stations or other spaces containing sources of ignition, unless specifically approved
5. Watertight integrity of all bulkhead openings and penetrations to be maintained
6. Watertight integrity of all deck openings and penetrations to be maintained
7. Minimize the extent of bulkhead and deck openings and penetrations
8. Additional restrictions and requirements may apply to installations of BWMS serving ballast tanks of oil and chemical carriers. See Section 5 for additional details.

8.2.2 Ventilation Systems

8.2.2.1 BWMS not Involving Hazardous Areas/Concerns
1. Where the BWMS is installed in the machinery space or engine room, the equipment is to be located in a well-ventilated area.
2. Where the BWMS is installed in a separate space that is not located within a hazardous area and does not serve any ballast tanks considered to be hazardous, the space is to be fitted with an independent mechanical extraction ventilation system providing at least six (6) air changes per hour or as specified by the BWMS manufacturer, whichever is greater.

8.2.2.2 BWMS Involving Hazardous Areas/Concerns
Unless specifically approved otherwise, the space for a BWMS serving a hazardous area is to comply with the following requirements:
1. Where the BWMS is installed in a separate compartment that is located within a hazardous area and treats the ballast water in the ballast tanks that are considered hazardous, but because of the system and enclosure arrangements (e.g., air lock access, ventilation outlets outside of hazardous area, etc.), the interior of the compartment is determined to be nonhazardous and does not contain any sources of release from a ballast tank that is considered to be hazardous, the following ventilation arrangements are to be provided:
   - A mechanical ventilation system that will maintain the space under a positive pressure relative to the external hazardous area
   - The relative overpressure or air flow is to be continuously monitored and so arranged that in the event of a ventilation failure an audible and visual alarm is given at a manned control station and the electrical supply of all equipment (not of the certified safe type) is to be automatically disconnected.
2. Where the BWMS is installed in a separate compartment that is considered to be a hazardous area, the ventilation system for the space is to provide:
   - At least twenty (20) air changes an hour if there are no sources of release (i.e., flanged connections, strainers, etc.) within the space,
   - At least thirty (30) air changes per hour if there are sources of release within the space, or
   - At least forty five (45) air changes per hour for hazardous space containing sources of release of specific cargoes being categorized such that compliance with Section 15.17 in the “Special Requirements” of the IBC Code is required.

4.2.2.3 Additional requirements
Additional ventilation requirements may apply depending on the type of treatment system utilized and the location involved.
8.2.3 Structural Considerations

The treatment unit and related equipment must be efficiently supported and the adjacent structures are to be adequately stiffened as required. Structural considerations are subject to all relevant requirements listed in this Guide and the RINA Rules, and international regulations, standards, guidelines and recommendations.

The installation of a ballast water management system on a new or existing ship shall not compromise the integrity of the ship hull, framing, decks, bulkheads, tank structures, existing equipment foundations, or additional structural members. Additionally, the application of a BWMS is not to adversely affect the ballast loading conditions, loading instrumentation, intact stability, damage stability and fire safety. Any modification to a ship's structure, stability, or safety considerations, as a result of the ballast water treatment equipment, shall be designed, constructed, and surveyed as indicated in this Guide and the RINA Rules Part B and Part C.

Careful attention to the BWMS design, foundation, supports, and distribution of weight is to be regarded as of the utmost importance for all BWMS installations, and especially for machinery space installations due to necessary openings in the machinery space, limited support for decks, and maintenance of side and bottom stiffness.

8.2.4 Corrosion Effects

Ballast water management systems are not to deteriorate, degrade, or reduce the functional life expectancy of the ballast tank coatings or means of corrosion prevention. Additionally, the treatment method employed is prohibited from resulting in damage, deterioration, or degradation to ballast piping and integral joints that are protected against corrosion by means of a coating or lining.

Several official IMO documents address the potential corrosive effects that ballast water management systems may have on the ballast tanks (including coatings) and the ballast system. Shipyards, BWMS manufacturers, owners and operators are to consider and where appropriate, address the following:

1. The active substances and preparations used for the BWMS as well as the treated ballast water must be compatible with the coating system (G9 Guidelines, Section 3.4);
2. Data-set on the corrosivity to the materials or equipment of normal ship construction should be provided (G9 Guidelines, Section 4.2.1.4);
3. Application should include corrosion testing of uncoated substrates and marine epoxy coated steel; coating in accordance with IMP Performance Standard for Protective Coatings) (MEPC 59/2/16, Section 5.1)
4. Documentation of preliminary assessment of the corrosion effects of the BWMS system (BWM.2/Circ.28)
5. Long term corrosion effects of the treated ballast water on the ballast system and other spaces (Annex to G8 Guidelines, Part 1, Paragraph 1.3)

Copies of the documentation relating to the corrosion effects of the BWMS, including the test report or preliminary assessment report, which are a part of the IMO Member State’s type approval dossiers are to be provided to RINA for reference.
8.2.5 Ballast System

8.2.5.1 General
The ballast systems are to provide a reliable means of filling, transferring and draining ballast tanks employing a ballast water management system through the provisions of redundancy, certification of BWMS pumps and suitable remote control, where fitted. A ballast system design including piping, pumps, valves, and other piping equipment must comply with all criteria for ballast systems as indicated in this Guide and Part C of the RINA Rules. Additional ballast system piping requirements for oil, liquefied natural gas, and chemical carriers including safety arrangement are to comply with the relevant sections of Part E of the RINA Rules. Where the ballast system has a capacity exceeding the treatment rated capacity of an in-line BWMS, an appropriate flow control arrangement is to be provided for the ballast pumps.

8.2.5.2 Ballast Pumps
Any modification to the existing ballast pumps, installation of new ballast pumps, or installation of booster pumps are to comply with the requirements in Part C of the RINA Rules.

8.2.5.3 Piping Components Materials and Design
1. The materials and design of all BWMS piping components are subject to the requirements of Part C, Ch 1, Section 10 of the RINA Rules.
2. In addition, BWMS piping using miscellaneous non-metallic components made of thermoplastic or thermosetting plastic material such as polyvinyl chloride (PVC), fiber reinforced plastic (FRP), etc., in general, are to comply with the requirements of Part C, Ch 1, Appendix 3 of the RINA Rules. However, special considerations may be given to the fire endurance and flammable spread requirements subject to the additional requirements specified below for acceptance by RINA:
   a) The components of the ballast water treatment equipment are to be arranged on a skid. Modular installation design will be subject to special consideration.
   b) The inlet, outlet and drain pipes connected to the skid-mounted unit are to be made of steel or equivalent materials. However, fiber reinforced plastic pipe of approved type and suitable design, which has passed at least the level 3 (L3) fire endurance tests, is considered acceptable.
   c) Depending on the exact location of the installed skid-mounted unit within an approved space, local fire fighting arrangements and/or a metallic enclosure covering the non-metallic components may be required at the discretion of RINA.
   d) In case of emergencies, suitable remote operable bypasses are to be provided to isolate the complete non-metallic piping system on the skid-mounted unit from the rest of the ship’s piping system.
   e) For the skid-mounted ballast water treatment equipment installed in hazardous locations, the requirements in this section are applicable in addition to the requirements specified in Section 9 of the Guide.
   f) The requirements of the ship’s Flag Administration for non-metallic components made of thermoplastic or thermosetting plastic material are to be satisfied.

8.2.5.4 Vent Piping
The vent pipe location of a ballast water management system that vents explosive and toxic gases is to comply with the intent of Part E, Chapter 7, Section 6 of the RINA Rules as applicable. A spherical distance within 3 m (10 feet) measured spherically with the vent outlet as the center is to be considered as hazardous.

8.2.5.5 Ballast Water Sampling Piping
Ballast water management systems are required to include all necessary access, piping and equipment for ballast water sampling to maintain operational safety and regulatory compliance. The sampling system is to provide for compliance with Section 5 of the Resolutions MEPC.173(58) Guidelines for Ballast Water Sampling (G2).

Piping is to be arranged such that samples are to be taken from the ballast water discharge piping as close to the point of discharge as feasible. BWMS that employ treatment during discharge operations must use in-line sampling. Details regarding the sampling facility design as required for compliance are located in Section 5, and Parts 1 and 2 of the G2 Guidelines.

8.2.5.6 Remote Control Valves
Remote control valves, where fitted, are to be arranged so that they will close and remain closed in the event of a loss of control power or emergency shutdown. Additionally, remote control valves are to be provided with position indicators in the BWMS instrumentation display at the ballast control station.

8.2.5.7 Damage Stability Consideration
BWMS piping, where installed within zones of the assumed extent of damage under damaged stability conditions, is to comply with Part F, Chapter 13, Section 11 of the RINA Rules.

8.2.5.8 Ballast Water Stripping
For ballast water management systems that employ a double passage method (i.e., treating the ballast water both at intake and at discharge), appropriate arrangements are to be provided such that, in the ballast stripping operation, the water stripped from the ballast tank can also be routed through all the required treatment equipment and processes identified in the IMO Member State’s type approval for the ballast discharge operation without damaging or incapacitating the BWMS due to sediment and particles in the stripped ballast.

For chemical treatment systems that need to neutralize the residual oxidants in the ballast water before discharge, the driving fluid for any eductor involved in the stripping operation could affect the efficacy of the neutralization, depending on where the neutralizer is applied (before or after the eductor) and where are the measurements of the TRO (total residual oxidants) level in the ballast system which cause the adjustment of the amount of neutralizer needed. The effectiveness of the neutralization is to be appropriately addressed in the ballast water stripping design and operation. For oil and chemical carriers, protection measures are to be provided to address the interconnection of piping between the fire/general service pump in the machinery space (non-hazardous space) and the ballast eductor in the cargo pump room (hazardous space). See para 9.3 of this Guide.

8.2.5.9 Bypass Arrangements
Suitable bypass and interlocking arrangements specifically accepted by RINA are to be provided to isolate the BWMS from the ballast system piping such that the ballast system can be operated
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totally independent of the BWMS in the event of emergency.

8.2.6 Electrical System
8.2.6.1 General
Unless specifically stipulated otherwise in this Guide, the electrical system and electrical equipment are to be in accordance with the electrical requirements of the RINA Rules.

8.2.6.2 Electrical Load Analysis
The total electrical load of a BWMS is to be such that under the normal in port operating conditions of ballasting or de-ballasting the electrical generating capacity installed on the ship is adequately demonstrated by an electrical load analysis.

8.2.7 Instrumentation
8.2.7.1 Local Instrumentation
Local instrumentation and controls of the BWMS are to be fitted so as to enable safe operation, maintenance and effective control in the event of an emergency or failure of any remote controls. Local instrumentation is to indicate ballast operating conditions and status of the ballast water treatment equipment. For installations where the ballast water treatment equipment is not located in the same space as the ballast pumps, the operational status of the ballast pumps is to be indicated near the ballast water treatment equipment. The local instrumentation is to include:
   a) Ballast pump operational status (e.g., pressure gauge)
   b) BWMS and equipment operational status
   c) Remote control valve, where fitted, position indication
   d) Necessary instrumentation for all BWMS equipment parameters and specific conditions, as applicable

8.2.7.2 Ballast Control Station Displays
Where remote control stations are fitted, the instrumentation parameters as indicated in 4.2.6.1 a) and c) and the ballast tank level indications are to be displayed at the remote control station. Display of items in 4.2.6.1 b) and d) at the remote control station is advisable.
A tank level gauging system, where fitted, is to be capable of measuring the full height of all ballast tanks individually and provided at the ballast control station. The selection of a tank level gauging system and the connection between the level gauging system and the BWMS are to be specially considered to verify the system compatibility such that the level gauging system work correctly with the BWMS.

8.3 MECHANICAL SEPARATION SYSTEMS
Ballast water management systems utilizing mechanical separation are to comply with the following:
   a) The maximum pressure loss across the BWMS is not to prevent or impair the ability of the ballast system to supply the most hydraulically remote ballast tank at an acceptable flow rate identified in the BWMS manual.
   b) The arrangements for backwashing, including the flow rate, pressure differential, sizing and routing of the overboard discharge piping, etc., are to be designed such that all wastes will be adequately removed from the system when taking into account the maximum static head imposed when the ship is at its maximum draft.
c) Arrangements (e.g., controls, procedures, etc.) are to be designed such that the separation system and associated piping will be backwashed and flushed clean upon completion of ballasting operations before the ship departs the ballasting port; and if applicable, before the ship departs the de-ballasting port.

d) The backwash is not to have an adverse impact on the local marine environment upon discharge when located downstream of an additional treatment measure, unless such arrangements have been approved by the IMO Member State in the type approval of the system.

8.4 PHYSICAL TREATMENT SYSTEMS
The primary physical treatments used in ballast water management systems include cavitation, thermal (heat), inert gas, ultrasound, and ultraviolet irradiation (UV). Additional criteria are included, as applicable, within the individual treatment subsection.

8.4.1 Cavitation and Ultrasound Systems
Any pressure loss across the cavitation or ultrasound treatment system shall not impair the ballast water flow to the furthest ballast tank at maximum capacity.

8.4.2 Thermal Systems
The application of thermal (heat) treatment for ballast water management systems shall require a review of all plans, energy balances, structural considerations and operations. Equipment installed for the application of heat to ballast water shall be subject to all relevant requirements in the RINA Rules.

8.4.3 Inert Gas De-oxygenation Systems
The design, construction and operational criteria for a treatment system supplying inert gas to ballast tanks are to comply with the RINA Guide for Inert Gas System. Where inert gas is injected directly into the ballast piping, equivalent arrangements for safety, monitoring and controls specified in the Guide for Inert Gas System are to be provided. Any interconnections of a shipboard inert gas system and a vendor supplied inert gas generator intended for ballast treatment is to be subject to special consideration, and arrangements for isolation, interlocks and controls are to be submitted for review. Additionally, any pressure loss across the treatment shall not impair or prevent the ballast water flow to the furthest ballast tank at maximum capacity. Inert gas ballast water management systems are required to comply with all applicable criteria as specified in this Guide, the above-referenced Guide, RINA Rules, and international regulations and standards.

8.4.4 Ultraviolet Irradiation (UV) Systems
Ultraviolet irradiation ballast water management systems are required to comply with all applicable criteria in this Guide, the RINA Rules, and international regulations, standards, guidelines and recommendations. Arrangements are to be provided such that the crew will not be exposed to excessive amounts of UV light during operation, maintenance or repairs of the system. Additionally, the following arrangements are to be provided:

a) A high temperature alarm and high-high temperature automatic shutdown
b) Means to prevent the accumulation of air in the top of the lamp enclosure or treatment chamber
c) A means to prevent operating the UV lamps without water in the treatment chamber in order to avoid over-heating the UV unit. Such means may include an interlock or an appropriate piping arrangement that maintains a constant flow of water through the treatment chamber to dissipate the heat, etc.
d) Protection of electrical equipment with respect to the degree of enclosure, insulation materials and maximum ambient temperatures in accordance with Part C, Chapter 2 of the RINA Rules and the manufacturer’s specifications.

Document confirming the instrumentation, monitoring and control equipment for all vital parameters such as the UV dose, lamp power, intensity, etc., including the application conditions for effective assessment of the treatment operations, as specified in the IMO Member State’s type approval is to be submitted to RINA.

8.5 CHEMICAL TREATMENT/ACTIVE SUBSTANCES SYSTEMS

8.5.1 Prepared Chemical Treatment Systems

8.5.1.1 General

Ballast water management systems employing a chemical treatment are required to comply with all criteria in this Guide, the RINA Rules and Guides, international standards, flag Administration criteria, recommendations or requirements specified in the chemical manufacturer’s Material Safety Data Sheet (MSDS), and local standards involving the discharge of chemical substances. All equipment, piping and components storing, conveying, or creating flammable, toxic or corrosive chemicals as provided for, created by, or resulting from a BWMS must be designed, constructed, operated and maintained in accordance with Part C, Chapter 1, Section 10 of the RINA Rules, and flag Administration criteria. These documents, standards, and criteria are to be reviewed and applied in conjunction with this Guide.

Additionally, the following arrangement/procedures as applicable to the specific chemical treatment system are to be satisfied:

a) Implementation of a safe and secure means of transferring chemical onto the ship. Such measures may include a containment that is impact resistant, leak-proof, airtight, and watertight. Volume, weight, and concentration standards may apply.
b) Design and installation of containment system for all liquid chemicals stored and in use. The containment system shall be designed to prevent any chemicals from escaping under the maximum inclination conditions and to accommodate the type and volume of chemical being used in the event the primary containment barrier fails.
c) When chemicals are provided as a gas the system shall comply with Part C, Chapter 1, Section 10, Para 19 of the RINA Rules.
d) A safe means is to be provided to apply the stored chemicals into operation.
e) An approved gas detection system shall be installed in all spaces housing the chemicals and chemical treatments to provide a safe environment, proper air supply and ventilation, and leakage detection. Alarm levels will be based on a case-by-case basis acceptable to RINA.
f) A high temperature and pressure alarm is to be provided, with its shutdown conditions identified.
g) A low pressure alarm is to be provided, with its shutdown conditions identified.
h) Chemical level indication, alarms, and automatic shutdown are to be arranged at remote and local control stations.
i) An adequate system capable of self-monitoring and recording of chemical dosages or treatment intensities is to be provided.
j) An adequate means to prevent overflowing the ballast tanks and unintentional ballast discharge prior to discharge treatment or at any point during the ballast retention above acceptable residual limits is to be provided. Such measures may not impair the safety and stability of the ship under all operating conditions.
k) All equipment, piping, components and coatings exposed to the chemical treatments shall be compatible with the chemical. Chemical treatments shall not induce or accelerate the corrosion of any BWMS or ballast system component.
l) Chemical storage tanks, and other components of the BWMS subject to leakage, if applicable, are to be provided with spill trays of ample size - large enough to cover the leakage points such that manholes, drain valves, gauge glass, filler, pumps, etc.

8.5.1.2 Safety Assessment
A safety assessment study to address the risk to the ship and its crew is to be conducted. The scope of the safety assessment is to include at least the following subjects:

a) The loading and storage of chemicals or preparations onto the ship
b) The transfer and application of chemicals or preparations from storage to the BWMS
c) The position of the BWMS and associated piping
d) Operation of the BWMS, specifically any potential impacts on the ship’s crew
e) Maintenance of the BWMS and safe work procedures
f) Spillages from the BWMS and emergency response plan

Specifically, this safety assessment is to address the adequacy of the chemical containment system, the ventilation system, fire protection and extinction of those spaces where the chemicals or preparations are stored as applicable, the ship-specific details concerned with the loading of the ballast water treatment chemicals onto the ship, the handling and applying of chemicals/preparations into the BWMS, and the development of ship-specific health and safety procedures for the normal operation of the BWMS; as well as the procedures to be followed in the event of a spillage on board or crew exposure to the treated ballast water, chemicals or preparations.

The safety assessment should be undertaken prior to the installation of the BWMS, so that any mitigation measures identified during the assessment study can be rectified either prior to, or during installation. This safety assessment is to be reviewed by RINA to confirm the adequacy of the proposed arrangements. Relevant information resulted from the safety assessment is to be documented in the ship’s ballast water management plan (BWMP).

Additional guidance can be found in the IMO BWM.2/Circ.20, “Guidance to ensure safe handling and storage of chemicals and preparations used to treat ballast water and the development of safety procedures for risks to ship and crew resulting from the treatment process”.

8.5.2 Ozone Injection Systems
8.5.2.1 Gas Detection
Ozone sensors are to be installed in the immediate vicinity of the ozone generating unit and along
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the route of the ozone piping where ozone gas could accumulate. The ozone sensors are to activate an alarm at a manned location when a concentration of 0.1 ppm or more is detected.

8.5.2.2 Ozone Pipe Routing
The routing of the ozone piping is to comply with the manufacturer’s recommendations and is not to pass through accommodations or service spaces.

8.5.2.3 Specific System Arrangements
The arrangements of an ozone system are to comply with the following:

a) Independent vents from the oxygen receiver safety relief valve and any ozone destructor unit are to be led directly to a place on the open deck where the discharges will not cause a safety or health hazard.

b) Arrangements are to be provided to automatically shut down the system immediately, close the power operated valves and stop all pumps under the following conditions:
   - High ambient oxygen concentration (25%);
   - High ambient ozone concentration (0.2 ppm);
   - The “ozone destructor” (VOD) not being available, if part of the approved system;
   - Activation of fire alarm in area of installation; and
   - Emergency stop push bottom pressed.

c) Permanent warning plates are to be installed near any areas into which the oxygen or ozone could escape.

8.5.3 Electrochlorination Systems
8.5.3.1 Installation Arrangement
The electrochlorination unit (ECU) of the electrochlorination BWMS is to be installed in an enclosed dedicated space unless specifically approved otherwise. The owner is to confirm that the electrochlorination unit will not result in the generation of excessive amounts of chlorine gas. The selection process shall take into consideration of the ship’s operating conditions with specific reference to the pH of the ballast water to be treated by the treatment system.

8.5.3.2 Ventilation Requirements
The space in which the electrochlorination unit is installed is to comply with the ventilation requirements of 4.2.2.2 point 2). The ventilation fans are to be non-sparking, suitable for use in hazardous areas and interlocked with the equipment so that the fans will be in operation any time when the electrochlorination unit is in operation.

8.5.3.3 ECU Vents
The exhaust vents for any gases generated in the electrochlorination process that could be flammable or harmful to the crew are to be led directly to a place in the open deck where such discharges will not cause a fire or explosion hazard. Where the vented gas could be flammable, the area within 3 meters (10 feet) around the vent outlet is to be considered to be a hazardous area. If the vented gas could be toxic, the location of the vent outlet is to be based on a gas dispersion analysis.
8.5.3.4 Additional Control Arrangements
Where the potential exists for flammable gases to accumulate inside the ECU when the system is not in operation, the system controls are to be arranged such that the electrodes cannot be energized until the unit is full of water. Similar controls are to be provided for any other portions of the system where flammable gases could accumulate if electrical equipment is installed therein.

8.5.3.5 Gas Detection Arrangements
A fixed hydrogen gas detection system is to be provided in the space housing the ECU and arranged such that the activation of the gas detection alarm will result in an automatic shutdown of all electrical power to the BWMS and activation of the ventilation system.

8.5.3.6 Potential Discharge to Ballast Tanks
The potential of any flammable or toxic gas released into the ballast tanks due to the operation of the electrochlorination system and the associated concentration and volume are to be identified and assessed. Where the concentration and/or volume of any flammable or toxic gases released into the ballast tanks could present a danger to the ship or a hazard to the crew, arrangements are to be provided for the safety of the ship and crew (e.g., suitability of level gauging system in tank, venting location and arrangements, etc.).

8.6 COMBINATION TREATMENT
Installation requirements for combination treatments are subject to all criteria and standards for the individual treatment methods applied to the combination treatment.

8.7 OTHER TREATMENT TYPES
Ballast water management systems involving process other than those specifically addressed in para 8.3 through 8.5 above are subject to special consideration.

8.8 SPECIAL FIRE FIGHTING EQUIPMENT AND ARRANGEMENTS
8.8.1 General
The requirements for fire safety are to be identified by the BWMS manufacturer and are to be based on the following principles:

a) The provision of appropriate fire detection and extinguishing system and equipment capable of extinguishing the type and scale of fire likely to occur in association with the installed BWMS.

b) The space containing the BWMS is to be such that the boundaries, will continue the fire for a period of at least one hour, to guard against the escape of flammable or toxic gases, and to minimize the likelihood of ignition.

c) The identification of fire risk of the BWMS, including the active substances or preparations used or generated, and the provisions of effective means to prevent and extinguish fires in the BWMS space is to be submitted for review by RINA.

Where such special instructions and/or requirements may interfere with the fire fighting equipment or system being provided in accordance with other Rule requirements, the same must be clearly identified and addressed to the satisfaction of RINA.
8.8.2 Recording in Ship’s Manual
The special fire fighting instructions and/or requirements in para 8.8.1 above are to be identified in the ship’s operating and safety manuals, and placards indicating the same are to be posted in appropriate locations.

8.9 SEDIMENT CONTROL
Ballast water tanks and their internal structure should be designed to minimize accumulation of sediments and permit for easy cleaning and maintenance. Design guidance of ballast tanks and other design enhancements given in the G12 Guidelines are to be adhered to as far as practicable.
There are also practical steps or procedures that can be implemented in the ballast water operation for sediment control. The recommendations given in the G4 Guidelines, Part A, Section 1.3, are to be adhered to as far as practicable.
Details of the methods and operational procedures for the sediment management on board the ship, including the disposal of sediments and the associated safety considerations, etc., are to be documented in the ship’s ballast water management plan (BWMP).
9 CONSIDERATIONS FOR OIL AND CHEMICAL CARRIERS

9.1 BASIC REQUIREMENTS
The provisions in this Section address the special requirements associated with the treatment of ballast water from tanks located adjacent to cargo tanks or other hazardous areas on oil or chemical carriers and are to be applied in conjunction with the requirements in Part E, Chapter 7 of the RINA Rules.

9.2 BWMS EQUIPMENT LOCATIONS
The ballast water management system, to the extent possible, is to be located in a non-hazardous area. Where a BWMS involves ballast water coming from or going to hazardous areas, the place where it is installed has to be considered hazardous area and electrical equipment are to be certified as safe type.

9.3 VENTILATION REQUIREMENTS
The ventilation systems serving spaces containing BWMS equipment are to comply with the requirements in para 8.2.2 of the Guide.

9.4 PIPING SYSTEM
9.4.1 General
The design and installation of the piping system of a BWMS on an oil or chemical carrier are to comply with the applicable requirements in Part E, Chapter 7 of the RINA Rules.

9.4.2 Interconnection Considerations
Piping system serving or having an opening into tanks or spaces that are considered to be hazardous is likewise to be regarded as contaminated and in general, is not permitted to enter machinery and other spaces normally containing sources of ignition as indicated in Part E, Chapter 7 of the RINA Rules due to the potential migration of flammable liquids or vapors from the hazardous area into the non-hazardous area. In association therewith, the following requirements are applicable:

a) Ballast piping serving ballast tanks considered to be hazardous is not to enter into or be routed through any non-hazardous areas.

b) Ballast piping serving hazardous areas is not to be interconnected with any piping system serving non-hazardous areas.

c) BWMS piping connected to ballast piping serving hazardous areas is not to be routed into nonhazardous areas unless specifically approved isolation arrangements are provided.

d) For BWMS equipment arranged with piping components made of thermoplastic or thermosetting plastic material, it is to comply with the requirements in para 8.2.5.3 (2) of the Guide.

9.5 SAFETY ASSESSMENT
Where determined to be necessary by RINA, a safety assessment study to address the risk to the ship and its crew is to be carried out. The scope of the assessment study is to include at least the following subjects:
The risk/safety assessment should be undertaken prior to the installation of the BWMS, so that any mitigation measures identified during the assessment study can be rectified either prior to, or during installation. This safety assessment study is to be reviewed by RINA to confirm the adequacy of the proposed arrangements.

Relevant information resulted from this safety assessment is to be documented in the ship’s ballast water management plan (BWMP).
10 OPERATIONAL MANAGEMENT

10.1 BALLAST WATER MANAGEMENT PLAN

10.1.1 General Content

Each ship shall have on board and implement a Ballast Water Management plan. Such a plan shall be approved by the Administration taking into account Guidelines developed by the Organization (“Guidelines for ballast water management and development of ballast water management plans”, MEPC.127(53)). The Ballast Water Management plan shall be specific to each ship and shall at least:

a) detail safety procedures for the ship and the crew associated with Ballast Water Management as required by this Convention

Detailed operating and safety manuals are to be provided on board the ship as indicated in para 4.1.2, Table 1 and key elements of the manuals are to be included in the ship’s Ballast Water Management Plan (BWMP), as appropriate. The manuals are to include the operational, safety and maintenance requirements, as well as occupational health hazards relevant to the ballast water treatment.

b) Contain information on Ballast Water Management System used on board

The operating manuals are to include an outline of the system design conditions that are to be maintained over the life of the system to comply with the approved design. Details of special tools and gauges required for service or repair are to be provided in the manuals. Additionally, the operating manuals are to include detailed instructions for both local and remote control, and guidance on procedures to be followed in the event of a fault or failure of the system.

c) provide a detailed description of the actions to be taken to implement the Ballast Water Management requirements and supplemental Ballast Water Management practices

The Ballast Water Management Plan should give guidance on the ballast handling procedures to be followed, including:
- uptake of ballast water;
- step-by-step procedures and sequences for the Ballast Water Management System used; and
- any operational or safety restrictions including those associated with the Ballast Water Management System used.

d) detail the procedures for the disposal of Sediments

The Plan should include procedures for the disposal of sediments and in particular:
- on the sediment removal or reduction at sea, and when cleaning of the ballast tanks to remove sediments;
- regarding the safety consideration to be taken if tank entry is required to remove sediments; and
- regarding the use of port reception facilities for sediments.
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e) include the procedures for coordinating shipboard Ballast Water Management that involves discharge to the sea with the authorities of the State into whose waters such discharge will take place

f) designate the officer on board in charge of ensuring that the plan is properly implemented. A BWM Officer is to be assigned on board the ship. This individual is responsible for the implementation of the BWMP and verifying that all applicable ballast water handling, treatment and maintenance procedures of the ballast water management system are followed and for recording and maintaining the appropriate logs and records.

g) contain the reporting requirements for ships provided for under this Convention. The Plan should contain guidance on the recording requirements according to ship’s Ballast Water Record Book provided for under this Convention including details of exemptions granted to the ship.

h) contain provisions for crew training and familiarization (see para 6.1.2)

i) be written in the working language of the ship. If the language used is not English, French or Spanish, a translation into one of these languages shall be included.

10.1.2 Provisions for crew training and familiarization
To assist in the implementation of the Ballast Water Management Plan (BWMP), the ship’s BWM Officers and crew must be trained in the operation of installed the ballast water management system (BWMS) that they serve and be familiar with the duties assigned and the tasks expected to them. Specifically, the training should include the following, as appropriate:

a) General Information
   - General nature of ballast water management;
   - Requirements of the ballast water management convention;
   - Information on ballast water management and sediment management practices;
   - General aspects of ballast water exchange;
   - General aspects of ballast water treatment technologies and approved treatment systems;
   - General safety considerations; and
   - Documentation requirements – ballast water management plan, ballast water management activity logs, and ballast water record book.

b) Ship-Specific
   - Details of the installed ballast water management system – features, components, system processes, control and monitoring, etc.;
   - Operating procedures of the BWMS
   - Maintenance requirements and procedures;
   - Safety aspects of the treatment system and safe work procedures employed onboard the ship;
   - Emergency response plan and preparedness;
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- Safety precautions for tank entry for sediment removal;
- Procedures for safe handling and packaging of sediment; and
- Storage of sediment.