

*Proposed 2013 Vessel General Permit (VGP)*

certification by the master or NOI certifier that one of the two above conditions are met regarding contamination.

In the event a vessel that normally uses PWS water as ballast is forced for purposes of vessel safety to take on untreated ballast water from a sea, estuary, lake or river source, such vessel may not return to using PWS water until the tanks and supply lines have been cleaned, including removal of all residual sediments.

**2.2.3.5.1.4 No Discharge of Ballast Water**

Vessels may meet the requirements of Part 2.2.3.5 of this permit by not discharging any ballast water into waters subject to this permit. EPA notes that any discharge of untreated ballast water, including for reasons of unscheduled voyages, loading of unexpected cargo, etc., do not qualify as an acceptable reason to discharge untreated ballast water into waters subject to this permit, and therefore constitute a permit violation. EPA notes that in the case of a shipboard emergency that endangers the safety of the vessel or its crew, ballast water may need to be pumped out quickly by bypassing the BWTS. In such cases, the provisions regarding the prohibition of bypassing treatment where unavoidable to prevent loss of life, personal injury or severe property damage may be applicable. See 40 CFR 122.41(m)(4)(A) and Part 1.13 of this permit.

**2.2.3.5.2 *Schedule for when Ballast Water Treatment Becomes BAT (and Therefore Required)***

Table 6 describes when BWTS will become the Best Available Technology Economically Achievable (BAT) and thus when any ballast water discharges from such vessels will be subject to the Effluent limitations in Part 2.2.3.5.1 of this permit. Vessels must meet the requirements in Part 2.2.3.5.1 according to the schedule below in Table 6.

**Table 6: Ballast Water Treatment to BAT Schedule**

|                  | <b>Vessel's Ballast Water Capacity</b> | <b>Date Constructed</b> | <b>Vessel's Compliance Date</b>                  |
|------------------|--|-------------------------|--|
| New vessels      |  | After January 1, 2012   | On delivery                                      |
| Existing vessels | Less than 1500 m <sup>3</sup>          | Before January 1, 2012  | First scheduled drydocking after January 1, 2016 |
|                  | 1500-5000 m <sup>3</sup>               | Before January 1, 2012  | First scheduled drydocking after January 1, 2014 |
|                  | Greater than 5000 m <sup>3</sup>       | Before January 1, 2012  | First scheduled drydocking after January 1, 2016 |

**2.2.3.5.3 *Vessels Not Required to Meet Part 2.2.3.5 Treatment Standards***

The following Vessel Types are not required to meet Part 2.2.3.5 ballast water management measures:

4 The Ballast Water record book shall be kept readily available for inspection at all reasonable times and, in the case of an unmanned ship under tow, may be kept on the towing ship.

5 Each operation concerning Ballast Water shall be fully recorded without delay in the Ballast Water record book. Each entry shall be signed by the officer in charge of the operation concerned and each completed page shall be signed by the master. The entries in the Ballast Water record book shall be in a working language of the ship. If that language is not English, French or Spanish the entries shall contain a translation into one of those languages. When entries in an official national language of the State whose flag the ship is entitled to fly are also used, these shall prevail in case of a dispute or discrepancy.

6 Officers duly authorized by a Party may inspect the Ballast Water record book on board any ship to which this regulation applies while the ship is in its port or offshore terminal, and may make a copy of any entry, and require the master to certify that the copy is a true copy. Any copy so certified shall be admissible in any judicial proceeding as evidence of the facts stated in the entry. The inspection of a Ballast Water record book and the taking of a certified copy shall be performed as expeditiously as possible without causing the ship to be unduly delayed.

**Regulation B-3**      *Ballast Water Management for Ships*

1 A ship constructed before 2009:

- .1 with a Ballast Water Capacity of between 1500 and 5000 cubic metres, inclusive, shall conduct Ballast Water Management that at least meets the standard described in regulation D-1 or regulation D-2 until 2014, after which time it shall at least meet the standard described in regulation D-2;
- .2 with a Ballast Water Capacity of less than 1500 or greater than 5000 cubic metres shall conduct Ballast Water Management that at least meets the standard described in regulation D-1 or regulation D-2 until 2016, after which time it shall at least meet the standard described in regulation D-2.

2 A ship to which paragraph 1 applies shall comply with paragraph 1 not later than the first intermediate or renewal survey, whichever occurs first, after the anniversary date of delivery of the ship in the year of compliance with the standard applicable to the ship.

3 A ship constructed in or after 2009 with a Ballast Water Capacity of less than 5000 cubic metres shall conduct Ballast Water Management that at least meets the standard described in regulation D-2.

4 A ship constructed in or after 2009, but before 2012, with a Ballast Water Capacity of 5000 cubic metres or more shall conduct Ballast Water Management in accordance with paragraph 1.2.

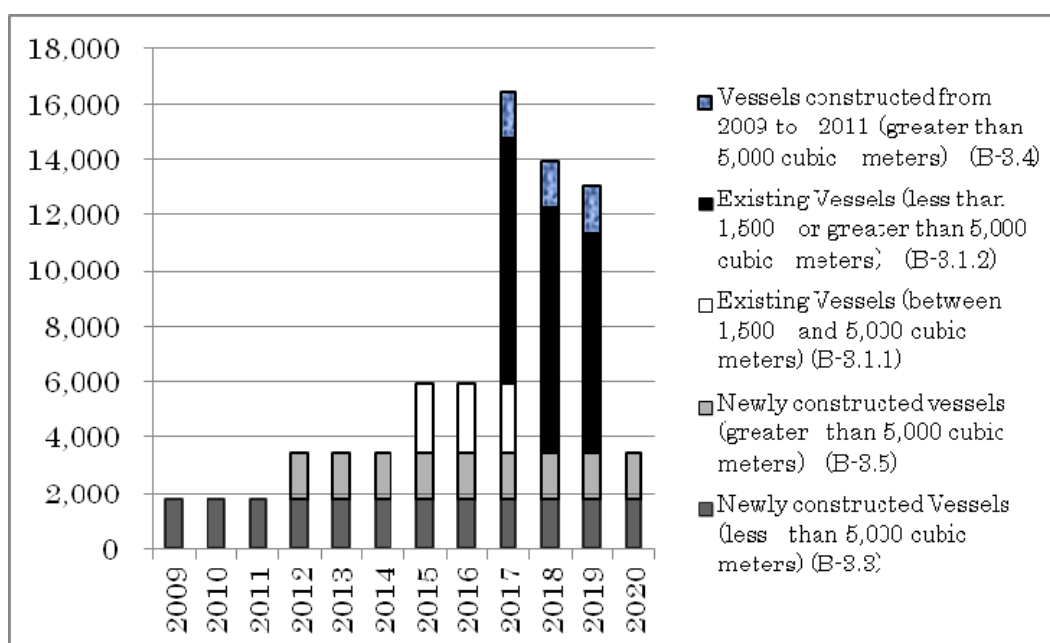
5 A ship constructed in or after 2012 with a Ballast Water Capacity of 5000 cubic metres or more shall conduct Ballast Water Management that at least meets the standard described in regulation D-2.

7 Japan calculated the number of vessels to which regulation D-2 will apply from 2009 to 2020. The method of calculation is shown at the annex. Table 1 shows that the number of vessels, subject to regulations B-3.1.1 and B-3.1.2, would be in total approximately 34,000 vessels and the number of vessels, which are required to retrofit BWMS is estimated at: 500 vessels in 2015 and 2016; 11,000 vessels in 2017; and 9,000 vessels in 2018 and 2019.

8 As shown in Figure 1, the number of vessels required to install BWMS is expected to rapidly increase in 2015 and sharply drop in 2020, because the vessels constructed before 2009 shall install BWMS between 2015 and 2019.

**Table 1: Estimated number of vessels which are required to retrofit BWMS**

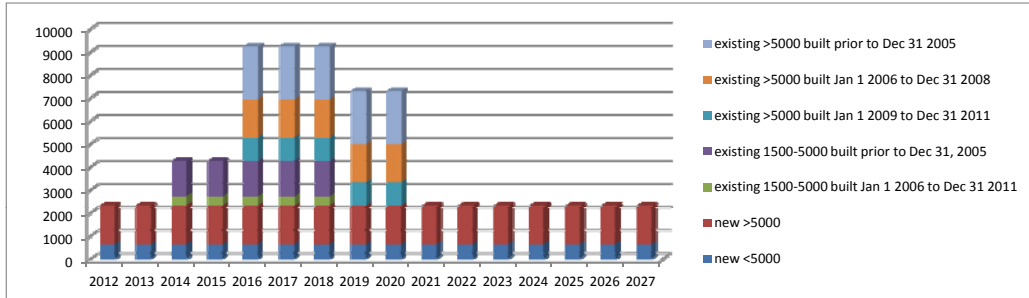
|   | 2009         | 2010         | 2011         | 2012         | 2013         | 2014         | 2015         | 2016         | 2017          | 2018          | 2019          | 2020         |
|---|--------------|--------------|--------------|--------------|--------------|--------------|--------------|--------------|---------------|---------------|---------------|--------------|
| Newly constructed Vessels (less than 5,000 cubic metres) (B-3.3)                | 1,740        | 1,740        | 1,740        | 1,740        | 1,740        | 1,740        | 1,740        | 1,740        | 1,740         | 1,740         | 1,740         | 1,740        |
| Newly constructed vessels (greater than 5,000 cubic metres) (B-3.5)             | 0            | 0            | 0            | 1,690        | 1,690        | 1,690        | 1,690        | 1,690        | 1,690         | 1,690         | 1,690         | 1,690        |
| Existing Vessels (between 1,500 and 5,000 cubic metres) (B-3.1.1)               | 0            | 0            | 0            | 0            | 0            | 0            | 2,500        | 2,500        | 2,500         | 0             | 0             | 0            |
| Existing Vessels (less than 1,500 or greater than 5,000 cubic metres) (B-3.1.2) | 0            | 0            | 0            | 0            | 0            | 0            | 0            | 0            | 8,800         | 8,800         | 8,800         | 0            |
| Vessels constructed from 2009 to 2011 (greater than 5,000 cubic metres) (B-3.4) | 0            | 0            | 0            | 0            | 0            | 0            | 0            | 0            | 1,690         | 1,690         | 1,690         | 0            |
| <b>Total</b>  | <b>1,740</b> | <b>1,740</b> | <b>1,740</b> | <b>3,430</b> | <b>3,430</b> | <b>3,430</b> | <b>5,930</b> | <b>5,930</b> | <b>16,420</b> | <b>13,920</b> | <b>13,920</b> | <b>3,430</b> |



**Figure 1: Estimated number of vessels required to install BWMS**

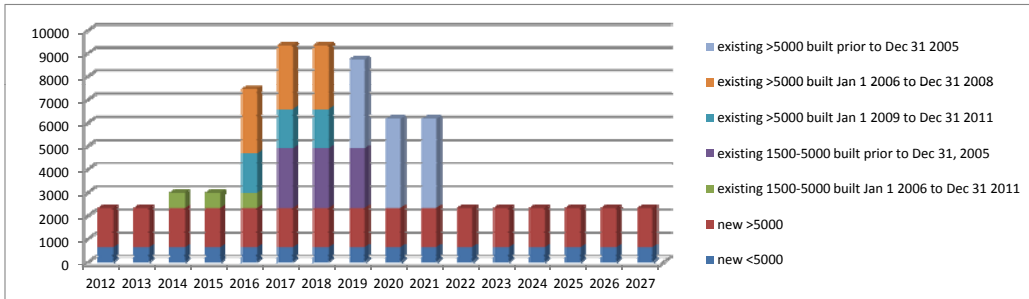
**Option 1 - Stretch Retrofit to Special Survey**

|  | 2012        | 2013        | 2014        | 2015        | 2016        | 2017        | 2018        | 2019        | 2020        | 2021        | 2022        | 2023        | 2024        | 2025        | 2026        | 2027        |
|--|-------------|-------------|-------------|-------------|-------------|-------------|-------------|-------------|-------------|-------------|-------------|-------------|-------------|-------------|-------------|-------------|
| new <5000  | 643         | 643         | 643         | 643         | 643         | 643         | 643         | 643         | 643         | 643         | 643         | 643         | 643         | 643         | 643         | 643         |
| new >5000  | 1690        | 1690        | 1690        | 1690        | 1690        | 1690        | 1690        | 1690        | 1690        | 1690        | 1690        | 1690        | 1690        | 1690        | 1690        | 1690        |
| existing 1500-5000 built Jan 1 2006 to Dec 31 2011 |             |             | 396         | 396         | 396         | 396         | 396         |             |             |             |             |             |             |             |             |             |
| existing 1500-5000 built prior to Dec 31, 2005     |             |             | 1542        | 1542        | 1542        | 1542        | 1542        |             |             |             |             |             |             |             |             |             |
| existing >5000 built Jan 1 2009 to Dec 31 2011     |             |             |             |             | 1014        | 1014        | 1014        | 1014        | 1014        |             |             |             |             |             |             |             |
| existing >5000 built Jan 1 2006 to Dec 31 2008     |             |             |             |             | 1658        | 1658        | 1658        | 1658        |             |             |             |             |             |             |             |             |
| existing >5000 built prior to Dec 31 2005          |             |             |             |             | 2300        | 2300        | 2300        | 2300        | 2300        |             |             |             |             |             |             |             |
| <b>TOTAL</b>                                       | <b>2333</b> | <b>2333</b> | <b>4271</b> | <b>4271</b> | <b>9243</b> | <b>9243</b> | <b>9243</b> | <b>7305</b> | <b>7305</b> | <b>2333</b> | <b>2333</b> | <b>2333</b> | <b>2333</b> | <b>2333</b> | <b>2333</b> | <b>2333</b> |



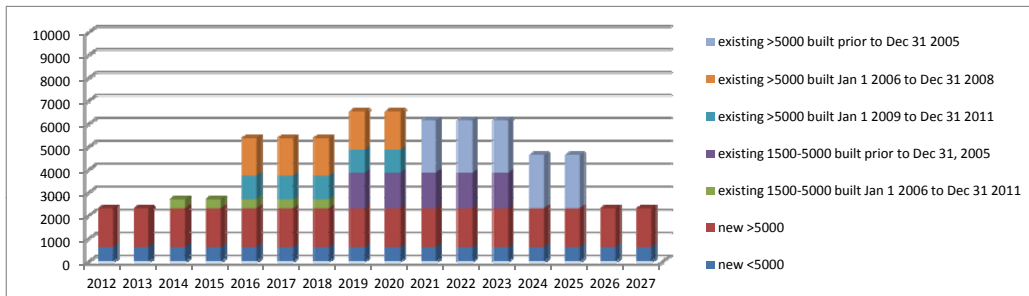
**Option 2 - Still Intermediate but Split by Age for Retrofit Phase In**

|  | 2012        | 2013        | 2014        | 2015        | 2016        | 2017        | 2018        | 2019        | 2020        | 2021        | 2022        | 2023        | 2024        | 2025        | 2026        | 2027        |
|--|-------------|-------------|-------------|-------------|-------------|-------------|-------------|-------------|-------------|-------------|-------------|-------------|-------------|-------------|-------------|-------------|
| new <5000  | 643         | 643         | 643         | 643         | 643         | 643         | 643         | 643         | 643         | 643         | 643         | 643         | 643         | 643         | 643         | 643         |
| new >5000  | 1690        | 1690        | 1690        | 1690        | 1690        | 1690        | 1690        | 1690        | 1690        | 1690        | 1690        | 1690        | 1690        | 1690        | 1690        | 1690        |
| existing 1500-5000 built Jan 1 2006 to Dec 31 2011 |             |             | 660         | 660         | 660         |             |             |             |             |             |             |             |             |             |             |             |
| existing 1500-5000 built prior to Dec 31, 2005     |             |             |             |             |             | 2570        | 2570        | 2570        |             |             |             |             |             |             |             |             |
| existing >5000 built Jan 1 2009 to Dec 31 2011     |             |             |             |             | 1690        | 1690        | 1690        |             |             |             |             |             |             |             |             |             |
| existing >5000 built Jan 1 2006 to Dec 31 2008     |             |             |             |             | 2763        | 2763        | 2763        |             |             |             |             |             |             |             |             |             |
| existing >5000 built prior to Dec 31 2005          |             |             |             |             |             |             |             | 3833        | 3833        | 3833        |             |             |             |             |             |             |
| <b>TOTAL</b>                                       | <b>2333</b> | <b>2333</b> | <b>2993</b> | <b>2993</b> | <b>7446</b> | <b>9356</b> | <b>9356</b> | <b>8736</b> | <b>6166</b> | <b>6166</b> | <b>2333</b> | <b>2333</b> | <b>2333</b> | <b>2333</b> | <b>2333</b> | <b>2333</b> |



**Option 3 - Stretch to Special Survey and Split by Age Phase-In for Retrofit**

|  | 2012        | 2013        | 2014        | 2015        | 2016        | 2017        | 2018        | 2019        | 2020        | 2021        | 2022        | 2023        | 2024        | 2025        | 2026        | 2027        |
|--|-------------|-------------|-------------|-------------|-------------|-------------|-------------|-------------|-------------|-------------|-------------|-------------|-------------|-------------|-------------|-------------|
| new <5000  | 643         | 643         | 643         | 643         | 643         | 643         | 643         | 643         | 643         | 643         | 643         | 643         | 643         | 643         | 643         | 643         |
| new >5000  | 1690        | 1690        | 1690        | 1690        | 1690        | 1690        | 1690        | 1690        | 1690        | 1690        | 1690        | 1690        | 1690        | 1690        | 1690        | 1690        |
| existing 1500-5000 built Jan 1 2006 to Dec 31 2011 |             |             | 396         | 396         | 396         | 396         | 396         |             |             |             |             |             |             |             |             |             |
| existing 1500-5000 built prior to Dec 31, 2005     |             |             |             |             |             |             |             | 1542        | 1542        | 1542        | 1542        | 1542        |             |             |             |             |
| existing >5000 built Jan 1 2009 to Dec 31 2011     |             |             |             |             | 1014        | 1014        | 1014        | 1014        | 1014        |             |             |             |             |             |             |             |
| existing >5000 built Jan 1 2006 to Dec 31 2008     |             |             |             |             | 1658        | 1658        | 1658        | 1658        | 1658        |             |             |             |             |             |             |             |
| existing >5000 built prior to Dec 31 2005          |             |             |             |             |             |             |             |             |             | 2300        | 2300        | 2300        | 2300        | 2300        |             |             |
| <b>TOTAL</b>                                       | <b>2333</b> | <b>2333</b> | <b>2729</b> | <b>2729</b> | <b>5401</b> | <b>5401</b> | <b>5401</b> | <b>6547</b> | <b>6547</b> | <b>6175</b> | <b>6175</b> | <b>6175</b> | <b>4633</b> | <b>4633</b> | <b>2333</b> | <b>2333</b> |



MARINE ENVIRONMENT PROTECTION  
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## HARMFUL AQUATIC ORGANISMS IN BALLAST WATER

### Preview of global ballast water treatment markets

Submitted by the Institute of Marine Engineering, Science  
and Technology (IMarEST)

#### SUMMARY

*Executive summary:* This document provides information on the scope of the world commercial market for ballast water management systems required to comply with the standard for ballast water treatment contained in regulation D-2 of the BWM Convention

*Strategic direction:* 2 and 7

*High-level action:* 2.0.1 and 7.1.2

*Planned output:* 2.0.1.13 and 7.1.2.3

*Action to be taken:* Paragraph 2

*Related document:* BLG 16/INF.4

#### Overview

1 The success of the IMO Ballast Water Management Convention will depend on the rapid development of a global Ballast Water Management Systems (BWMS) market by 2016. With this market still in its infancy, industry leaders and Governments in IMO Member States are looking for at least preliminary answers to questions about the potential size (and value) of the global markets for BWMS. The annex presents a document that aims to develop preliminary answers to these questions, including tentative estimates of the number of vessels that will need to install BWMS in various years and the expected cost of purchasing and installing various types of BWMS. It is based on 2009 and 2010 reports produced by the Maritime Environmental Resource Center (MERC), which includes an analysis of Lloyd's Fairplay, November 2009 global fleet data. It was concluded that the value of the global market for purchasing and installing BWMS between 2011 and 2016 will be in the range of US\$50 to \$74 billion.<sup>1</sup> The full version of this document, ***Preview of Global Ballast Water Treatment Markets***, D.M. King, P.T Hagan, M. Riggio and D.A. Wright, is in

<sup>1</sup> King D M, Riggio M, and Hagan P T. 2009. *Preliminary Analysis of Cost of Ballast Water Treatment Systems. MERC Ballast Water Economics Discussion Paper No.1.* Available at [www.maritime-enviro.org/reports/Reports.html](http://www.maritime-enviro.org/reports/Reports.html); King DM, Riggio M, and Hagan PT, 2010. *Preliminary Overview of Global Ballast Water Treatment Markets. MERC Ballast Water Economics Discussion Paper No.2.* Available at [www.maritime-enviro.org/reports/Reports.html](http://www.maritime-enviro.org/reports/Reports.html).

press in the international peer-reviewed Journal of Marine Engineering & Technology, Vol. 11, Issue 1 (January 2012).

**Action requested of the Committee**

2 The Committee is invited to note the information contained in this document.

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**ANNEX****PREVIEW OF GLOBAL BALLAST WATER TREATMENT MARKETS****Introduction**

1 Data were analysed by type of ship for "delivered" ships listed in the Lloyd's Fairplay database. With full compliance, it was estimated that more than 68,000 vessels in the global merchant fleet will install onboard BWMS before 2020 (Table 1).

**Table 1: Vessel type by estimated ballast capacity**

| <b>Sub-type</b>                   | <b>Count</b>  | <b>Ballast capacity of &lt;1,500m<sup>3</sup></b> | <b>Ballast capacity of 1,500-5,000m<sup>3</sup></b> | <b>Ballast capacity of &gt;5,000m<sup>3</sup></b> |
|-----------------------------------|---------------|---|---|---|
| Barges                            | 574           | 0   | 0   | 574   |
| Bulk Carriers                     | 8,110         | 0   | 0   | 8,110   |
| Containership                     | 4,724         | 0   | 0   | 4,724   |
| Crude Oil Tanker                  | 2,160         | 0   | 0   | 2,160   |
| Chemical Tanker                   | 1,474         | 0   | 0   | 1,474   |
| Chemical/Oil Products Tanker      | 9,323         | 0   | 0   | 9,323   |
| General Cargo Ship                | 18,187        | 0   | 16,535  | 1,652   |
| Fishing Vessels                   | 8,001         | 7,970   | 30  | 1   |
| LNG Tanker                        | 327           | 0   | 0   | 327   |
| LPG Tanker                        | 1,194         | 540   | 0   | 654   |
| OSVs                              | 2,000         | 1,923   | 0   | 77  |
| Passenger (Cruise) Ship           | 515           | 0   | 479   | 36  |
| Passenger-Passenger/Cargo (Ro-Ro) | 3,359         | 3,324   | 35  | 0   |
| Passenger Ship                    | 2,942         | 2,941   | 1   | 0   |
| Refrigerated Cargo Ship           | 2,542         | 0   | 2,538   | 4   |
| Ro-Ro Cargo Ship                  | 1,873         | 0   | 1,700   | 173   |
| Livestock Carrier                 | 101           | 0   | 90  | 11  |
| Vehicle Carrier                   | 784           | 0   | 196   | 588   |
| <b>TOTAL</b>                      | <b>68,190</b> | <b>16,698</b>                                     | <b>21,604</b>                                       | <b>29,888</b>                                     |

2 Depending on a number of factors that are still uncertain, this estimate of the relevant global fleet may overstate or understate the size of the global BWMS market. For purposes of analysis, for example, it was assumed that all vessels will comply regardless of their age, even though it is likely that some older vessels will either be retired or rerouted so that they are not subject to ballast water regulations. This would result in lower demand for BWMS than what would be expected based on the size of the relevant fleet. On the other hand, to be in compliance, many larger ships in the relevant global fleet will most certainly require multiple ballast water treatment units, which would tend to make the market for BWMS larger than what is reflected by our estimate of the number of ships complying.

3 Although more than 7,000 fishing vessels under 1,000 deadweight tons (DWT) were included in this analysis of the global fleet, it was assumed that ships in this category are likely to comply through the use of less expensive products that are still to be determined, and these were therefore not considered in this analysis of BWMS markets. It was determined that the sub-types listed in Table 1 would be subject to IMO regulations for ballast water treatment. In the case of fishing vessels, only vessels of 300 gross tons or more were included. Other sub-types that were determined as not carrying ballast water or that would only be operating within one "Captain-of-the-Port Zone" (COPTZ) were also excluded.

#### **Vessel type**

4 Analyses indicated that more than 21,000 ships will be subject to the first round of IMO retrofit requirements, which includes those ships with ballast water capacity of 1,500-5,000 m<sup>3</sup>. These ships will be required to have BWMS starting in 2014. Of those ships, the great majority – more than 16,000 – are general cargo ships (Table 1). About two thirds of the demand for installation of technology to meet the IMO D-2 standard will be associated with meeting the 2016-deadline for ships with less than 1,500 m<sup>3</sup> capacity (more than 16,000 ships) and with more than 5,000 m<sup>3</sup> capacity (more than 29,000 ships).

#### **Vessel size**

5 The database was further sorted by DWT to develop a more comprehensive view of the various-sized vessels in the world merchant fleet subject to ballast water regulations (Table 2). Again, in the case of fishing vessels, only those of 300 gross tons or more were included in the analysis. More than 92 per cent of an estimated 8,001 fishing vessels subject to IMO ballast water regulations are less than 1,000 DWT. Given the slim operating profit margins of smaller fishing vessels, it is unlikely that they will be able to afford the types of BWMS that are the focus of this document, or will have room aboard to accommodate them. It is anticipated that these smaller fishing vessels will need to find some other way to comply with IMO ballast water regulations. In addition, the merchant fleet data were sorted according to age of ship.



Table 2: Vessel type by deadweight tonnage

| Vessel type                               | World Fleet DWT |               |                 |                 |                 |              |               |
|---|-----------------|---------------|-----------------|-----------------|-----------------|--------------|---------------|
|   | 0 – 999         | 1,000 - 9,999 | 10,000 - 29,999 | 30,000 - 49,999 | 50,000 - 69,999 | >=70,000     | Total         |
| Barges                                    | 274             | 275           | 15              | 8               |                 | 2            | 574           |
| Bulk Carriers                             | 392             | 878           | 1,703           | 1,743           | 1,264           | 2,130        | 8,110         |
| Containerships                            | 6               | 788           | 1,628           | 1,013           | 812             | 477          | 4,724         |
| Crude Oil Tankers                         | 16              | 112           | 37              | 163             | 120             | 1,712        | 2,160         |
| Chemical Tankers                          | 423             | 806           | 164             | 79              | 1               | 1            | 1,474         |
| Chemical/Oil Products Tankers             | 1,665           | 4,621         | 1,206           | 1,249           | 245             | 337          | 9,323         |
| General Cargo Ships                       | 5,921           | 10,612        | 1,409           | 223             | 22              | 0            | 18,187        |
| Fishing Vessels                           | 7,395           | 604           | 2               | 0               | 0               | 0            | 8,001         |
| LNG Tankers                               | 1               | 5             | 12              | 11              | 36              | 262          | 327           |
| LPG Tankers                               | 193             | 678           | 154             | 71              | 98              | 0            | 1,194         |
| OSVs                                      | 600             | 1,399         | 1               | 0               | 0               | 0            | 2,000         |
| Passenger (Cruise) Ships                  | 243             | 227           | 45              | 0               | 0               | 0            | 515           |
| Passenger -Passenger/ Cargo (Ro-Ro) Ships | 2,327           | 997           | 35              | 0               | 0               | 0            | 3,359         |
| Passenger Ships                           | 2,883           | 58            | 1               | 0               | 0               | 0            | 2,942         |
| Refrigerated Cargo Ships                  | 832             | 1,453         | 254             | 3               | 0               | 0            | 2,542         |
| Ro-Ro Cargo Ships                         | 840             | 726           | 292             | 15              | 0               | 0            | 1,873         |
| Livestock Carriers                        | 22              | 68            | 9               | 2               | 0               | 0            | 101           |
| Vehicle Carriers                          | 13              | 183           | 558             | 28              | 2               | 0            | 784           |
| <b>TOTAL</b>                              | <b>24,046</b>   | <b>24,490</b> | <b>7,525</b>    | <b>4,608</b>    | <b>2,600</b>    | <b>4,921</b> | <b>68,190</b> |

### Vessel age

6 Table 3 shows the world fleet by vessel type and age. The table includes 2009 newbuilds (1,804 ships) listed in the database as of November 2009. Because IMO granted a delay for the first set of ships subject to the regulations (those ships constructed in 2009 or later with a ballast water capacity of less than 5,000 m<sup>3</sup>), these ships now have until the vessel's second survey to comply, although the "**no later than December 31, 2011**" deadline will slip again, because full ratification did not occur before that date. More than 60 per cent of the new vessels listed as under construction in 2009 were bulk carriers, containerships, or tankers that are estimated to have greater than 5,000 m<sup>3</sup> ballast water capacity, which do not require treatment technology for newbuilds until – putatively – 2012, depending on the timing of ratification.

**Table 3: Vessel age by ship type**

| Vessel type                         | 0-4 years     | 5-14 years    | 15-24 years   | 25+ years     | 2009 Builds  | Total         |
|-------------------------------------|---------------|---------------|---------------|---------------|--------------|---------------|
| Barges                              | 27            | 30            | 125           | 387           | 5            | 574           |
| Bulk Carriers                       | 1,592         | 2,328         | 1,894         | 1,938         | 358          | 8,110         |
| Containerships                      | 1,650         | 1,881         | 675           | 323           | 195          | 4,724         |
| Crude Oil Tankers                   | 624           | 788           | 473           | 127           | 148          | 2,160         |
| Chemical Tankers                    | 281           | 278           | 501           | 338           | 76           | 1,474         |
| Chemical/Oil Products Tankers       | 2,088         | 1,781         | 1,748         | 3,283         | 423          | 9,323         |
| General Cargo Ships                 | 1,705         | 2,692         | 3,779         | 9,794         | 217          | 18,187        |
| Fishing Vessels                     | 283           | 1,119         | 2,454         | 4,132         | 13           | 8,001         |
| LNG Tankers                         | 18            | 78            | 151           | 52            | 28           | 327           |
| LPG Tankers                         | 217           | 322           | 289           | 320           | 46           | 1,194         |
| OSVs                                | 491           | 245           | 220           | 889           | 155          | 2,000         |
| Passenger (Cruise) Ships            | 58            | 157           | 109           | 183           | 8            | 515           |
| Passenger – Passenger/Cargo (Ro-Ro) | 287           | 674           | 670           | 1,702         | 26           | 3,359         |
| Passenger Ships                     | 222           | 788           | 776           | 1,128         | 28           | 2,942         |
| Refrigerated Cargo Ships            | 62            | 298           | 945           | 1,232         | 5            | 2,542         |
| Ro-Ro Cargo Ships                   | 283           | 441           | 333           | 785           | 31           | 1,873         |
| Livestock Carriers                  | 0             | 7             | 6             | 88            | 0            | 101           |
| Vehicle Carriers                    | 221           | 213           | 191           | 117           | 42           | 784           |
| <b>TOTAL</b>                        | <b>10,109</b> | <b>14,120</b> | <b>15,339</b> | <b>26,818</b> | <b>1,804</b> | <b>68,190</b> |

### Installation costs

7 Based on analysis that incorporated information from vendors and other sources, the range of expected BWMS purchase costs across system types and categories of ship types/sizes listed above was estimated to be \$640,000 to \$947,000. For all types of systems, there may be some economies of scale when purchasing bulk orders (e.g. 10 ships), reducing the cost of a system by \$40,000 to \$100,000 per unit, depending on the system type, although it is important to note that installation costs will vary widely, even within a particular ship type/size, depending on the characteristics of individual ships and the space and other requirements of specific types of BWMS. As a general rule it has been assumed in the majority of cases that a system will be installed aboard each qualifying vessel. However, depending on the number of ballast pumps aboard, at least two BWMS may be required. Additionally, on larger vessels containing very large volumes of ballast water, multiple BWMS may be required to handle the huge flow rates involved. A recent fleet installation involving two systems per ship and a bulk-equipment price resulted in a cost of approximately \$1,800,000 per vessel.

8 Even with all the necessary caveats due to uncertainty about implementation, enforcement, and compliance, the number of ships in the affected global fleet represents a massive potential global market for BWMS, perhaps 10,000 units per year (or 30 installations per day) for multiple years. Once all existing ships are in compliance, it is hoped that by 2017 or so, only newbuild ships will require the installation of BWMS, so global BWMS markets will then shrink to around 2,000 ships per year (five or so installations per day).

### Installation logistics

9 Because of "**footprint problems**", many BWMS vendors offer modular systems that can be installed and connected together wherever there is adequate space. While these modular features make it possible for more BWMS to be considered potential candidates for installation aboard more types and sizes of ships, taking advantage of these modular features can add significantly to installation costs. As a general "rule of thumb", it might be assumed that installation costs would be approximately half the equipment cost. However, this 2:1 ratio could approach 4:3 if substantial footprint problems and increased fabrication needs are encountered.

10 Preliminary surveys of vendors and shipowners suggest that there will be minimal or no lost revenue from retrofitting a merchant ship with a BWMS as long as installation time fits within normal shipyard time. Hull painting is typically the critical path item in terms of limited shipyard capacity and usually requires a minimum of seven days. Interviews and follow-up discussions indicated that ballast water treatment retrofit could take up to one month to complete, depending on the degree of fabrication required. Although the cost of having a dedicated crew install a BWMS while the ship is at sea is slightly more expensive than having the system installed at a shipyard, survey information did not indicate that this would be a cost-prohibitive option for most vessel types if BWMS installation needs did not coincide with a routine shipyard visit. Interviews indicated that such installations have been successfully completed with no vessel downtime recorded. However, several ships may not have sufficient accommodation for the extra crew required for installation. This could mean installation would have to be done in stages, which would add to time and cost.