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HARMFUL AQUATIC ORGANISMS IN BALLAST WATER

Final report on the study on the implementation of the ballast water performance standard described in regulation D-2 of the BWM Convention

Note by the Secretariat

SUMMARY

Executive summary:	This document provides the final report on the study on the implementation of the ballast water performance standard described in regulation D-2 of the BWM Convention
Strategic direction:	7
High-level action:	7.1.2
Output:	7.1.2.1
Action to be taken:	Paragraph 8
Related documents:	MEPC 66/2/11, MEPC 66/21; MEPC 67/2/5, MEPC 67/20, MEPC 67/WP.11; MEPC 68/2/11, MEPC 68/21 and MEPC 68/WP.8

Introduction

1 This document provides the final report on the study on the implementation of the ballast water performance standard described in regulation D-2 of the Ballast Water Management Convention (the D-2 standard), hereafter "the Study", which had been requested by the Committee to be provided at this session.

2 The Study was carried out in accordance with the timeline endorsed by the Committee, as set out in document MEPC 67/2/5, annex 1, taking into account the recommendations of the Ballast Water Review Group outlined in paragraph 22 of the Group's report (MEPC 67/WP.11) and the revised terms of reference as set out in annex 5 of the report and endorsed by the Committee.

3 A note by the Secretariat submitted to the sixty-eighth session of the Committee (MEPC 68/2/11) provided a broad progress report on the Study, as had been requested by MEPC 67, and a presentation was delivered during the same session on 11 May 2015.

Structure of the final report

4 An executive summary of the Study is provided in annex 1 while the final report is provided in annex 2 to this document and it presents the findings of the Study. The results of the Study do not intend to designate "correct" or "best" approaches. In addition, the final report respects the respondents' confidentiality by not disclosing specific names, affiliations or ship details.

5 The final report is structured as follows:

.1 background information briefly introducing the context of the Study;

.2 Study methodology and method of work;

.3 the Study results organized in accordance with the two survey tracks (Track 1 – Similarities/differences in testing and certification and Track 2 – BWMS operational performance); and

.4 conclusions of the Study.

Main findings of the Study

6 The Study results suggest that ballast water management system (BWMS) testing and type approval approaches currently employed follow the *Guidelines for approval of ballast water management systems (G8)*. However, due to divergent interpretation of the Guidelines (G8), several differences exist in how BWMS testing is carried out and how type approval is granted. In addition, lack of publicly available documentation on processes and verifications hinders transparency and may impair confidence in the testing and approval regime.

7 Furthermore, the Study results also suggest that BWMS installed on ships appear to be irregularly operated and monitored. This restricts the ability to evaluate the overall BWMS performance. The lack of monitoring is particularly noticeable with regard to the assessment of biological efficacy and environmental safety of discharged water.

Action requested of the Committee

8 The Committee is invited to consider the findings of the study on the implementation of the ballast water performance standard described in regulation D-2 of the BWM Convention, including in its ongoing review of Guidelines (G8), and take action as deemed appropriate.

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ANNEX 1

EXECUTIVE SUMMARY OF THE STUDY ON THE IMPLEMENTATION OF THE BALLAST WATER PERFORMANCE STANDARD DESCRIBED IN REGULATION D-2 OF THE BWM CONVENTION

1 Significant progress has been made towards the entry into force and the facilitation of the implementation of the BWM Convention; however, a few critical issues remain. One such issue is the need to better understand the approaches and processes used by test facilities and Administrations in implementing the *Guidelines for approval of ballast water management systems (G8)* (resolution MEPC.174(58)). Another is the need to reduce uncertainties around the current performance of ballast water management systems (BWMS), which have been type approved, installed and fully commissioned on board ships, in order to better understand if the approval process is resulting in effective, reliable and safe treatment of ballast water.

2 In the interest of addressing these issues, MEPC 66 requested the Secretariat to explore the possibility of conducting a study on the implementation of the D-2 standard (the Study). Consequently, the Secretariat developed a proposed plan for conducting the Study, including terms of reference, timeline and execution modalities, which were endorsed by MEPC 67. The resulting Study was based on stakeholder input of verifiable facts and data under two distinct overarching themes or "tracks".

Track 1 – Similarities/differences in testing and certification

3 Track 1 focused on similarities and/or differences between approaches and procedures used in testing of BWMS and the issuance of Type Approval Certificates by Administrations, and employed online surveys and document collection. The goal was to collect facts on existing practices and to identify similarities and differences in approaches followed by different stakeholders but not to designate the "correct" or "best" approach.

4 The Study results suggest that, for the most part, BWMS testing and type approval approaches and processes currently employed follow the Guidelines (G8). However, as the Guidelines (G8) leave certain opportunities for interpretation and use of "best judgement", several significant differences do exist in how BWMS testing is carried out and how type approval is granted. In particular, differences in testing methodologies may result in significantly differing conclusions regarding the performance of BWMS. In addition, while transparency is critical for confidence and credibility, in some cases it has been found to be lacking.

5 The main findings of Track 1 can be summarized as follows:

.1 While transparency is critical for confidence in and credibility of the BWMS testing and approval regime, it is lacking in some cases. Indeed, few testing facilities provide publicly available documentation on their conflict of interest policies, quality assurance and standard operating procedures.

.2 While the majority of test facilities use validated procedures, some may also use methods that have yet to be reviewed or validated. Moreover, not all facilities have been audited by an accredited body.

.3 The survey shows that not all facilities offer testing under all of the three categories of salinity, as this is not required by Guidelines (G8), so in some cases a combination of test facilities may be required for BWMS to be tested under three salinity conditions.

.4 The ways challenge conditions of test waters are achieved vary significantly, which could lead to differences in testing results. Some test facilities do not manipulate biological challenge conditions while others do in varying ways and to varying levels. It also appears that most test facilities manipulate physical/chemical challenge conditions to some extent but the specific parameters differ and the methods used to make adjustments also vary greatly.

.5 While the majority of test facilities apply standard methods for sampling, the approaches described in Guidelines (G8) are not used by all facilities. It is important to note that the sampling approaches described in Guidelines (G2), which are used by many test facilities, and those described in Guidelines (G8) are very different.

.6 While the responses in the survey indicate a high degree of consistency between test facilities in applying standard methods for analysis of organisms more than 50 µm in size and bacteria, a much larger number of very different methods of analysis are used amongst the test facilities and organizations to determine viability of organisms between 10 and 50 µm in size.

.7 A variety of operational parameters are monitored and considered during land-based and shipboard testing (e.g. power consumption, flow rate, UV intensity, etc.) but there is no consistency with regard to which parameters are monitored or how they are quantified.

.8 The survey responses indicated that in land-based testing Administrations require five successful trials on at least two of the three salinity ranges; however, many do not require these five successful trials to be consecutive, as this is not required by Guidelines (G8). The survey responses also indicated that in shipboard testing Administrations require a minimum six-month period and three consecutive successful trials, in accordance with Guidelines (G8).

6 In conclusion, there are significant differences in how Guidelines (G8) are interpreted and implemented in different test facilities. This could affect type approval certification and operational performance of BWMS.

Track 2 – Operational performance of BWMS

7 For Track 2, BWMS operational performance was evaluated through online surveys and data collection on the technical, mechanical, biological and environmental reliability and efficacy of systems with Type Approval Certificates that have been installed, commissioned and are in operation on board ships. The goal was, again, to collect facts on BWMS operational performance and not to suggest what is "acceptable" or "best".

8 Study results for Track 2 suggest that there are many BWMS, with Type Approval Certificates, which have been installed and commissioned on board ships. However, very few BWMS appear to be operated with any regularity and even fewer are monitored or evaluated for performance after commissioning.

9 Data for 122 ships were submitted to the Study, representing 5% of the estimated 2,410 ships equipped with BWMS (based on information provided by IACS to the Study in July 2015). Based on these data, it appears that very few assessments of biological performance have been conducted in general on board ships to determine if the BWMS was meeting the ballast water performance standard in regulation D-2 of

the Convention and in particular only four ships were reported to have performed independent biological performance testing or monitoring (i.e. with independent third-party evaluators). While this lack of monitoring does not currently allow for an extensive and definitive assessment of the reliability and performance of BWMS in routine operation, the overall information presented in this report represents the most current and comprehensive assessment to date based on information from a variety of stakeholders (shipowners/operators, BWMS manufacturers, independent evaluators), which could support the Committee in its current deliberations.

10 The main findings of Track 2 can be summarized as follows:

.1 The survey responses indicate that a relatively small proportion of the BWMS installed on board ships are currently used in routine ballasting operations.

.2 The absence of current requirements to monitor BWMS performance affects the willingness to systematically monitor BWMS in operation. Regular monitoring could provide valuable feedback on the functioning of these systems.

.3 Training and documentation are in most cases provided by the BWMS manufacturer to support operation and maintenance of BWMS. However, it has not been possible to determine the quality and quantity of training and documentation, nor the training follow-up and handover after crew change. Although relatively uncommon, it is important to note that in some cases no training or manual seems to have been provided by the BWMS manufacturer.

.4 It appears that monitoring by the crew and self-monitoring equipment installed on BWMS are the main means of monitoring. It has not been possible to determine if there are specific policies to monitor the BWMS and systemize data collection. A small proportion of systems are monitored by the BWMS manufacturer and an even smaller part by third parties.

.5 The majority of the attempts to monitor BWMS focused on technical/mechanical performance, with much fewer assessments of ability or reliability in meeting the D-2 standard (biological efficacy) and environmental safety.

.6 Several technical/mechanical malfunctions were reported. It appears that sensors/controls and piping/valve systems, as well as problems associated with filtration, constitute the major sources of difficulties during routine ship operation.

.7 Based on the responses received as part of the Study, it appears that too few assessments of ability or reliability in meeting the D-2 standard (biological efficacy) and environmental safety have been conducted on board ships with installed BWMS to allow a definitive analysis of BWMS performance under routine operation.

11 In accordance with the Committee's instructions, the Study has been factual, avoiding subjective opinions and suggestions. Therefore, the findings listed above reflect the data collected and analysed as part of the Study without making any interpretations. These findings are presented to the Committee for its consideration.

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ANNEX 2

STUDY ON THE IMPLEMENTATION OF THE BALLAST WATER PERFORMANCE STANDARD DESCRIBED IN REGULATION D-2 OF THE BWM CONVENTION

TABLE OF CONTENTS

1 BACKGROUND

1.1 In order to provide a fact-based approach as to how Guidelines (G8) may be improved in the future, MEPC 67 requested the Secretariat to undertake an assessment of the current situation regarding the testing, approval and operation of BWMS.

1.2 Noting that a Correspondence Group (CG) for the review of Guidelines (G8) was established during the same session of the Committee, it was expected that the present work could contribute to the considerations of the CG.

1.3 To design and execute the Study, the Secretariat entered into a partnership with the World Maritime University (WMU). The WMU, with the support of a team of international experts, collected and analysed relevant data and undertook the preparation of the final report together with the Secretariat. The recommendations made by the Ballast Water Review Group and the Committee were followed, all relevant stakeholder groups were engaged and identified priority topics were addressed.

2 STUDY METHODOLOGY

Aims and objectives

2.1 The Study has been conducted in accordance with the requirements set out in document MEPC 67/2/5, the recommendations of the Ballast Water Review Group and the revised terms of reference as set out in the Group's report (MEPC 67/WP.11, annex 5), all endorsed by the Committee.

2.2 As highlighted in the broad progress report previously provided to the Committee (MEPC 68/2/11), the Study aimed to assess current issues related to:

.1 testing of BWMS in accordance with Guidelines (G8), including relevant approaches and procedures;

.2 type approval and certification approaches and practices followed by Administrations; and

.3 operational performance of currently approved BWMS.

2.3 The success of the Study depended on the active engagement and contribution of various stakeholders involved in the type approval process including, but not limited to: test facilities and organizations conducting testing in accordance with Guidelines (G8); Administrations issuing Type Approval Certificates; and BWMS manufacturers holding Type Approval Certificates for systems that are currently in operation on board ships. Additionally, classification societies, shipowners, operators and related stakeholders were expected to provide relevant data as well as information on issues encountered when installing and operating such systems.

Method of work

2.4 To ensure the highest possible response rates, online surveys (employing a commonly used public survey platform and associated software) and document collection methods were employed. These methods have been proven easier, less expensive and faster to administer than traditional interviews and mail or phone surveys.

2.5 Therefore, and as set out in document MEPC 68/2/11, the Study, and particularly the online survey, was designed to:

.1 be open and inclusive;

.2 build in safeguards for data and information quality and avoid multiple counting of the same data and information; and

.3 ensure the required confidentiality.

2.6 A plan of implementation was developed, according to which the Study involved two parallel "tracks" to facilitate and optimize the collection of data. In order to address the requirements set out in annex 2 of document MEPC 67/2/5, the tracks were the following:

.1 Track 1 – collection of documents and other information on approaches and practices relating to the type approval of BWMS. This track aimed to analyse similarities and differences in existing practices employed by test facilities/organizations for the type approval testing of BWMS and by Administrations to assess and grant Type Approval Certificates for BWMS (MEPC 67/WP.11, annex 5); and

.2 Track 2 – collection of data on the performance of operational BWMS (installed on board ships) with Type Approval Certificates. This track aimed to collect information from various stakeholder groups (e.g. BWMS manufacturers, ship operators, port State control officers) to examine the performance of BWMS after installation on board ships (MEPC 67/WP.11, annex 5).

2.7 Under each track separate questionnaires were designed and customized for each of the various stakeholder groups.

2.8 Individual responses are, and have been throughout the whole process, kept confidential, and specific responses, documents, data and information are not linked to any individuals, organizations, facilities or ships. In some cases, survey responses and data were pooled (when needed) by individual organization (Track 1) or individual ship (name and/or IMO number, Track 2) to avoid counting data/information more than once.

Timeline of main activities

2.9 The Study's data collection efforts were initiated on 11 March 2015 with the launching of the Study's website and online surveys, official announcement on the IMO website and issuance of Circular Letter No.3537. Invitations to participate in the Study were emailed directly to over 500 individual stakeholders and announced on several media outlets and forums. In order to facilitate participation, build awareness and answer any questions, an open two-hour informational webinar was held on 21 April 2015. The Secretariat and WMU also supported direct engagement of stakeholders during meetings at IMO Headquarters in London. In this respect, the Secretariat arranged for the members of the Study team to attend PPR 2 and MEPC 68 in order to further identify and engage stakeholders, promote the Study and be available for questions.

2.10 A team from WMU was present at PPR 2 to pursue the active engagement and participation of Administrations, industry associations and other key stakeholders, as well as to follow the deliberations of the Correspondence Group for the review of Guidelines (G8), which met in the margins of PPR 2, in order to facilitate the appropriate interaction between the two activities. During MEPC 68, and in addition to an active presence of the Study team, the Secretariat hosted a lunchtime presentation on 11 May 2015 to update the Committee on the Study's then-current status and to encourage further participation.

2.11 The deadline for participation in the surveys and to submit information was initially planned for 1 June 2015, but after meetings and exchanges during MEPC 68 the Secretariat and the Study team decided to extend the deadline to 10 June 2015 (with further announcement of the deadline extension and issuance of an additional Circular Letter No.3537/Add.1).

Screening of responses

2.12 All survey responses were carefully reviewed by the administrators of the Study and individual files were removed from consideration if any of the following conditions applied:

.1 the respondent had not included the required information for identification (name, affiliation, email address and/or ship name or IMO number);

.2 responses were determined to be inconsistent and/or inappropriate for the Study;

.3 responses included clearly redundant or duplicate information.

2.13 The accompanying analytical and statistical tools, provided by the online survey platform, were used to generate summary percentages and figures, with some additional analysis carried out by the Study administrators, as needed.

3 STUDY RESULTS

3.1 The following sections set out the results of the five individual stakeholder online surveys under Track 1 and Track 2. The presentation of the results follows the design of the survey, as follows:

Track 1 – Similarities/differences in testing and certification

Questionnaire 1 – Test facilities, organizations and independent experts
Questionnaire 2 – Administrations, other Government agencies and recognized organizations

Track 2 – BWMS operational performance

Questionnaire 1 – Shipowners and operators
Questionnaire 2 – BWMS manufacturers
Questionnaire 3 – Independent third-party evaluators

3.2 The outcome of each of the questions from the questionnaires is presented and the significant results are analysed and supplemented with comments and references to Guidelines (G8), where appropriate.

Track 1 – Similarities/differences in testing and certification

3.3 Track 1 was designed to collect information on, and analyse the similarities/differences in, existing practices for testing and certification of BWMS. The survey requested information from the various stakeholders involved in the approval process of BWMS.

3.4 Following the process outlined in section 2, a total of 33 responses were used for the final analysis of Track 1, 17 of which originated from test facilities, organizations and independent experts while 16 originated from Administrations and other Government agencies and recognized organizations.

Questionnaire 1 – Test facilities, organizations and independent experts

3.5 This specific survey focused on approaches and procedures employed in the testing of BWMS against the performance standard in regulation D-2 of the BWM Convention and for type approval. A total of 17 individual test facilities, organizations and independent experts from around the world provided information (if more than one member of a test facility or organization responded to the survey, answers were combined). The following is the list of questions asked and summaries of responses. Initial questions on name, affiliation, etc. (required to ensure that the respondents are valid entities), are kept confidential.

3.6 Policies, documentation, validation and transparency

Q4 – Was land-based testing in accordance with Guidelines (G8) conducted independent of the BWMS vendor (i.e. testing facility not owned, operated by or funded by the BWMS manufacturer; and vendor not allowed to operate or adjust the BWMS during testing)?

- **73% (11) answered Yes** and 27% (4) answered No
- Answered: 15, Skipped: 2

Q5 – Was shipboard testing in accordance with Guidelines (G8) conducted independent of the BWMS vendor (i.e. vendor not allowed to operate or adjust the BWMS during testing)?

- **75% (12) answered Yes** and 25% (4) answered No
- Answered: 16, Skipped: 1

Study analysis: *The majority of the respondents (over 70%) confirmed that tests were performed independent of the manufacturers.*

Q6 – Have you established a policy to avoid conflict of interest?

- **67% (10) answered Yes** and 33% (5) answered No
- Answered: 15, Skipped: 2

Q7 – Is the Conflict of Interest policy publicly available?

- 30% (3) answered Yes and **70% (7) answered No**
- Answered: 10, Skipped: 7

Q8 – Is the Conflict of Interest policy available in English?

- **100% (3) answered Yes**
- Answered: 3, Skipped: 14

Q9 – Do you have a Quality Management Plan?

- **94% (16) answered Yes** and 6% (1) answered No
- Answered: 17, Skipped: 0

Q10 – Is the Quality Management Plan publicly available?

- 25% (4) answered Yes and **75% (12) answered No**
- Answered: 16, Skipped: 1

Q11 – Is the Quality Management Plan available in English?

- **100% (4) answered Yes**
- Answered: 4, Skipped: 13

Study analysis: *While most test facilities have replied that they have Conflict of Interest policies and Quality Management Plans, very few testing facilities provide publicly available documentation, which may have an effect on the perceived transparency of the type approval testing being conducted.*

Q12 – Do you have Standard Operating Procedures?

- **88% (15) answered Yes** and 12% (2) answered No
- Answered: 17, Skipped: 0

Q13 – Are the Standard Operating Procedures publicly available?

- 27% (4) answered Yes and **73% (11) answered No**
- Answered: 15, Skipped: 2

Q14 – Are the Standard Operating Procedures available in English?

- **100% (3) answered Yes**
- Answered: 3, Skipped: 14

Study analysis: *While most test facilities have replied that they have Standard Operating Procedures (SOP), very few testing facilities provide publicly available documentation. This can have an effect on the uniform implementation of Guidelines (G8) across test facilities.*

Q15 – Has your facility, individual laboratories and the procedures used (by facilities, laboratories or independent experts) for land-based and shipboard testing in accordance with Guidelines (G8), been validated?

- **63% (10) answered Yes** and 37% (6) answered No
- Answered: 16, Skipped: 1

Study analysis: *It appears that, while the majority of test facilities uses validated procedures, some may also use methods that have yet to be reviewed or validated, which could impact data quality and reliability.*

Q16 – If the facility, individual laboratories and the procedures used (by facilities, laboratories or independent experts) for land-based and shipboard testing in accordance with Guidelines (G8) have been validated, is documentation publicly available?

- 30% (3) answered Yes and **70% (7) answered No**
- Answered: 10, Skipped: 7

Study analysis: *Public availability of testing procedures and test plans is important for the perceived transparency and credibility of type approval testing.*

Q17 – Has your facility, individual laboratories and the procedures used for land-based and shipboard testing in accordance with Guidelines (G8), been audited and approved by an Administration, other Government agency, recognized organization or other independent authority?

- **75% (12) answered Yes** and 25% (4) answered No
- Answered: 16, Skipped: 1

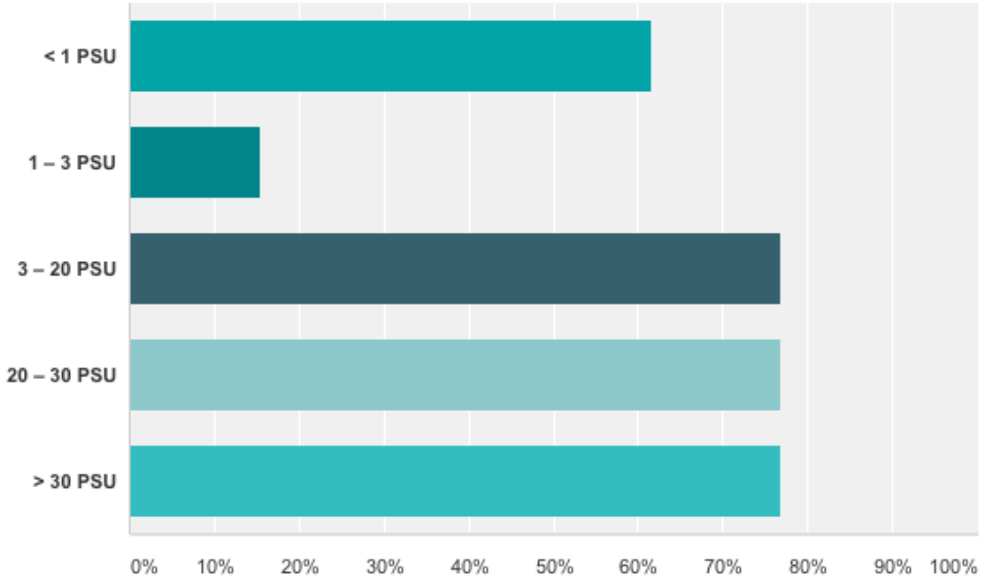
Q18 – If Yes to Q17, please provide name of auditor.

- Ten different agencies, classification societies and organizations were listed.

Study analysis: *The majority of test facilities were audited by an accredited body but some do not appear to have independent review or oversight, which could impact data quality and reliability.*

3.7 Test conditions

Q19 – Under what salinity ranges are land-based tests being conducted?

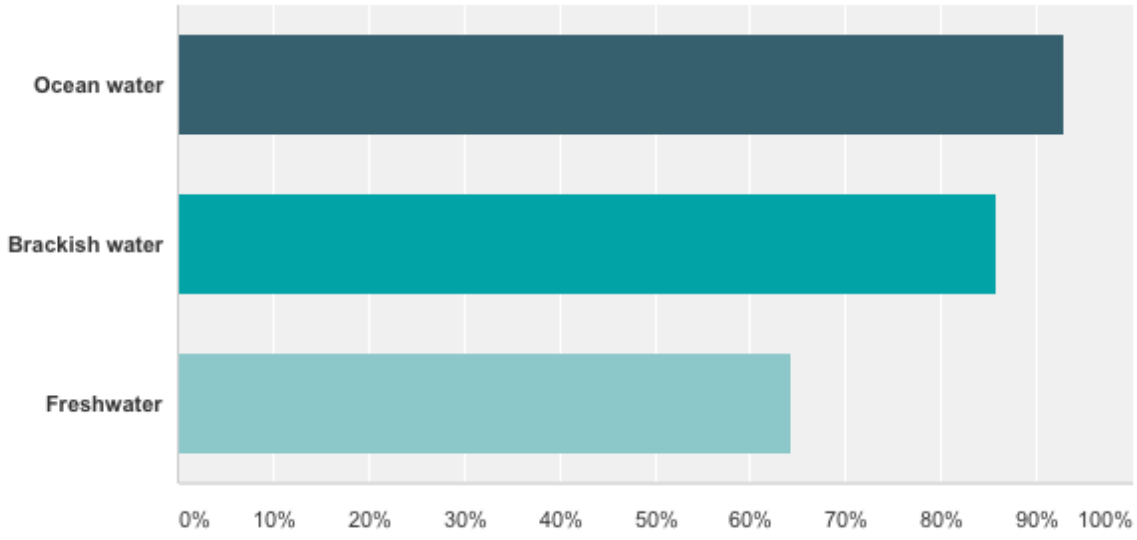


Answer Choices	Responses	
< 1 PSU	62%	8
1 – 3 PSU	15%	2
3 – 20 PSU	77%	10
20 – 30 PSU	77%	10
> 30 PSU	77%	10
Total Respondents: 13		

- Answered: 13, Skipped: 4

Study analysis: *It appears that BWMS can be tested under the three salinity conditions described in Guidelines (G8) within the capacities of existing test facilities. On the other hand, it is noted that not all facilities offer testing under all three conditions, so in some cases a combination of test facilities may be required for BWMS to be tested under all salinity conditions.*

Q20 – Under how many distinct salinity ranges are individual BWMS tested?

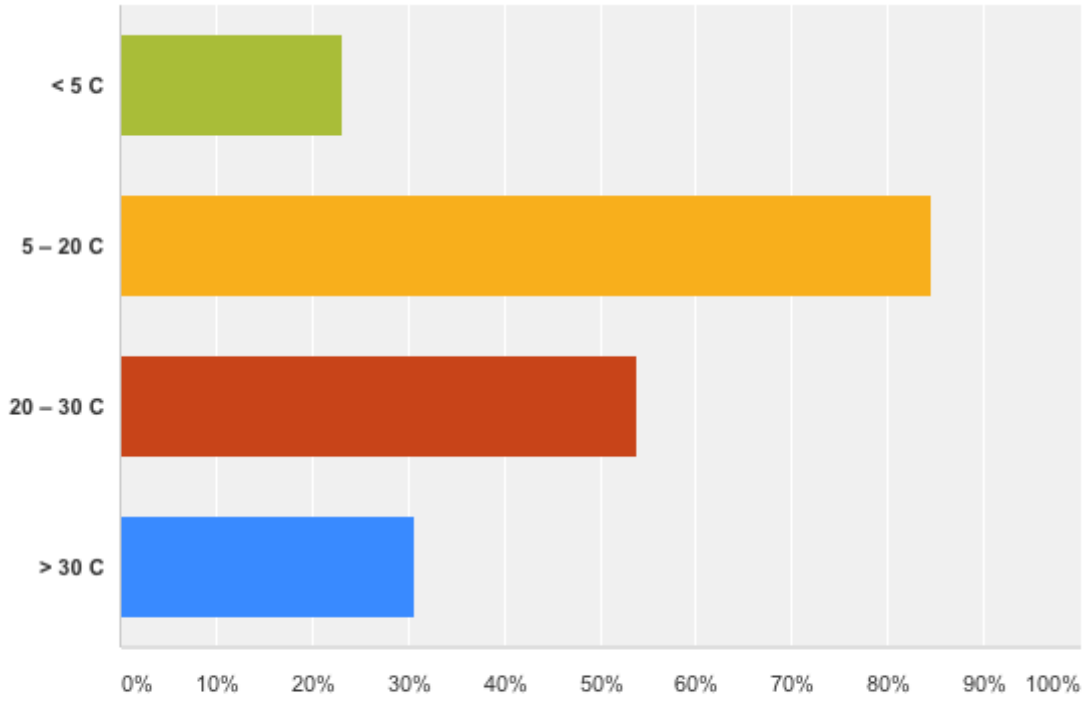


Answer Choices	Responses	
Ocean water	**93%**	13
Brackish water	**86%**	12
Freshwater	**64%**	9
Total Respondents: 14		

- Answered: 14, Skipped: 3

Study analysis: *It appears that the majority of BWMS have been tested under two distinct salinity ranges, as described in Guidelines (G8), but the conditions clearly do exist at facilities around the world for testing under all three salinity ranges (in some cases at one facility alone but more often by conducting tests at multiple facilities).*

Q21 – Under what temperature ranges is land-based testing being conducted?

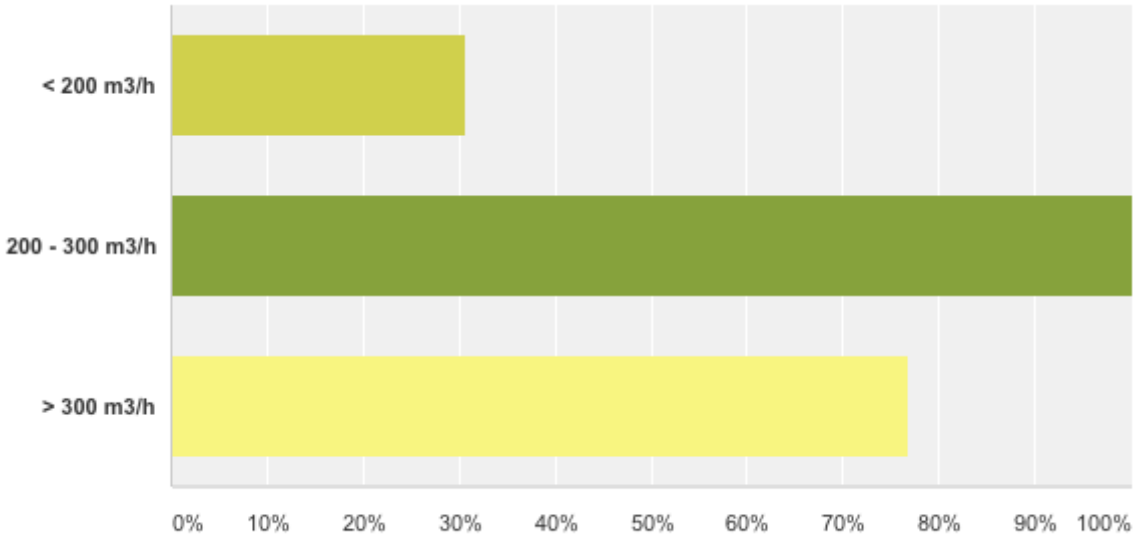


Answer Choices	Responses	
< 5 C	23%	3
5 – 20 C	85%	11
20 – 30 C	54%	7
> 30 C	31%	4
Total Respondents: 13		

- Answered: 13 Skipped: 4

Study analysis: *Results reflect the ability of test facilities to conduct tests under different temperature ranges, not the number of BWMS tested under the different ranges. The conditions clearly do exist at facilities around the world for testing under different temperature ranges depending on the season and geographical location of the test facility.*

Q22 – At what flow rates has land-based testing been conducted?



Answer Choices	Responses	
< 200 m3/h	31%	4
200 - 300 m3/h	100%	13
> 300 m3/h	77%	10
Total Respondents: 13		

- Answered: 13, Skipped: 4

Q23 – If land-based testing at flow rates less than 200 m^3/h has been conducted, please include the lowest flow rate tested.

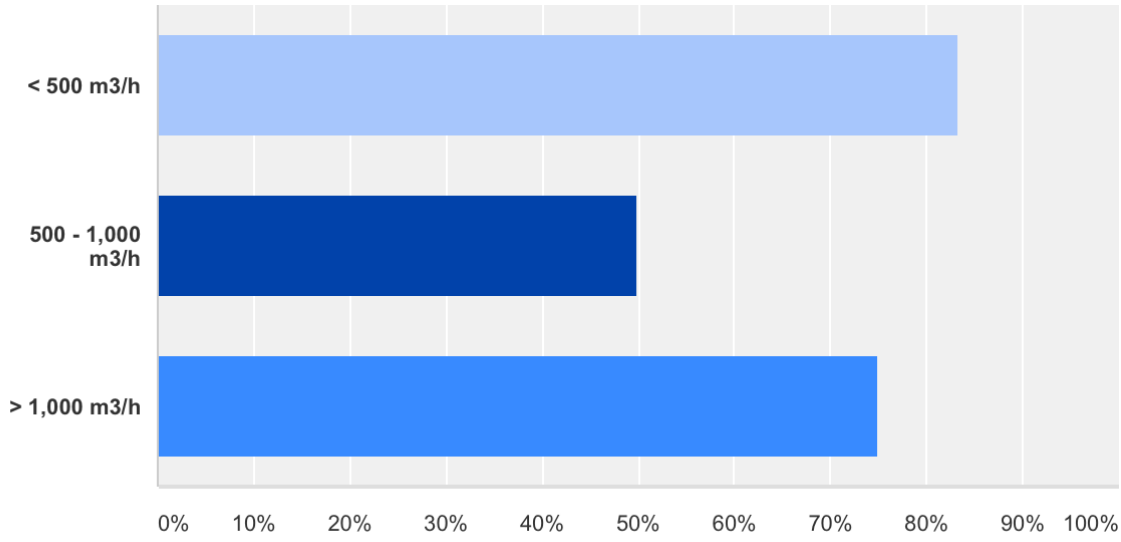
- Lowest flow rate listed was 50 m^3/h
- Answered: 9, Skipped: 8

Q24 – If land-based testing at flow rates above 300 m^3/h has been conducted, please include the highest flow rate tested.

- Highest flow rates tested were 1000 m^3/h and 1250 m^3/h
- Answered: 4, Skipped: 13

Study analysis: *The responses indicate that tests are conducted under a wide range of flow rates (from below 200 m^3/h to above 300 m^3/h).*

Q25 – At what flow rates has shipboard testing been conducted?



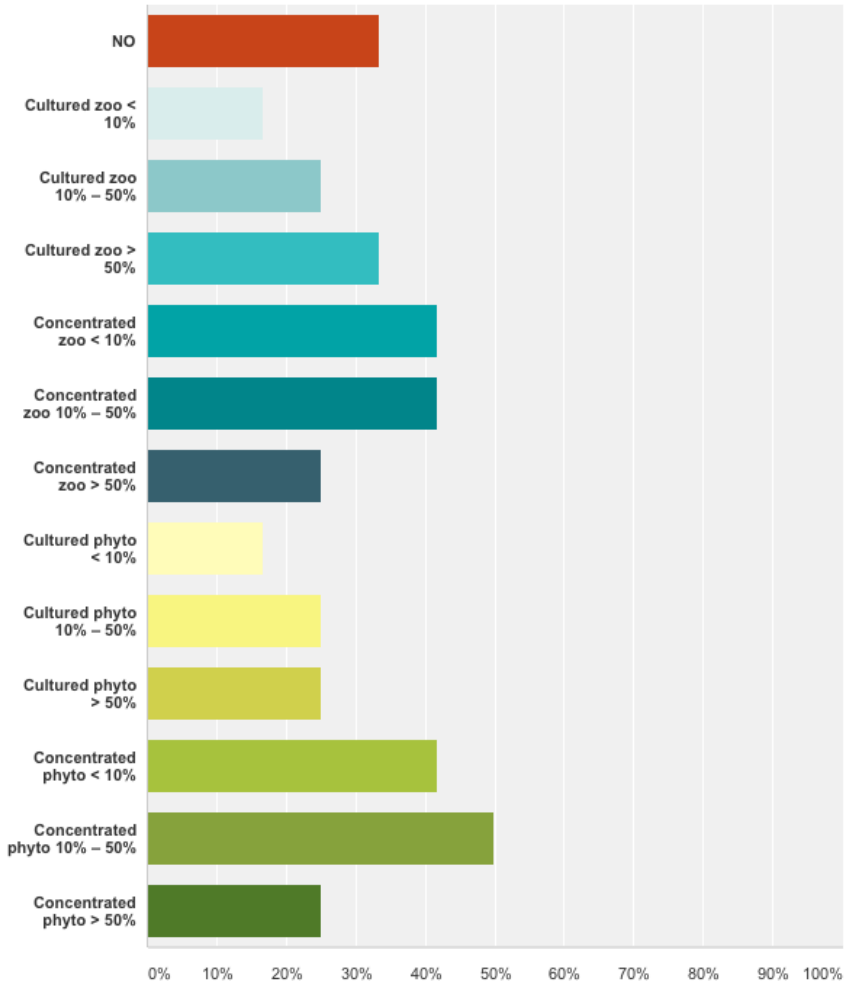
Answer Choices	Responses	
< 500 m3/h	**83%**	10
500 - 1,000 m3/h	**50%**	6
> 1,000 m3/h	**75%**	9
Total Respondents: 12		

- Answered: 12, Skipped: 5

Study analysis: *Shipboard tests are conducted over a wide range of flow rates. The flow rates used appear to be reflective of actual flow rates encountered on board commercial ships of different sizes.*

Q26 – Are biological conditions of challenge water being adjusted for land-based testing?

- Answered: 12, Skipped: 5



Answer Choices	Responses	
NO	33%	4
Yes, Cultured zooplankton for < 10% of the challenge conditions	17%	2
Yes, Cultured zooplankton for 10% – 50% of the challenge conditions	25%	3
Yes, Cultured zooplankton for > 50% of the challenge conditions	33%	4
Yes, Concentrated ambient/native zooplankton for < 10% of the challenge conditions	42%	5
Yes, Concentrated ambient/native zooplankton for 10% – 50% of the challenge conditions	42%	5
Yes, Concentrated ambient/native zooplankton for > 50% of the challenge conditions	25%	3
Yes, Cultured phytoplankton for < 10% of the challenge conditions	17%	2
Yes, Cultured phytoplankton for 10% – 50% of the challenge conditions	25%	3
Yes, Cultured phytoplankton for > 50% of the challenge conditions	25%	3
Yes, Concentrated ambient/native phytoplankton for < 10% of the challenge conditions	42%	5
Yes, Concentrated ambient/native phytoplankton for 10% – 50% of the challenge conditions	50%	6
Yes, Concentrated ambient/native phytoplankton for > 50% of the challenge conditions	25%	3
Total Respondents: 12		

Study analysis: *Clearly some test facilities do not manipulate biological challenge conditions and some do, but in different ways. These varying approaches generate lack of consistency, which could lead to large differences in test results for the same BWMS evaluated by different facilities/organizations. The findings on approaches and procedures used by test facilities to adjust biological conditions (or not), as indicated in these responses, can be useful to the discussion of the Correspondence Group on the review of Guidelines (G8) in relation to the use of Standard Test Organisms (STO).*

Q27 – Are physical and/or chemical conditions of challenge water being adjusted for land-based testing?

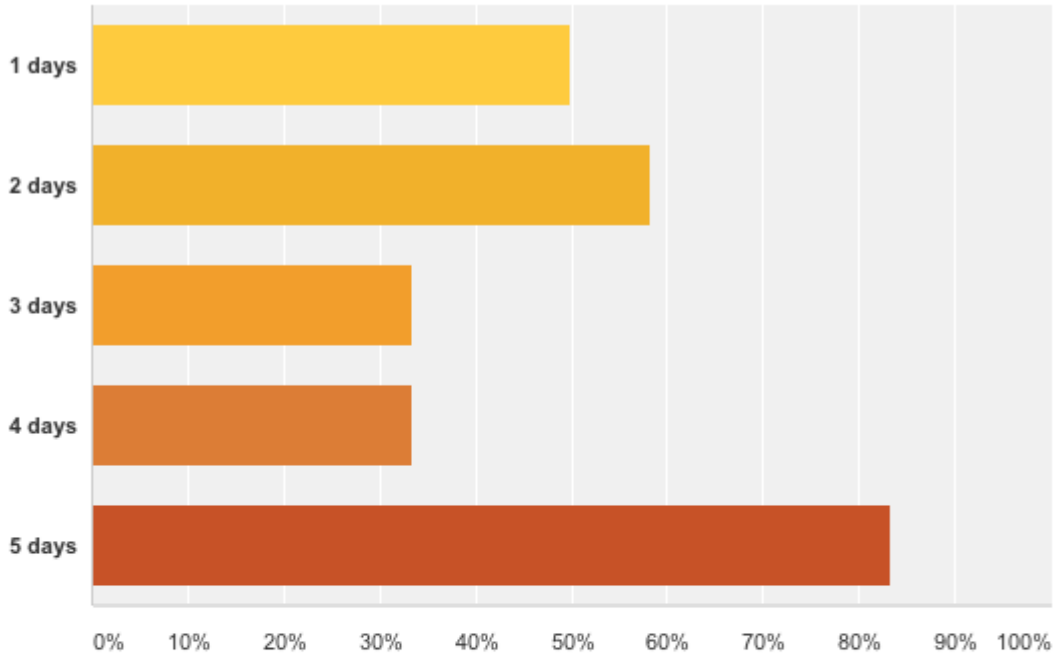
- **75% (9) answered Yes** and 25% (3) answered No
- Answered: 12, Skipped: 5

Q28 – If physical and/or chemical conditions of challenge water are being adjusted for land-based testing (Yes to Q27), by how much and how?

- **44% (4 of 9) increase salinity by less than 10 PSU** by adding salt or brine.
- No one (0 of 9) responded that salinity is increased by more than 10 PSU.
- **44% (4 of 9) decrease salinity by less than 10 PSU** by adding tap or freshwater.
- No one (0 of 9) responded that salinity is decreased by more than 10 PSU.
- **56% (5 of 9) increase total suspended solids by less than 10 mg/l** by adding various inorganic and organic material.
- **56% (5 of 9) increase total suspended solids by more than 10 mg/l** by adding various inorganic and organic material.
- 11% (1 of 9) increase particulate organic carbon by less than 2 mg/l by adding various organic material.
- **78% (7 of 9) increase particulate organic carbon by more than 2 mg/l** by adding various organic material.
- 33% (3 of 9) increase dissolved organic carbon by less than 2 mg/l by adding various organic material.
- **56% (5 of 9) increase dissolved organic carbon by more than 2 mg/l** by adding various organic material.
- No one (0 of 9) responded that dissolved oxygen is adjusted.
- No one (0 of 9) responded that temperature is adjusted.
- No one (0 of 9) responded that any other physical and/or chemical conditions are adjusted.
- Answered: 9, Skipped: 8

Study analysis: *It appears that most test facilities manipulate physical/chemical challenge conditions to some extent but the specific parameters differ and the method used to make adjustments varies greatly. These varying approaches generate lack of consistency, which could lead to large differences in test results for the same BWMS evaluated by different facilities/organizations. The findings on approaches and procedures used by test facilities to adjust physical/chemical conditions (or not), as indicated in these responses, can be useful to the discussions of the Correspondence Group on the review of Guidelines (G8) in relation to the adjustment of salinity, temperature, DOC, POC, TSS, etc.*

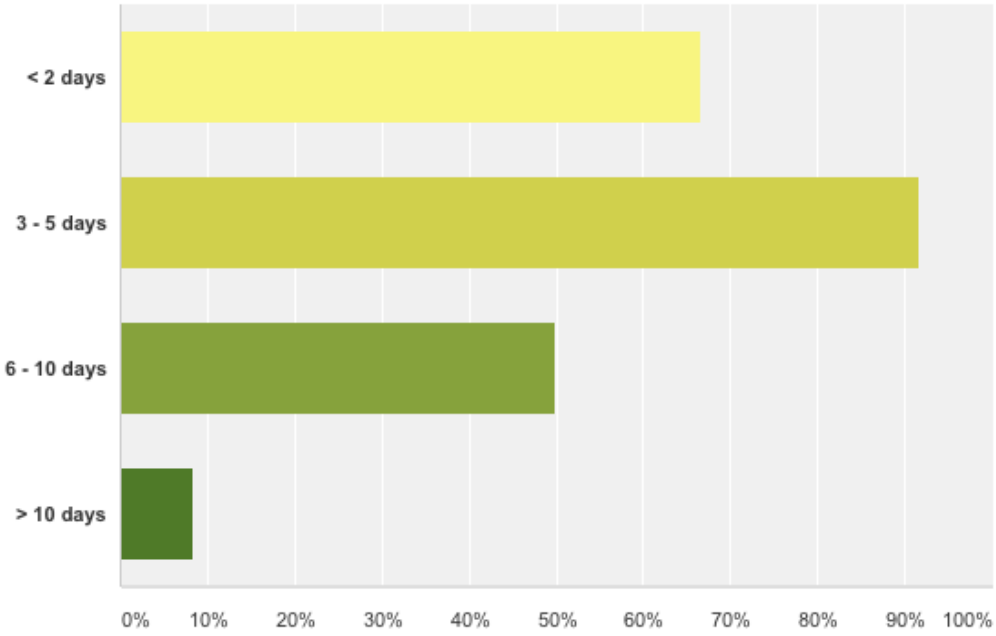
Q29 – What ballast water holding times are used for treated and control water in land-based testing?



Answer Choices	Responses	
1 days	50%	6
2 days	58%	7
3 days	33%	4
4 days	33%	4
5 days	83%	10
Total Respondents: 12		

- Answered: 12, Skipped: 5

Q30 – What ballast water holding times are used for treated and control water in shipboard testing?



Answer Choices	Responses	
< 2 days	67%	8
3 - 5 days	92%	11
6 - 10 days	50%	6
> 10 days	8%	1
Total Respondents: 12		

- Answered: 12, Skipped: 5

Study analysis: *It is important to note that the responses to Questions 29 and 30 are an indication of what test facilities have applied in general, not what has been used as holding time during testing of any individual BWMS. For example, a test facility may have tested with holding times ranging from less than 2 days to over 10 days, depending on the BWMS they have tested on various occasions, but this does not mean that every individual BWMS was tested for both less than 2 days and over 10 days. BWMS have therefore been tested at holding times ranging from less than 2 days to over 10 days, however, as there is no indication as to which systems passed the tests or not, conclusions cannot be drawn from this question on how the varying holding times have affected type approval testing.*

3.8 Test methods

Q31 - Are land-based testing samples collected according to the approach described in Guidelines (G8) (with three replicates at beginning, middle and end of fill or discharge) or Guidelines (G2) (with continuous isokinetic, time-integrated "representative" sampling)?

- **67% (8) answered use of the approach in Guidelines (G8)**
- **75% (9) answered use of the approach in Guidelines (G2)**
- Answered: 12, Skipped: 5

Q32 – Are shipboard testing samples collected according to the approach described in Guidelines (G8) (with three replicates at beginning, middle and end of fill or discharge) or Guidelines (G2) (with continuous isokinetic, time-integrated "representative" sampling)?

- **67% (8) answered use of the approach in Guidelines (G8)**
- **67% (8) answered use of the approach in Guidelines (G2)**
- 8% (1) answered that another approach is used but it was not described
- Answered: 12, Skipped: 5

Study analysis: *While the responses above indicate some level of consistency between test facilities in applying standard methods for sampling, it is important to note that the sampling approaches described in Guidelines (G2) and (G8) are very different. This discrepancy in sampling methods may generate lack of consistency, which could lead to large differences in test results for the same BWMS evaluated by different facilities/organizations.*

Q33 – How are samples for each regulated biological category analyzed for shipboard testing?

- 100% (12) provided information on analysis of viable organisms more than 50 µm in size. **All listed similar methods of microscopic observations, stimuli and movement. Three include use of a vital stain.**
- 92% (11) provided information on analysis of viable organisms between 10 and 50 µm in size. **Disparate methods were listed, including vital stains and epi-fluorescent microscopy, flow-cytometry, pulsed/variable fluorescence and culture/growth assays.**
- 83% (10) provided information on analysis of regulated bacteria. **All listed similar approved or standard methods.**
- Answered: 12, Skipped: 5

Q34 – How are samples for each regulated biological category analyzed for land-based testing?

- 100% (11) provided information on analysis of viable organisms more than 50 µm in size. **All listed similar methods of microscopic observations, stimuli and movement.**
- 100% (11) provided information on analysis of viable organisms between 10 and 50 µm in size. **Disparate methods were listed, including vital stains and epi-fluorescent microscopy, flow-cytometry, pulsed/variable fluorescence and culture/growth assays.**
- 91% (10) provided information on analysis of regulated bacteria. **All listed similar approved or standard methods.**
- Answered: 11, Skipped: 6

Study analysis: *While the responses above indicate a high degree of consistency between test facilities in applying standard methods for analysis of organisms more than 50 µm in size and bacteria, a much larger number of very different analysis methods are used amongst the test facilities and organizations to determine viability of organisms between 10 and 50 µm in size. These varying methods generate lack of consistency, which could lead to large differences in test results for the same BWMS evaluated by different facilities/organizations.*

Questionnaire 2 – Administrations, other Government agencies and recognized organizations

3.9 This specific survey is focused on approaches used for type approval. A total of 16 Administrations, agencies and classification societies acting as ROs from around the world provided information. The following is the list of questions asked and summaries of responses. Initial questions on name, affiliation, etc., are kept confidential.

3.10 Certification activities

Q4 – How many BWMS type approval applications have you reviewed and during which calendar years?

- Average of 6.8 with a range from 1 to 26 reviews.
- Earliest were conducted in 2006 and 60% (9 of 15) had ongoing reviews at the time of the survey.
- Answered: 15, Skipped: 1

Q5 – How many BWMS Type Approval Certificates have you issued and during which calendar year(s)?

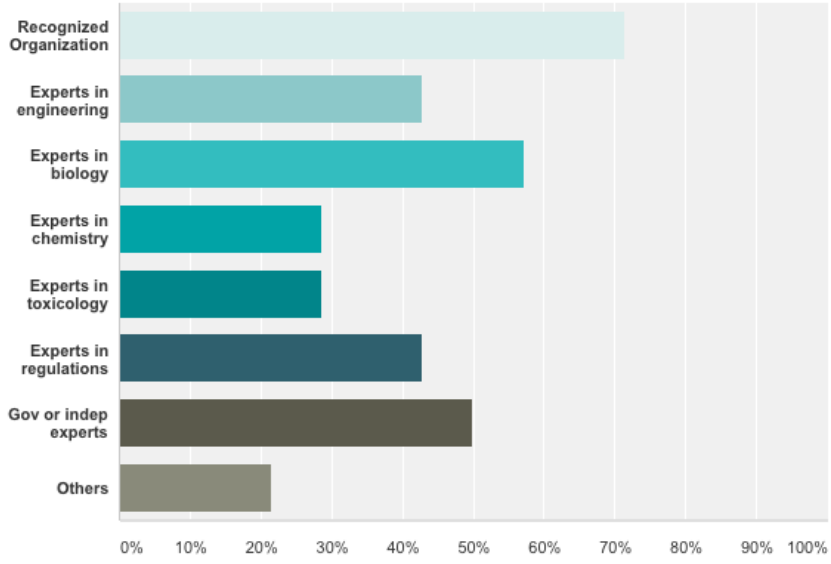
- Average of 3.9 with a range from 1 to 13 Type Approval Certificates issued.
- Earliest certification was in 2006 and 47% (7 of 15) have issued Type Approval Certificates in 2015.
- Answered: 15, Skipped: 1

Study analysis: *For Questions 4 and 5, it is important to note that some entities (especially ROs) have reviewed BWMS that are already type approved by others. The difference between the figures in Questions 4 and 5 is that a large number of type approval applications were started in 2014 so they were probably not yet finished at the time of the survey.*

3.11 Certification process and criteria

Q6 – Who is involved in the review process for type approval?

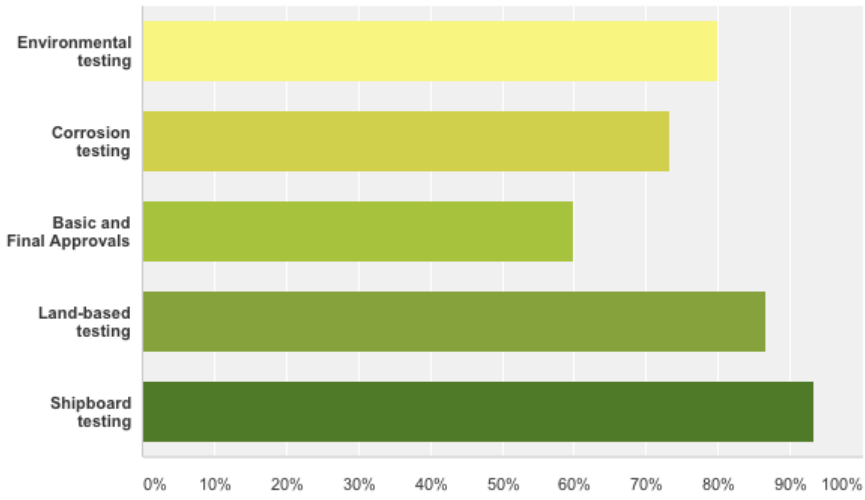
- "Others" included experts in fluid dynamics and biodosimetry.
- Answered: 14, Skipped: 2



Answer Choices		Responses	
Recognized Organization		71.43%	10
Expert(s) in engineering (Government Staff/Independent Experts)		42.86%	6
Expert(s) in biology (Government Staff/Independent Experts)		57.14%	8
Expert(s) in chemistry (Government Staff/Independent Experts)		28.57%	4
Expert(s) in toxicology (Government Staff/Independent Experts)		28.57%	4
Expert(s) in regulations/policy (Government Staff/Independent Experts)		42.86%	6
Government Staff/Independent Experts		50.00%	7
Other (please specify)	Responses	21.43%	3
Total Respondents: 14			

Q7 – What are the criteria used in the review of a BWMS application for type approval?

- Answered: 15, Skipped: 1

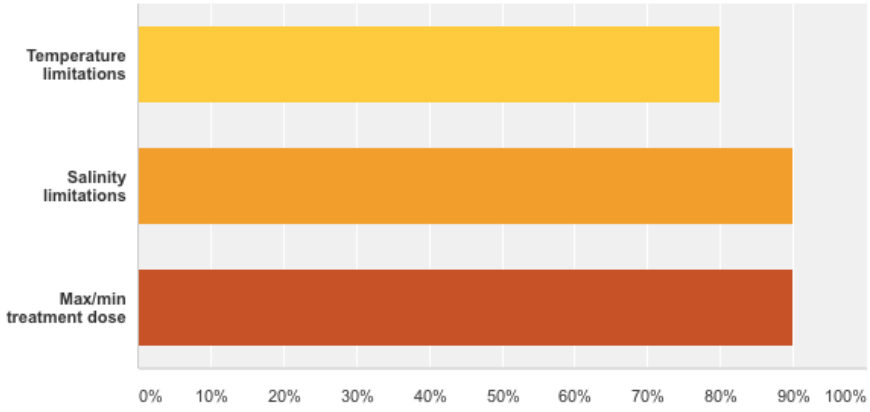


Answer Choices	Responses	
Environmental tests following Part 3 of the Annex to Guidelines (G8)	80.00%	12
Corrosion tests	73.33%	11
Recommendations from Basic and Final Approval granted by MEPC	60.00%	9
Land-based testing	86.67%	13
Shipboard testing	93.33%	14
Total Respondents: 15		

Study analysis: *While lack of evaluation for corrosion tests and recommendations from Basic and Final Approval granted by MEPC may be a result of the technology used (e.g. UV-based BWMS do not require Basic and Final Approval), the lack in some responses of the three basic forms for tests that should apply to all equipment (land-based, shipboard or environmental tests) is due to responses from some respondents not covering all tests (e.g. some ROs are responsible only for some parts of the type approval process (for example corrosion testing) and not the complete testing process).*

Q8 – Which of the following criteria are measured and included in the Type Approval Certificate?

- Answered: 10, Skipped: 6



Answer Choices	Responses	
Temperature limitations	**80.00%**	8
Salinity limitations	**90.00%**	9
Maximum/minimum dose of TRO/UV/Active Substance/Preparation (as applicable)	**90.00%**	9
Total Respondents: 10		

Q9 – If maximum/minimum dose of Total Residual Oxidants (TRO) concentration are measured and included in the Type Approval Certificate, were TRO values used from land-based tests?

- 38% (5) answered Yes, 8% (1) answered No and **54% (7) answered Not Applicable**.
- Answered: 13, Skipped: 3

Q10 – If maximum/minimum dose of Total Residual Oxidants (TRO) concentration are measured and included in the Type Approval Certificate, were TRO values used from shipboard tests?

- 31% (4) answered Yes, 16% (2) answered No and **54% (7) answered Not Applicable**.
- Answered: 13, Skipped: 3

Q11 – If No to Q9 and Q10, how was TRO determined?

- **The 4 received answers included manufacturer R&D test data and GESAMP-BWWG recommendations**.
- Answered: 4, Skipped: 12

Study analysis: *These responses are valuable in understanding how TRO are considered for the issuance of a Type Approval Certificate.*

Q12 – If maximum/minimum dose of UV treatment are measured and included in the Type Approval Certificate, what is measured?

- **100% (10) answered and listed performance of UV reactors, UV intensity and exposure time (including flow rate), and UV lamp power regulation.**
- **70% (7) answered that water UV transmittance was measured during testing, with two at land-based testing only and five at both land-based and shipboard testing.**
- Answered: 10, Skipped: 6

Q13 – Are there other operational criteria that were measured during land-based or shipboard tests?

- **Other operational criteria listed included: power consumption (3); ozone levels (1); flow rate (5); filter backflush frequency (4); and differential pressure (4).**
- Answered: 11, Skipped: 5

Study analysis: *A variety of operational parameters are monitored and considered during land-based and shipboard testing but there is no clear consistency in which parameters are monitored or how they are quantified.*

Q14 – Do you require five successful test trials in land-based testing at each salinity?

- **62% (8) answered Yes** and 38% (5) answered No.
- Answered: 13, Skipped: 3

Study analysis: *It should be clarified that all of the responses confirmed that five successful trials are conducted, as recommended in Guidelines (G8). Those who answered No specified that they did not test on all three salinity ranges, only two of the three, but they still conducted five tests for each of these two salinities.*

Q15 – Do you require five consecutive successful test trials in land-based testing at each salinity?

- 46% (6) answered Yes and **54% (7) answered No**.
- Answered: 13, Skipped: 3

Study analysis: *All of the respondents who answered No explained that this is not required by the current version of Guidelines (G8). However, it is important to note that the question does not distinguish between test trials that were not "successful" because they were deemed "invalid" (e.g. challenge conditions were not appropriate, test facility equipment failure, etc.) or "valid" trials that resulted in the BWMS not meeting the D-2 standard. Only one respondent confirmed that invalidity of challenge water is the reason why five consecutive successful tests were not required.*

Q16 – Do you require a minimum 6-month (first through last trial) period for shipboard testing?

- **92% (12) answered Yes** and 8% (1) answered No.
- Answered: 13, Skipped: 3

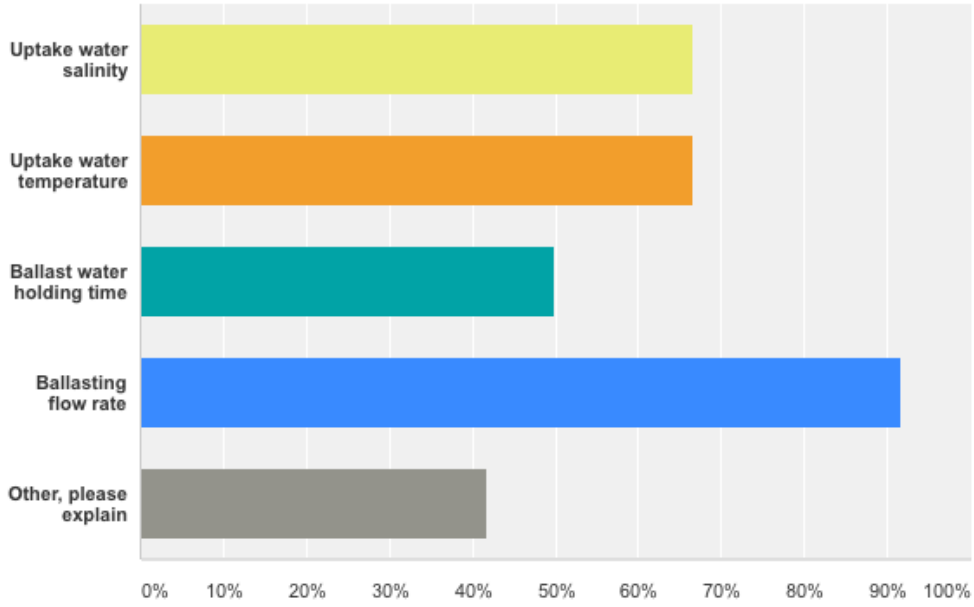
Q17 – Do you require 3 consecutive successful test trials in shipboard testing?

- **92% (12) answered Yes** and 8% (1) answered No.
- Answered: 13, Skipped: 3

Study analysis: *The respondent who answered No to Questions 16 and 17 explained that they issued the Type Approval Certificate based on reports from another Administration. Thus the response does not indicate that an Administration is not requiring 6-month shipboard tests or 3 consecutive successful shipboard tests.*

3.12 Certification stipulations and transparency

Q18 – Do or can your Type Approval Certificates include stipulations (requirements) and restrictions for use and operation?



Answer Choices		Responses	
Uptake water salinity		66.67%	8
Uptake water temperature		66.67%	8
Ballast water holding time		50.00%	6
Ballasting flow rate		91.67%	11
Other, please explain	Responses	41.67%	5
Total Respondents: 12			

- "Other" included sequence of treatment; maximum pressure; minimum UV intensity; and maximum dose of Active Substance.
- Answered: 12, Skipped: 4

Study Analysis: *Many Administrations are including restrictions for use and operation of the BWMS on their Type Approval Certificates. Temperature and salinity, which are discussed within the Correspondence Group for the revision of Guidelines (G8), are stipulated in two-thirds of the answers received. Flow rate, or treatment rated capacity, is mentioned by more than 90% of the respondents.*

Q19 – Are all test results (including BWMS technical, mechanical and biological failures) reported to, and considered by, the Administration?

- **100% (12) answered Yes**.
- Answered: 12, Skipped: 4

Q20 – Are all test results (including BWMS technical, mechanical and biological failures) made available publicly?

- 46% (6) answered Yes and **54% (7) answered No**.
- Answered: 13, Skipped: 3

Study analysis: *Public availability of test reports is important for the perceived transparency and credibility of the type approval process.*

Q21 – How do you evaluate and certify BWMS for multiple units in a model series, sizes, and/or flow rates (system scaling)?

- **The 12 responses included:**

  .1 in accordance with BWM.2/Circ.33 (6);
  .2 CFD analysis and mathematical modelling (4);
  .3 use of land-based testing as minimum and shipboard testing as maximum for scaling systems (4); and
  .4 manufacturer calculations (2).

- Answered: 12, Skipped: 4

Study analysis: *Respondents could select more than one option and the responses indicate that the approach under BWM.2/Circ.33 is the most commonly employed. Some Administrations rely on their recognized organizations to deal with scaling with no indication on how Type Approval Certificates are issued for the scaled units. Some responses indicated that certain Administrations deviated from the approach in BWM.2/Circ.33 in their evaluations.*

Track 2 – BWMS operational performance

3.13 Operators of ships, equipment manufacturers and third party verifiers were encouraged by the Committee to provide data on the operation of BWMS installed on board ships.

3.14 The online surveys were designed to collect information from individual organizations or on individual ships with BWMS. However, in some cases, responses to the surveys included combined or pooled answers for multiple ships under a single questionnaire. While it was not possible to include these pooled responses in the statistical results for individual ships or BWMS, the information was valuable and was considered in the context of supporting or conflicting with the trends found in the individual responses; it is therefore included in this report in summary form.

3.15 Responses for a total of 122 individual ships (installed and commissioned BWMS) were included (based on the screening approach described in the previous chapter) in the final analysis of Track 2, 68 of which originated from shipowners/operators, 16 from BWMS vendors, 8 from independent evaluators, while the remaining were pooled responses representing multiple ships.

3.16 It was estimated that at the time of this Study 2,410 ships had been equipped with BWMS (based on information contributed to the Study by IACS in July 2015). Regrettably, no information regarding the number of individual ships having fully commissioned BWMS is presently available. Commissioned BWMS are those that have been evaluated by the manufacturer and verified as installed properly and operating according to their design and specifications. Given that BWMS are not often operated (see below) and there is no current requirement to monitor technical/mechanical, biological or environmental performance, the number of responses to Track 2 is still considered significant and valuable.

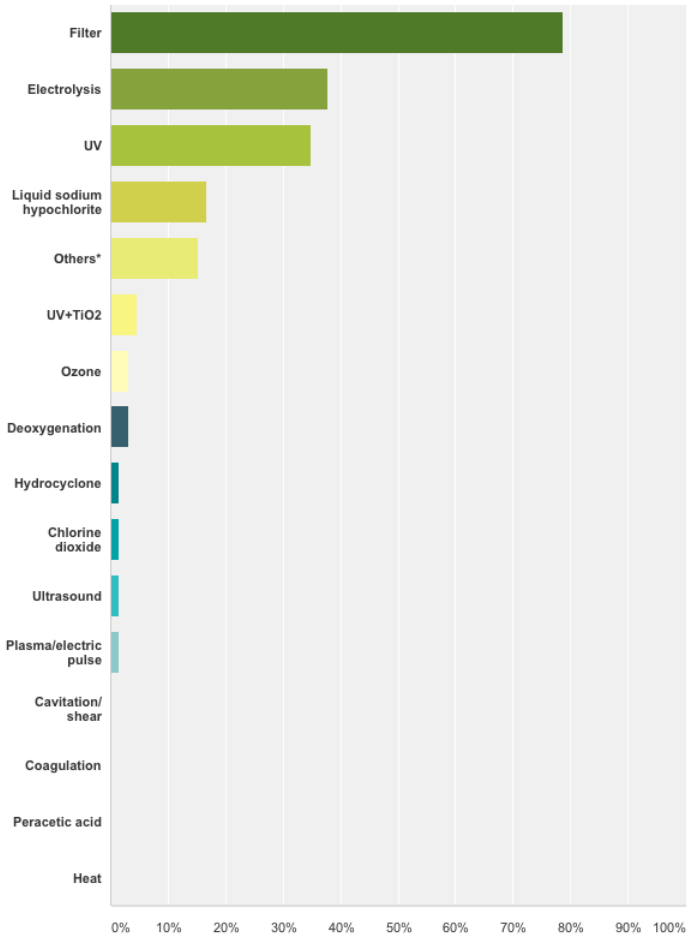
Questionnaire 1 – Shipowners and operators

3.17 Six responses to this survey included combined answers for 3 to 19 different ships each, with various installed and commissioned BWMS with Type Approval Certificates. Very similar trends were found in these responses compared to those received for single ships and notes on the combined responses are added to specific questions below. Initial questions on name, affiliation, ship name or IMO number, etc. (required to ensure that the respondents are valid entities), are kept confidential.

3.18 BWMS characteristics

Q5 – What is (are) the basic treatment approach(es) for the BWMS installed on this specific ship?

- Answered: 66, Skipped: 2



Answer Choices		Responses	
Filter		78.79%	52
Electrochlorination		37.88%	25
UV		34.85%	23
Liquid sodium hypochlorite		16.67%	11
Other, please list _____	Responses	15.15%	10
UV+TiO2		4.55%	3
Ozone		3.03%	2
Deoxygenation		3.03%	2
Hydrocyclone		1.52%	1
Chlorine dioxide		1.52%	1
Ultrasound		1.52%	1
Plasma/electric pulse		1.52%	1
Cavitation/shear/physical damage		0.00%	0
Coagulation		0.00%	0
Peracetic acid		0.00%	0
Heat		0.00%	0
Total Respondents: 66			

Note: "Other" included 9 descriptions of neutralization prior to discharge and 1 mention of a magnetic treatment.

Q6 – Is it retrofitted or installed during ship construction?

- **79% (52) answered New Build** and 21% (14) answered Retrofit.
- Answered: 66, Skipped: 2

Study analysis: *With regard to the types of BWMS that have received Type Approval Certificates, it was observed that filtration with electrochlorination and filtration with UV treatment were by far the most common responses from this stakeholder group. There was also a clear prevalence of newbuildings over existing ships (retrofits).*

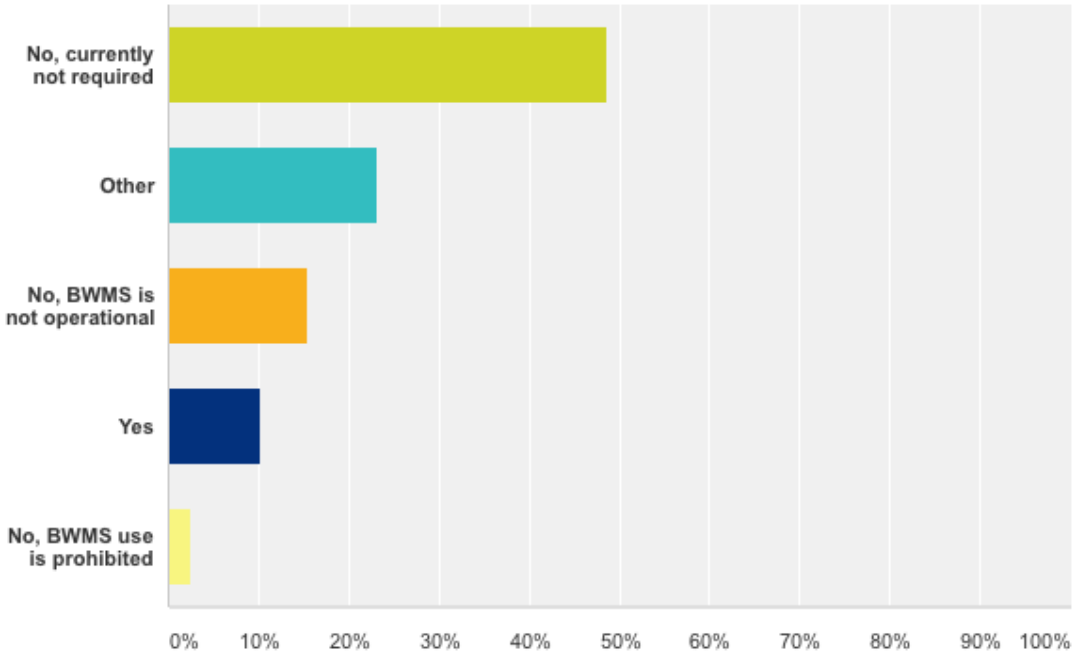
3.19 BWMS operation and evaluation

Q7 – Have any attempts been made to operate and evaluate or monitor the technical, mechanical, environmental and/or biological performance of the BWMS after commissioning?

- **58% (38) answered Yes** and 42% (27) answered No.
- Answered: 65, Skipped: 3

Study analysis: *As described above, there is currently no requirement to monitor BWMS performance. However, such practices could provide valuable feedback on the functioning of BWMS.*

Q8 – Is the BWMS currently used in routine ballasting operations?



Answer Choices		Responses	
NO, Currently not required		48.72%	19
Other (please specify)	Responses	23.08%	9
NO, BWMS is currently not operational		15.38%	6
Yes		10.26%	4
NO, BWMS use is prohibited in regions of operation		2.56%	1
Total			39

- "Others" included (in no particular order):

  (a) Not all the time because filter backflushing is limited by bilge holding tank capacity;
  (b) Additional testing is required;
  (c) Only for California terminals;
  (d) Mechanical problems;
  (e) Operated only when conditions permit; and
  (f) Ballast water exchange is still required in some areas.

- Answered: 39, Skipped: 29

Q9 – If the BWMS is currently used in routine ballasting operations, how often is it typically used (precise numbers are not required)?

- Responses ranged from only 3 or 4 ballasting operations per year to 500 to 600 ballasting operations per year.
- Responses ranged from 2 hours to 24 hours of operation per ballasting event.
- Answered: 36, Skipped: 32

Study analysis: *Only 10% of the BWMS installed on board ships appear to be currently used in routine ballasting operations. Therefore, the sample size for the following information is limited.*

Q10 – Is treatment dose monitored and recorded (e.g. TRO levels, UV intensity, etc.)?

- **63% (24) answered Yes**, 32% (12) answered No and 5% (2) answered Unknown.
- The great majority who answered Yes stated TRO or UV intensity is monitored and recorded. When the specific methods used to monitor TRO and UV intensity were provided, the great majority mentioned sensor-based approaches.
- Answered: 38, Skipped: 30

Study analysis: *Not all the responses were specific to the manufacturer of the BWMS, so it is not possible to determine whether the lack of monitoring is due to a first generation system, a misunderstanding of how the BWMS works, or another reason.*

Q11 – Does the BWMS (manufacturer and/or Type Approval Certificate) require a minimum holding time in tank for treatment to meet the D-2 discharge standard?

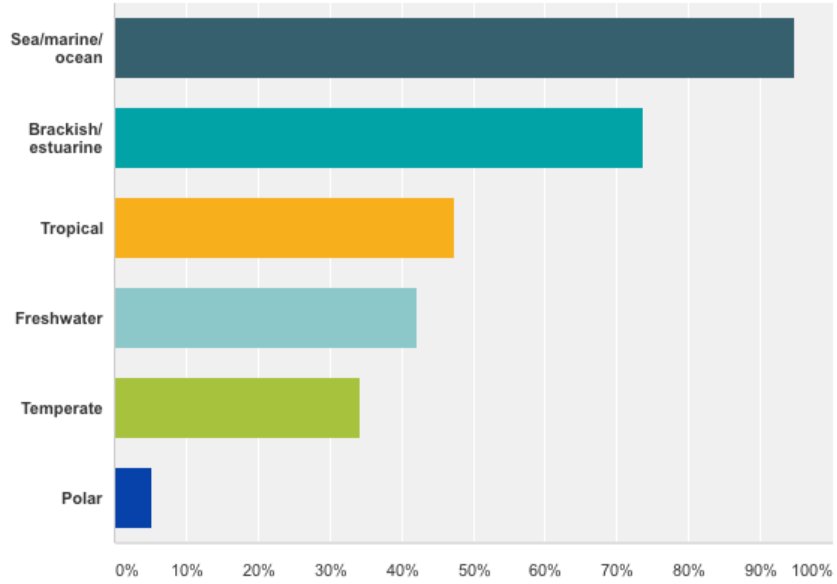
- 8% (3) answered Yes, **74% (28) answered No** and 18% (7) answered Unknown.
- Answered: 38, Skipped: 30

Study analysis: *While there might be many reasons for Type Approval Certificates missing holding time information, it is important to note that the majority of the respondent shipowners are not aware of this restriction. The Correspondence Group on the review of Guidelines (G8) might consider requiring this information to be clearly indicated on the Type Approval Certificate.*

Q12 – What are the most common flow rate operating parameters for the BWMS (e.g. minimum and maximum flow rates required for effective use)?

- 27% (10) answered below 500 m^3/h, 19% (7) answered 500 to 1,000 m^3/h and 16% (6) answered greater than 1,000 m^3/h (14 respondents did not make a selection).
- Ballasting flow rates listed for these ships ranged from as low as 250 m^3/h to as high as 6,000 m^3/h, with the majority below 1,000 m^3/h.
- Answered: 37, Skipped: 31

Q13 – Select the sources of water your ship may encounter during normal operation according to general location, salinity and temperature. These are general categories, please use your best judgement and select all that apply per ship.

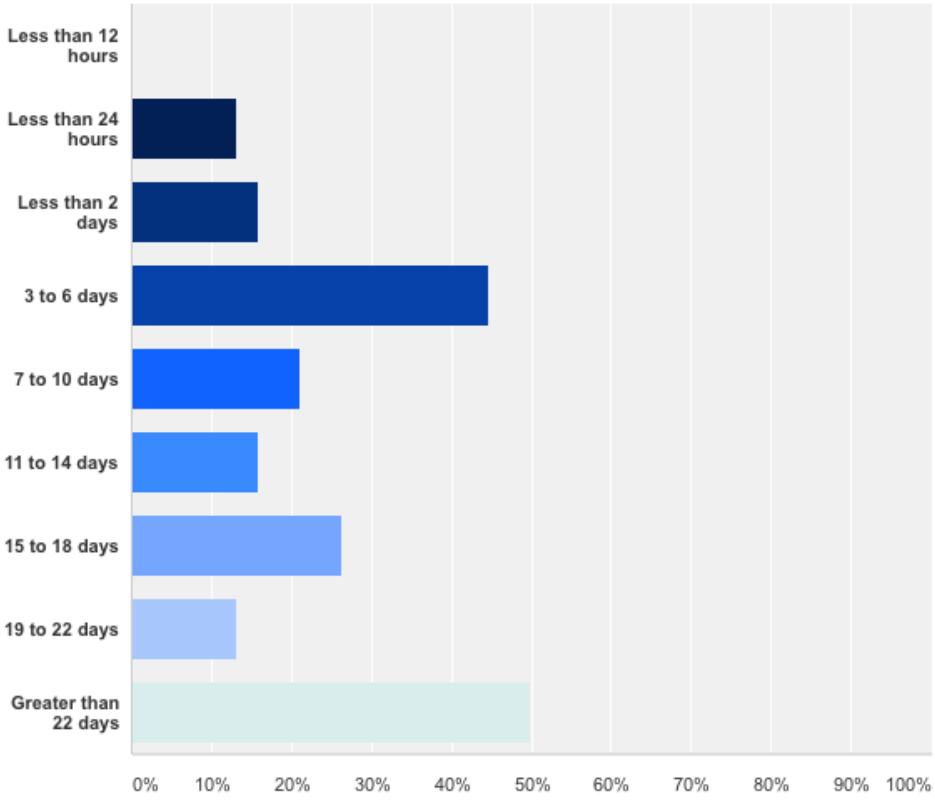


Answer Choices	Responses	
Sea/marine/ocean (high salinity)	94.74%	36
Brackish/estuarine (low salinity)	73.68%	28
Tropical	47.37%	18
Freshwater	42.11%	16
Temperate	34.21%	13
Polar	5.26%	2
Total Respondents: 38		

- Answered: 38, Skipped: 30

Study analysis: *While responses were incomplete, it appears that ships with commissioned BWMS operated most often under marine or brackish water conditions and under a variety of climates. It appears also that installed BWMS are used under a wide range of flow rates.*

Q14 – What is the range of the voyage time for this ship?



Answer Choices	Responses	
Less than 12 hours	0.00%	0
Less than 24 hours	13.16%	5
Less than 2 days	15.79%	6
3 to 6 days	44.74%	17
7 to 10 days	21.05%	8
11 to 14 days	15.79%	6
15 to 18 days	26.32%	10
19 to 22 days	13.16%	5
Greater than 22 days	50.00%	19
Total Respondents: 38		

- Answered: 38, Skipped: 30

Study analysis: *Ships with commissioned BWMS appear to have very diverse operational patterns, including many with relatively short voyages of three to six days and others with very long voyages of over 22 days. It is interesting to note that many of the ships had a holding time that exceeds the minimum required by Guidelines (G8) for land-based tests, which is five days.*

3.20 BWMS training

Q15 –Is any training provided before operation and maintenance of the BWMS?

- **87% (33) answered Yes** and 13% (5) answered No.
- Answered: 38, Skipped: 30
- In all cases where training was provided, it was carried out by the BWMS manufacturer.
- One combined answer for multiple ships stated that no training was provided.

Q16 – Does the BWMS manufacturer provide a complete and detailed operation and maintenance manual with maintenance schedule and required materials/spare parts?

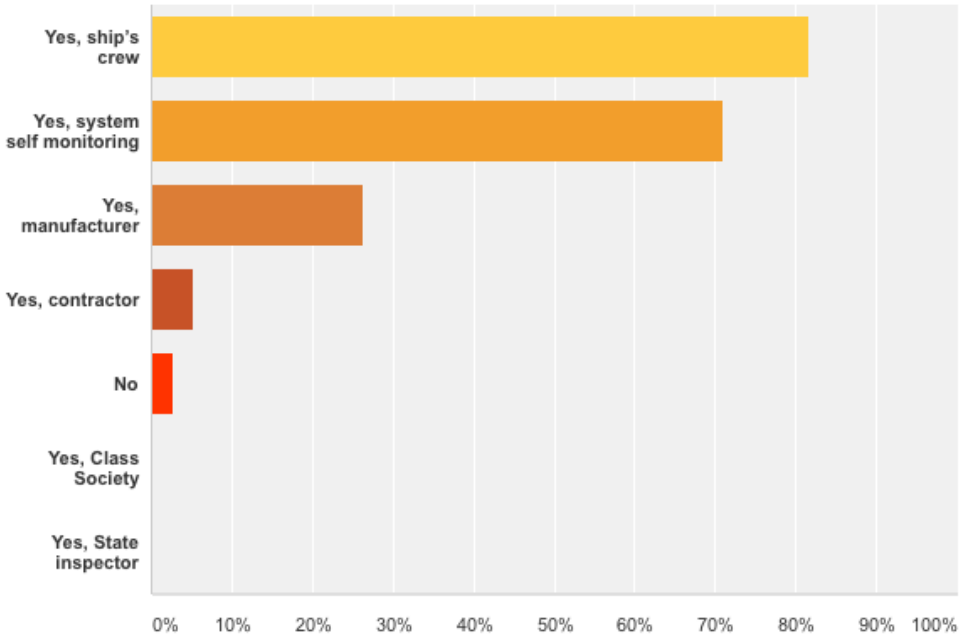
- **95% (35) answered Yes** and 5% (2) answered No.
- Answered: 37, Skipped: 31

Study analysis: *Training and documentation are in most cases provided to support operation and maintenance of BWMS. However, it is not possible to determine the quality and quantity of training and documentation. Although uncommon, it is important to note that in some cases no training or manual seems to have been provided.*

As to the invitation by the Committee (MEPC 68/21, paragraph 2.44) to consider the matter identified by the correspondence group on whether or not operational training manuals for ships´ crew should be a standardized template and part of the type approval procedure, this was considered but it is not possible to provide any recommendations on this matter, based on the results obtained from the survey.

3.21 Evaluation of mechanical performance

Q17 –Is (has) the technical/mechanical performance of the BWMS (been) monitored?

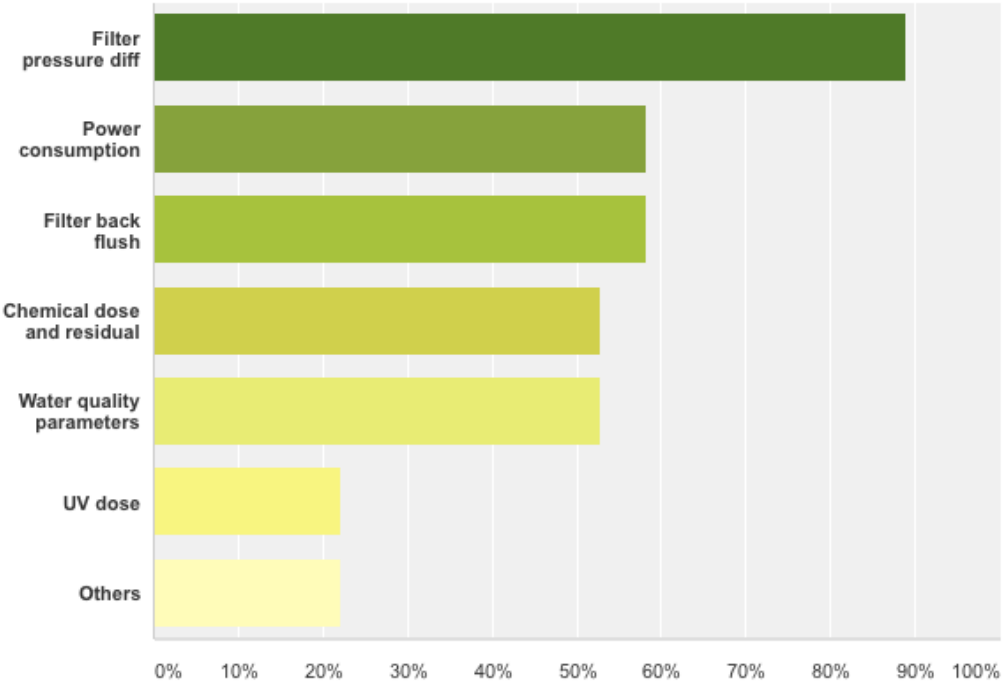


Answer Choices	Responses	
Yes, by Ship's crew	81.58%	31
Yes, by System self monitoring (and recording)	71.05%	27
Yes, by BWMS manufacturer	26.32%	10
Yes, by Independent/third-party contractor	5.26%	2
No	2.63%	1
Yes, by Classification society	0.00%	0
Yes, by Flag State and port State control inspectors	0.00%	0
Total Respondents: 38		

- Answered: 38, Skipped: 30

Study analysis: *The crew remains the main group monitoring the equipment. It is not possible to determine if there are policies to monitor the systems and systemize data collection.*

Q18 – If the technical/mechanical performance of the BWMS is (has been) monitored, what parameters are monitored/recorded?



Answer Choices	Responses	
Filter pressure differential / filter integrity	88.89%	32
BWMS power consumption	58.33%	21
Filter back flush frequency	58.33%	21
Dose and residual of Active Substances (specific chemicals and/or TRO)	52.78%	19
Water quality parameters (e.g. dissolved oxygen, temperature, pH, salinity)	52.78%	19
Dose of UV	22.22%	8
Others, please explain Responses	22.22%	8
Total Respondents: 36		

- "Others" included hydrogen and chlorine gas ventilation and ballasting flow rates and pressures.
- Answered: 36, Skipped: 32

Q19 –If the technical/mechanical performance of the BWMS is (has been) monitored, what are the measured BWMS technical/mechanical failure rates?

- The total number of ballasting events or operational cycles listed ranged from zero (0) to 82, with the majority at less than 10.
- Total number of observed failures, alarms, problems and/or issues requiring corrective action ranged from zero (0, including the one ship with 82 operational cycles monitored for technical/mechanical performance) to each operation with several issues per operation (including 12 over 4 operational cycles monitored for technical/mechanical performance).
- Reported failure rates per ship ranged from 0% to 100% of ballast water operational cycles, with the majority between 25% and 50% failure rates. However, it must be noted that this is based on a limited sample size and will obviously vary between specific BWMS.
- Answered: 27, Skipped: 41
- Reported failure rate from one combined answer for multiple ships was 75% (30 out of 40) of ballast water operational cycles.

Q20 – List the type of most common failure or problem you experienced and its approximate frequency.

- Failures, malfunctions, issues or alarms in order of number of respondents who mentioned the general category:

  .1 various BWMS sensors;
  .2 BWMS piping and valves;
  .3 BWMS controls and automation;
  .4 ballasting flow outside of acceptable range;
  .5 problems associated with filtration;
  .6 treatment dose outside of acceptable range;
  .7 problems with BWMS associated pumps and blowers;
  .8 problems with BWMS power or batteries;
  .9 other alarms, faults or interruptions.

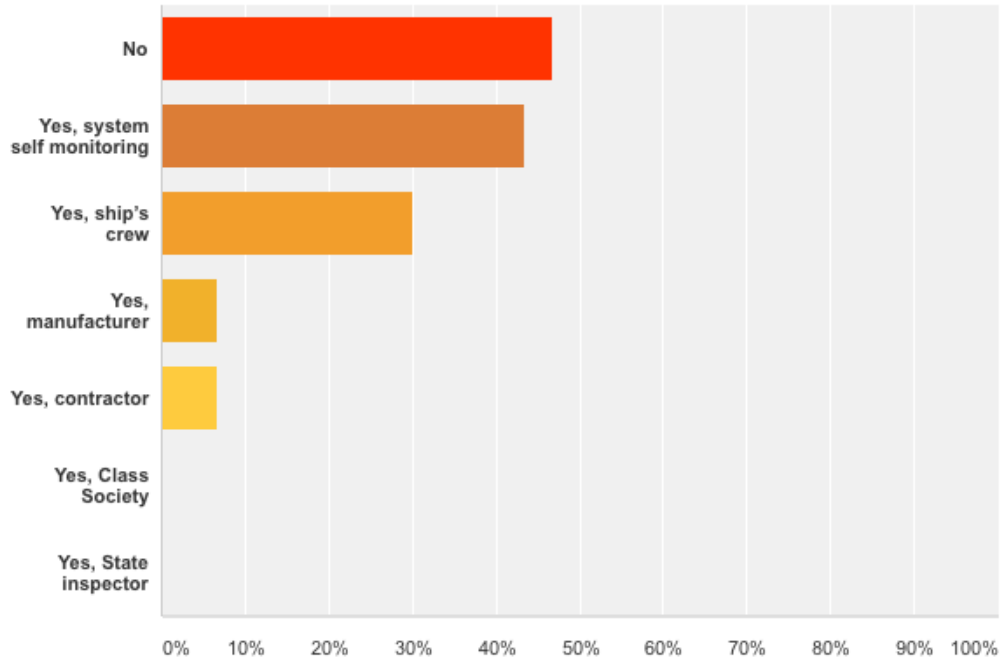
- Answered: 30, Skipped: 38

- Failures, malfunctions, issues or alarms from combined answers for multiple ships in a single response included: significant filter clogging requiring manual cleaning; sensor malfunctions; and errors in data recording.

Study analysis: *Several technical/mechanical malfunctions were reported but the terminology used varied and specific numbers or frequencies were not provided by individual respondents. Thus, while failures could not be quantified, it does appear that sensors/controls and piping/valve systems, as well as problems associated with filtration, constitute the major sources of difficulties during routine ship operation.*

3.22 Evaluation of biological performance

Q21 – Is (has) the biological performance of the BWMS (been) monitored (i.e. compliance or non-compliance with the D-2 standard)?



Answer Choices	Responses	
No	46.67%	14
Yes, by System self monitoring (and recording)	43.33%	13
Yes, by Ship's crew	30.00%	9
Yes, by BWMS manufacturer	6.67%	2
Yes, by Independent/third-party contractor	6.67%	2
Yes, by Classification society	0.00%	0
Yes, by Flag State and port State control inspectors	0.00%	0
Total Respondents: 30		

- Answered: 30, Skipped: 38
- The great majority of combined answers for multiple ships reported that no biological performance evaluation had been conducted.

Q22 – What biological parameters are monitored/recorded?

- **46% (6) answered indicative or bulk biomass estimate**, however the method was not specified. Only 1 answered with numbers of cycles and failure to meet the D-2 standard, with 4 monitored deballasting events and 4 failures to meet requirements for viable organisms of more than 50 µm in size and viable organisms between 10 and 50 µm in size.
- **85% (11) answered direct biological measurements/counts**, however only 1 specified the method for direct biological counts and they focused on *E. coli*, Enterococci and heterotrophic bacteria.
- Answered: 13, Skipped: 55
- One combined answer for multiple ships stated that biological performance was evaluated and there were no observed failures to meet the D-2 standard for 15 individual ballasting cycles.

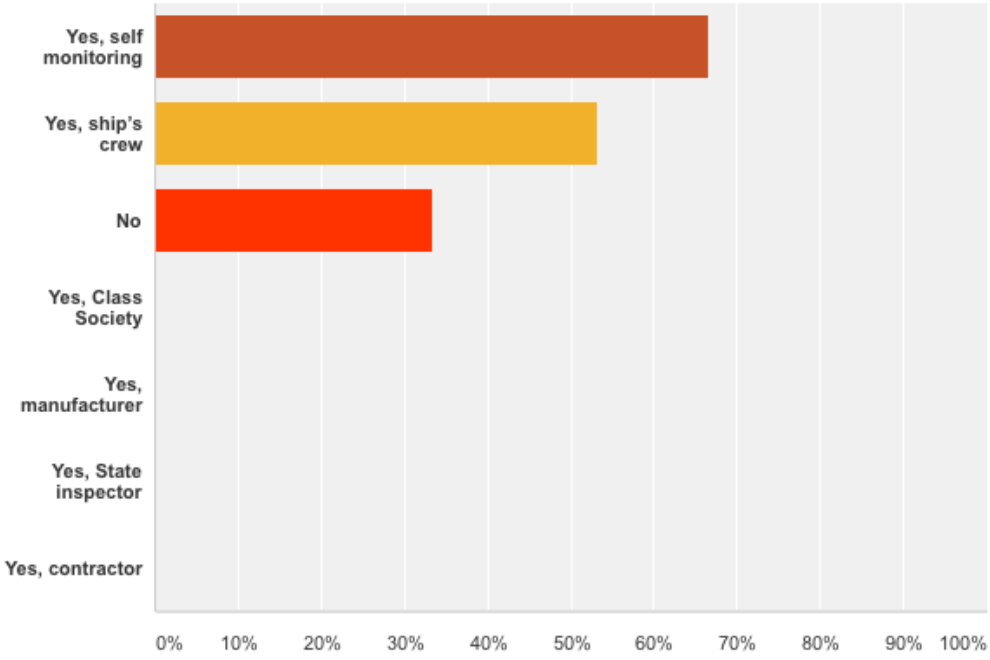
Study analysis: *Relatively few assessments of biological efficacy have been conducted, which prevents the identification of any clear trend or conclusion from the responses.*

Q23 – What are the measured biological failure rates (number of discharge events found non-compliant versus the total number sampled/monitored for the D-2 standard) for each of the following? (Note: various options had been listed in the questionnaire)

- Incomplete and insufficient information was received to allow any meaningful analysis.
- Answered: 8, Skipped: 60

3.23 Evaluation of environmental safety

Q24 – Is (has) the environmental safety of treated water discharge (been) monitored?



Answer Choices	Responses	
Yes, by System self monitoring (and recording)	66.67%	20
Yes, by Ship's crew	53.33%	16
No	33.33%	10
Yes, by Classification society	0.00%	0
Yes, by BWMS manufacturer	0.00%	0
Yes, by Flag State and port State control inspectors	0.00%	0
Yes, by Independent/third-party contractor	0.00%	0
Total Respondents: 30		

- Answered: 30, Skipped: 38

Q25 – What parameters are monitored/recorded?

- **100% (18) answered oxidant levels or TRO**.
- Answered: 18, Skipped: 50

Q26 – What are the measured environmental safety failure rates (number of discharge events found above required limits)?

- The total number of ballasting events or operational cycles reported ranged from zero (0) to 82, with the majority at less than 10.
- No environmental safety failures were reported
- Answered: 16, Skipped: 52
- All the combined responses for multiple ships also reported no environmental safety failures or problems.

Study analysis: *Although there are limited data, it is important to note that when environmental safety was monitored no problems or failures have been noted, at least by the respondents to this survey.*

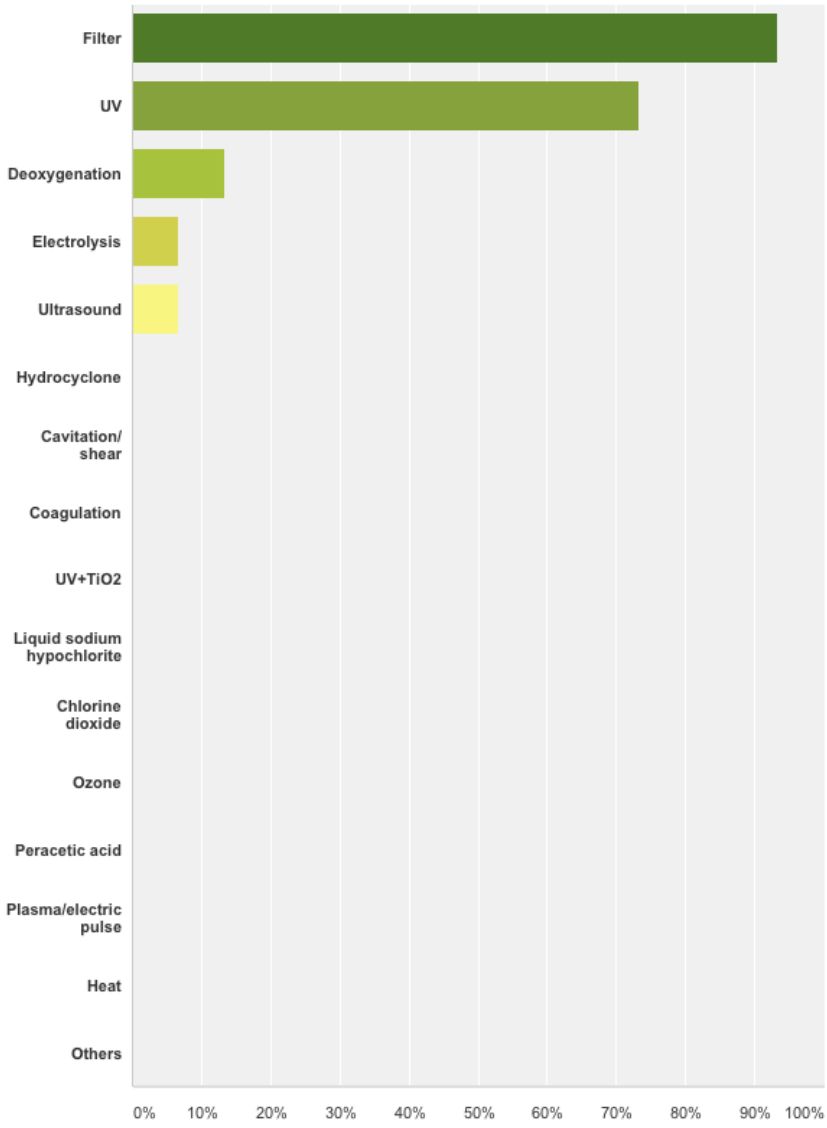
Questionnaire 2 – BWMS manufacturers

3.24 While more than 50 BWMS have received type approval certification, 16 different manufacturers responded to the survey. One response to this survey included combined answers for 12 different ships with the same installed and commissioned BWMS. Very similar trends were found in this response compared to those who responded for single ships and notes on the combined response are added to specific questions below. Initial questions on name, affiliation, ship name or IMO number, etc. (required to ensure that the respondents are valid entities), are kept confidential.

3.25 BWMS characteristics

Q5 – What is (are) the basic treatment approach(es) for the BWMS installed on this specific ship?

- Answered: 15, Skipped: 1



Answer Choices	Responses	
Filter	93.33%	14
UV	73.33%	11
Deoxygenation	13.33%	2
Electrochlorination	6.67%	1
Ultrasound	6.67%	1
Hydrocyclone	0.00%	0
Cavitation/shear/physical damage	0.00%	0
Coagulation	0.00%	0
UV+TiO2	0.00%	0
Liquid sodium hypochlorite	0.00%	0
Chlorine dioxide	0.00%	0
Ozone	0.00%	0
Peracetic acid	0.00%	0
Plasma/electric pulse	0.00%	0
Heat	0.00%	0
Other, please list _____ Responses	0.00%	0
Total Respondents: 15		

Q6 – Is it retrofitted or installed during ship construction?

- **69% (9) answered Retrofit** and 31% (4) answered New Build.
- Answered: 13, Skipped: 3

Study analysis: *With regard to the types of BWMS that have received Type Approval Certificates, it was observed that filtration with UV treatment was by far the most common response from this stakeholder group. There was also a clear prevalence of existing ships (retrofits) over newbuildings, in contrast to the feedback from shipowners/operators.*

3.26 BWMS operation and evaluation

Q7 – Have any attempts been made to operate and evaluate or monitor the technical, mechanical, environmental and/or biological performance of the BWMS after commissioning?

- **46% (6) answered Yes**, 23% (3) answered No and 31% (4) answered Unknown.
- Answered: 13, Skipped: 3

Study analysis: *As described above, there is currently no requirement to monitor BWMS performance. However, such practices could provide valuable feedback on the functioning of BWMS.*

Q8 – Is the BWMS currently used in routine ballasting operations?

- 50% (3) answered Yes and 50% (3) answered No, currently not required.
- Answered: 6, Skipped: 10

Q9 – If the BWMS is currently used in routine ballasting operations, how often is it typically used (precise numbers are not required)?

- Answers ranged from 20 to 30 ballasting operations per year.
- Answers ranged from 2 hours to 42 hours of operation per ballasting event.
- Answered: 2, Skipped: 14

Study analysis: *Although the number of responses is low, it appears that BWMS are often not operated after installation and commissioning.*

Q10 – Is treatment dose monitored and recorded (e.g. TRO levels, UV intensity, etc.)?

- **100% (5) answered Yes**.
- Those who answered Yes stated TRO, UV intensity or dissolved oxygen level is monitored and recorded. When the specific methods used to monitor TRO and UV intensity were provided, the great majority mentioned sensor-based approaches.
- Answered: 5, Skipped: 11

Q11 – Does the BWMS require a minimum holding time in tank for treatment to meet the D-2 discharge standard?

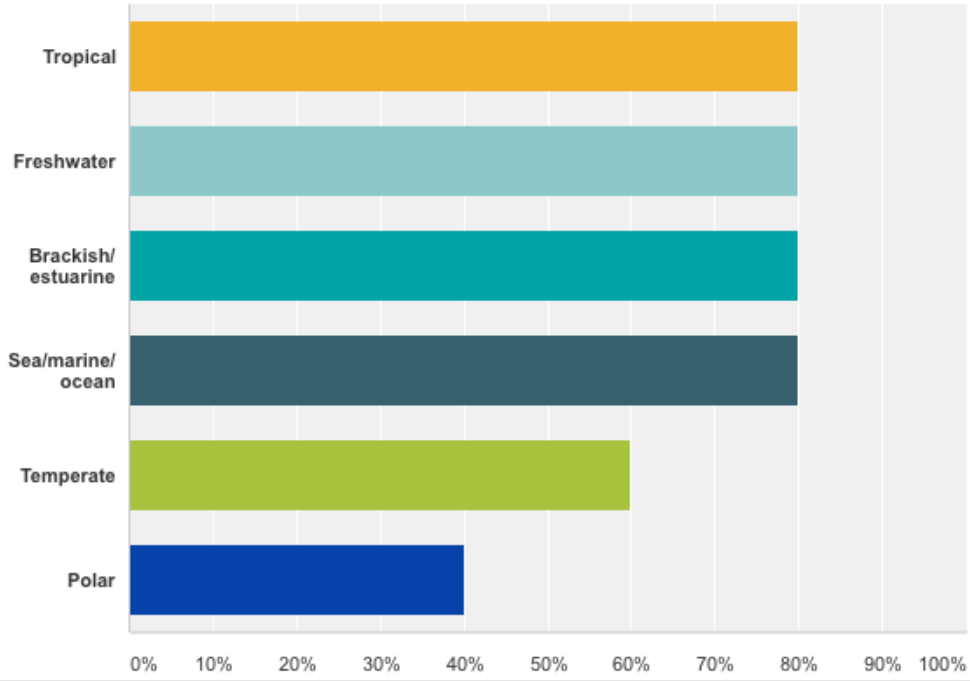
- **60% (3) answered No**, 40% (2) answered Yes.
- Those who answered Yes stated that either a 10 h or a 96 h holding time is required.
- Answered: 5, Skipped: 11

Q12 – What are the most common flow rate operating parameters for the BWMS (e.g. minimum and maximum flow rates required for effective use)?

- 20% (1) answered below 500 m^3/h, 20% (1) answered 500 to 1,000 m^3/h and 20% (1) answered greater than 1,000 m^3/h (2 respondents did not make a selection).
- Ballasting flow rates listed for these vessels ranged from as low as 200 m^3/h to as high as 6,350 m^3/h, similar ranges for both who provided such information.
- Answered: 5, Skipped: 11

Study analysis: *It appears that the great majority of BWMS have built-in measurement of treatment dose and there also appears to be an understanding of dose and holding time requirements needed to meet the D-2 discharge standard. Although the number of responses is low, it appears that BWMS, when operated, are used under a wide range of flow rates.*

Q13 – Select the sources of water your commissioned BWMS has encountered during normal operation according to general location, salinity and temperature. These are general categories, please use your best judgement and select all that apply per ship.

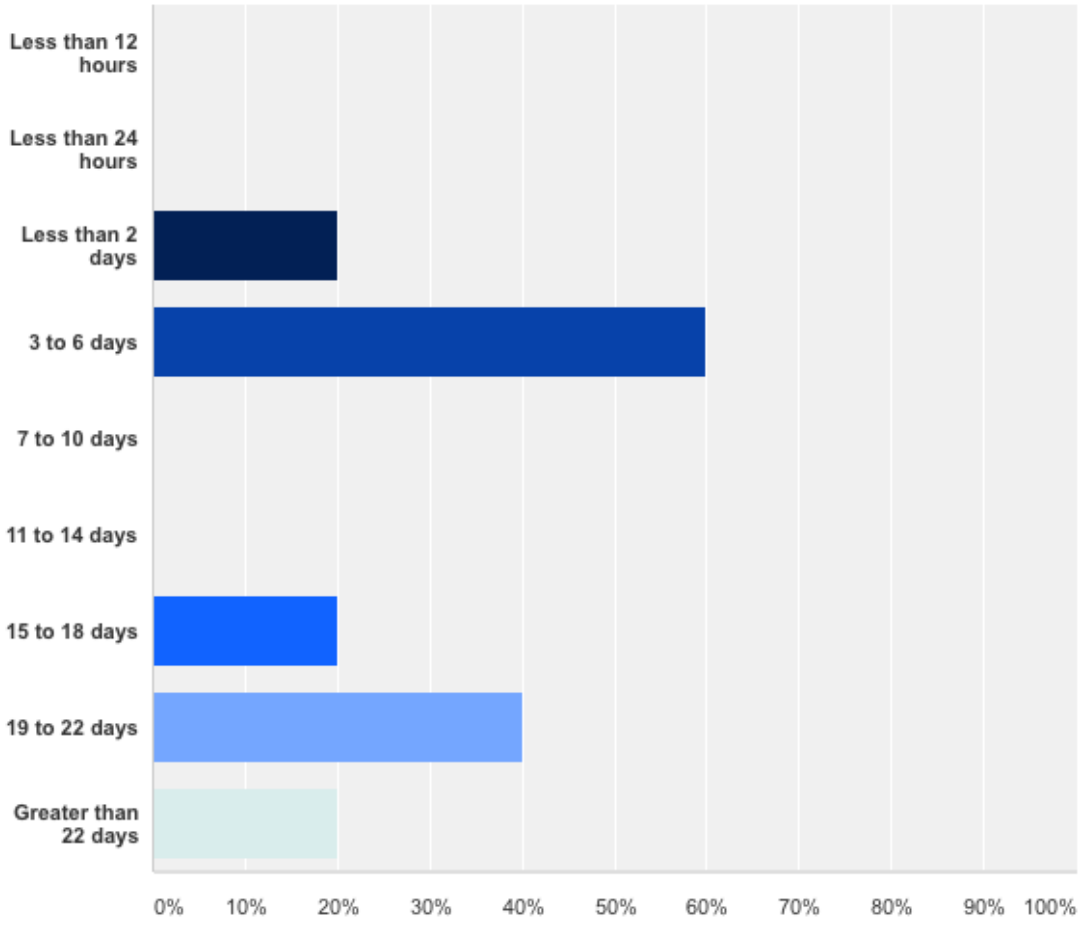


Answer Choices	Responses	
Tropical	80.00%	4
Freshwater	80.00%	4
Brackish/estuarine (low salinity)	80.00%	4
Sea/marine/ocean (high salinity)	80.00%	4
Temperate	60.00%	3
Polar	40.00%	2
Total Respondents: 5		

- Answered: 5, Skipped: 11

Study analysis: *While responses were incomplete, it appears that ships with commissioned BWMS operated under diverse salinity and climate conditions.*

Q14 – What is the range of the voyage time for this ship?



Answer Choices	Responses	
Less than 12 hours	0.00%	0
Less than 24 hours	0.00%	0
Less than 2 days	20.00%	1
3 to 6 days	60.00%	3
7 to 10 days	0.00%	0
11 to 14 days	0.00%	0
15 to 18 days	20.00%	1
19 to 22 days	40.00%	2
Greater than 22 days	20.00%	1
Total Respondents: 5		

- Answered: 5, Skipped: 11

Study analysis: *Ships with commissioned BWMS appear to have very diverse operational patterns, including several with relatively short voyages of three to six days and others with long voyages of over 15 days. It is interesting to note that several of the ships had a holding time that exceeds the minimum required by Guidelines (G8) for land-based tests, which is five days.*

3.27 BWMS training

Q15 – Do you provide training before operation and maintenance of the BWMS?

- **100% (5) answered Yes**.
- Answered: 5, Skipped: 11

Q16 – Do you provide a complete and detailed operation and maintenance manual with maintenance schedule and required materials/spare parts?

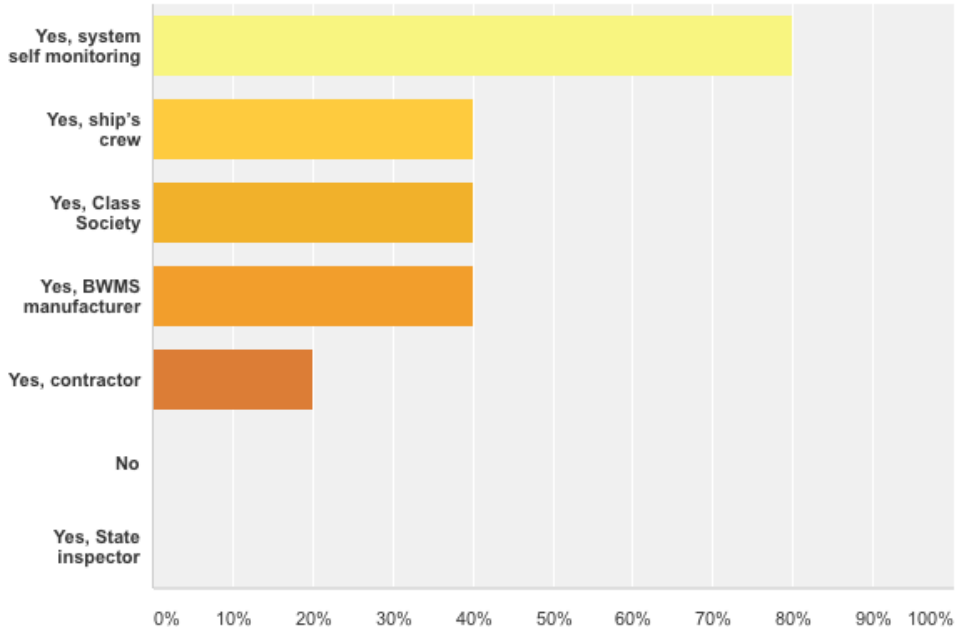
- **100% (5) answered Yes**.
- Answered: 5, Skipped: 11

Study analysis: *While a small percentage (13%) of shipowners/operators replied that training was not provided (see Questionnaire 1 above), all manufacturers who responded to the survey stated they provide some level of training (at least to the first crew receiving the systems) and detailed documentation. However, training and document quality cannot be assessed as part of this Study.*

As to the invitation by the Committee (MEPC 68/21, paragraph 2.44) to consider the matter identified by the correspondence group on whether or not operational training manuals for ships' crew should be a standardized template and part of the type approval procedure, this was considered but it is not possible to provide any recommendations on this matter, based on the results obtained from the survey.

3.28 Evaluation of mechanical performance

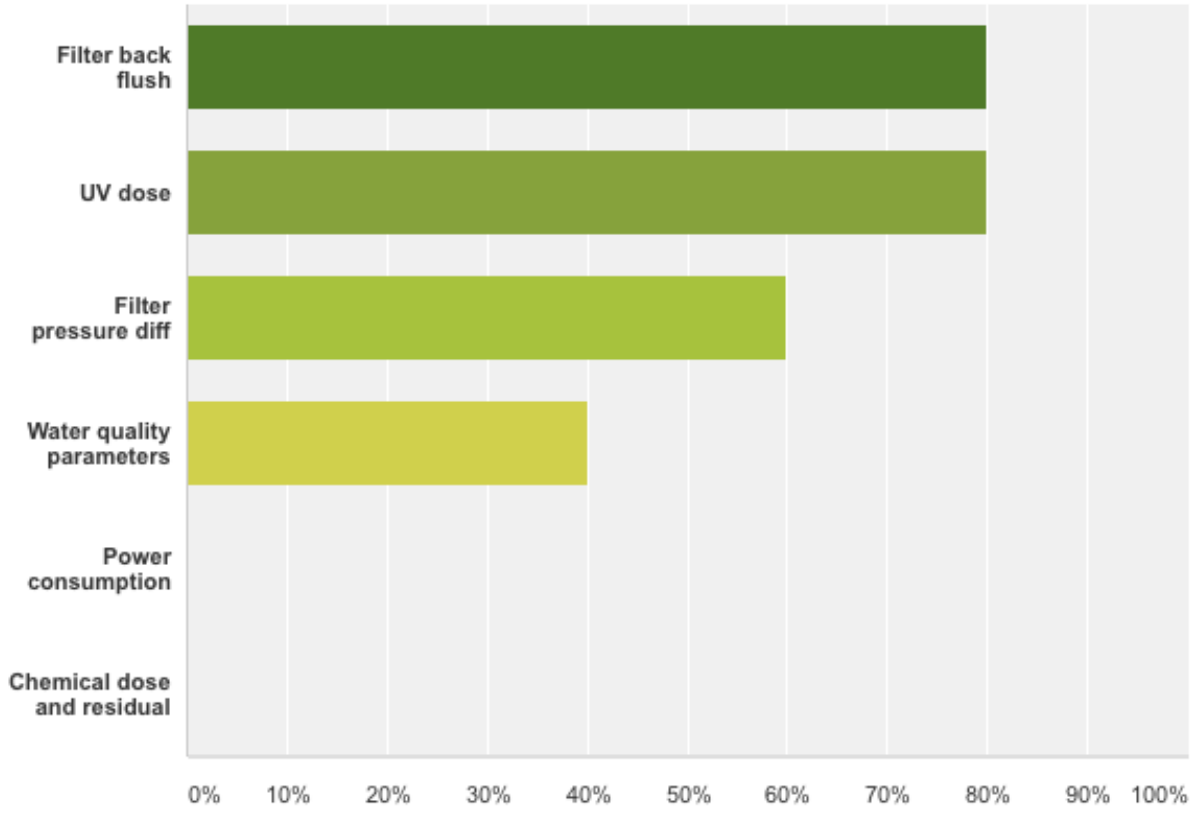
Q17 – Is (has) the technical/mechanical performance of the BWMS (been) monitored?



Answer Choices	Responses	
Yes, by System self monitoring (and recording)	80.00%	4
Yes, by Ship's crew	40.00%	2
Yes, by Classification society	40.00%	2
Yes, by Yourself (BWMS manufacturer)	40.00%	2
Yes, by Independent/third-party contractor	20.00%	1
No	0.00%	0
Yes, by Flag State and port State control inspectors	0.00%	0
Total Respondents: 5		

- Answered: 5, Skipped: 11
- Combined response for 12 ships with the same BWMS was Yes by system self-monitoring, ship's crew, classification society and BWMS manufacturer.

Q18 – If the technical/mechanical performance of the BWMS is (has been) monitored, what parameters are monitored/recorded?



Answer Choices	Responses	
Filter back flush frequency	80.00%	4
Dose of UV	80.00%	4
Filter pressure differential / filter integrity	60.00%	3
Water quality parameters (e.g. dissolved oxygen, temperature, pH, salinity)	40.00%	2
BWMS power consumption	0.00%	0
Dose and residual of Active Substances (specific chemicals and/or TRO)	0.00%	0
Total Respondents: 5		

- Answered: 5, Skipped: 11
- Combined response for 12 ships with the same BWMS listed power consumption, filter pressure differential, dose and residual TRO, and water quality parameters.

Q19 – If the technical/mechanical performance of the BWMS is (has been) monitored, what are the measured BWMS technical/mechanical failure rates?

- The total number of ballasting events or operational cycles was only provided in one of the three answers and it was 22 ballasting events. Another response mentioned over 3,700 hours of operation of their BWMS for a specific ship.
- Total number of observed failures, alarms, problems and/or issues requiring corrective action ranged from 4 for the ship with 22 operational cycles monitored to less than 50 for the BWMS with over 3,700 hours of operation.
- Answered: 3, Skipped: 13

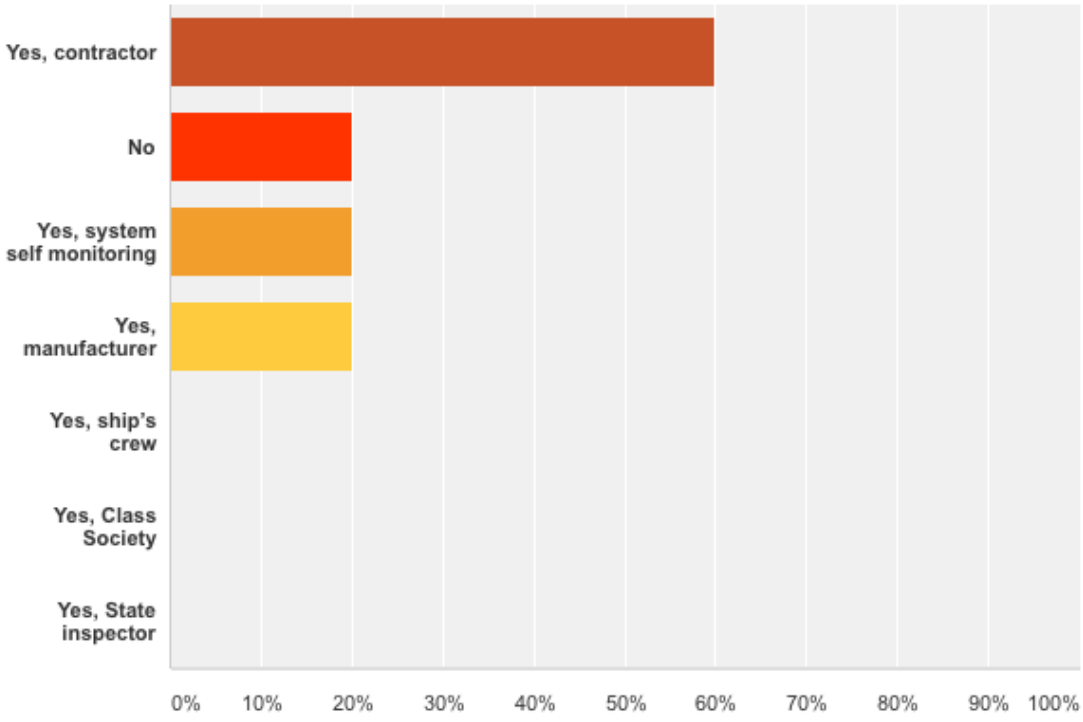
Q20 – List the type of most common failure or problem you experienced and its approximate frequency.

- Insufficient information was provided for failures, malfunctions, issues or alarms.
- Answered: 2, Skipped: 13

Study analysis: *Although the sample is extremely small, failure rates appear to be lower than those reported by shipowners and operators (see Questionnaire 1 above).*

3.29 Evaluation of biological performance

Q21 – Is (has) the biological performance of the BWMS (been) monitored (i.e. compliance or non-compliance with the D-2 standard)?



Answer Choices	Responses	
Yes, by Independent/third-party contractor	60.00%	3
No	20.00%	1
Yes, by System self monitoring (and recording)	20.00%	1
Yes, by Yourself (BWMS manufacturer)	20.00%	1
Yes, by Ship's crew	0.00%	0
Yes, by Classification society	0.00%	0
Yes, by Flag State and port State control inspectors	0.00%	0
Total Respondents: 5		

- Answered: 5, Skipped: 11

Q22 – What biological parameters are monitored/recorded?

- Only one respondent provided relevant information and mentioned that direct biological count similar to shipboard testing for certification in accordance with Guidelines (G8) was conducted after 5 years of operation.
- Answered: 3, Skipped: 13
- The combined response for 12 ships with the same BWMS reported that no biological performance evaluation has been conducted.

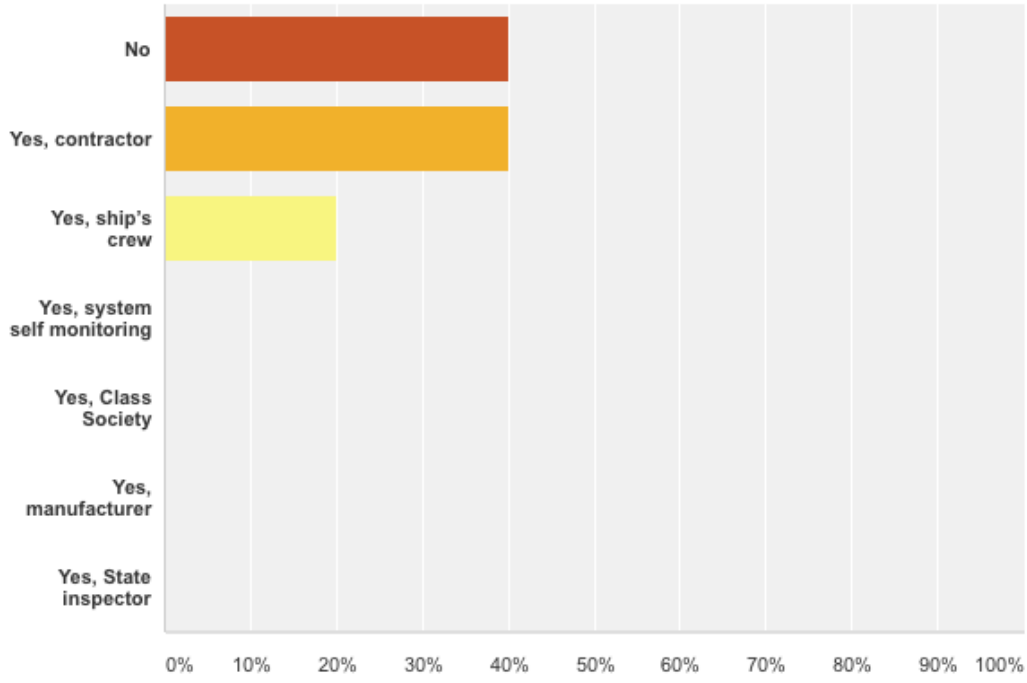
Q23 – What are the measured biological failure rates (number of discharge events found non-compliant versus the total number sampled/monitored for the D-2 standard) for each of the following? (Note: various options had been listed in the questionnaire)

- One respondent answered that the biological performance was evaluated during 3 ballasting events and all 3 were in compliance with all parameters of the D-2 standard. A second respondent answered that the biological performance was evaluated during 1 ballasting event and was found to be in compliance with all parameters of the D-2 standard.
- Answered: 3, Skipped: 13

Study analysis: *Given the extremely limited information provided on biological performance, identification of any clear trend or conclusion is not possible. However, it may be interesting to note that no biological failures have been observed by BWMS manufacturers.*

3.30 Evaluation of environmental safety

Q24 – Is (has) the environmental safety of treated water discharge (been) monitored?



Answer Choices	Responses	
No	40.00%	2
Yes, by Independent/third-party contractor	40.00%	2
Yes, by Ship's crew	20.00%	1
Yes, by System self monitoring (and recording)	0.00%	0
Yes, by Classification society	0.00%	0
Yes, by Yourself (BWMS manufacturer)	0.00%	0
Yes, by Flag State and port State control inspectors	0.00%	0
Total Respondents: 5		

- Answered: 5, Skipped: 11

Q25 – What parameters are monitored/recorded?

- One respondent listed acute toxicity and disinfection by-product chemistry and another listed pH and dissolved oxygen levels.
- Answered: 2, Skipped: 14

Q26 – What are the measured environmental safety failure rates (number of discharge events found above required limits)?

- Incomplete and insufficient information was received to allow any meaningful analysis.
- Answered: 1, Skipped: 15

Study analysis: *It is not possible to draw any conclusions due to the limited response rate.*

Questionnaire 3 – Independent third-party evaluators

3.31 While the low number of responses (8) to this specific survey likely reflects the current lack of requirements to monitor BWMS performance, they do provide valuable insight and the limited data does support (is consistent with) other Track 2 findings. Initial questions on name, affiliation, ship name or IMO number, etc. (required to ensure that the respondents are valid entities), are kept confidential.

3.32 BWMS evaluation activities

Q4 – Have you conducted independent/third-party evaluations of a BWMS that had already received type approval certification?

- **100% (8) answered Yes**.
- Answered: 8, Skipped: 0

Q5 – If Yes to the previous question, was the performance of the BWMS found to be consistent between the prior certification testing and your subsequent evaluations?

- **63% (5) answered Yes** and 37% (3) answered No.
- Answered: 8, Skipped: 0

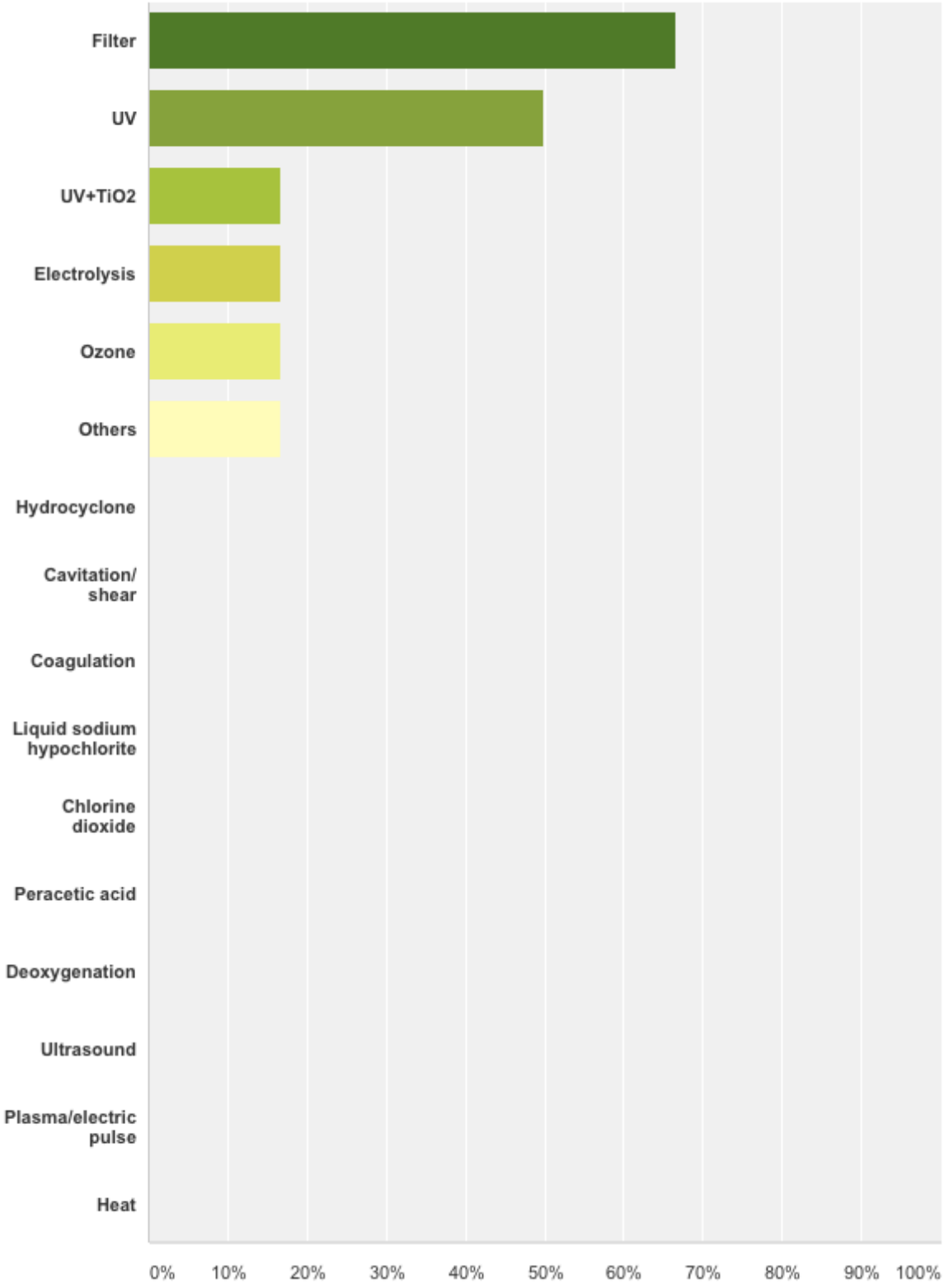
Q6 – If No, were there clear differences in testing approaches, facilities, procedures or methods that could account for the inconsistencies in performance?

- **100% (4) answered Yes**.
- Differences in testing methods (such as stains for live/dead analyses) and challenge water conditions (such as the BWMS not having been tested in freshwater in prior evaluations) were listed.
- Answered: 4, Skipped: 4

Study analysis: *While the information provided is limited, a significant proportion of respondents reported differences in results from evaluations of BWMS performance compared to prior testing. This may be due to differences in the approaches, procedures or methods used, since it appears that they can be different depending on the type and goal of the performance evaluations and the testing facility or organization.*

3.33 BWMS characteristics

Q8 – What is (are) the basic treatment approach(es) for the BWMS installed on this specific ship?



Answer Choices		Responses	
Filter		66.67%	4
UV		50.00%	3
UV+TiO2		16.67%	1
Electrochlorination		16.67%	1
Ozone		16.67%	1
Other, please list _____	Responses	16.67%	1
Hydrocyclone		0.00%	0
Cavitation/shear/physical damage		0.00%	0
Coagulation		0.00%	0
Liquid sodium hypochlorite		0.00%	0
Chlorine dioxide		0.00%	0
Peracetic acid		0.00%	0
Deoxygenation		0.00%	0
Ultrasound		0.00%	0
Plasma/electric pulse		0.00%	0
Heat		0.00%	0
Total Respondents: 6			

- The one responded that selected "Other" did not specify treatment type.
- Answered: 6, Skipped: 2

Study analysis: *With regard to the types of BWMS that have received Type Approval Certificates, it has been observed that filtration with UV treatment was the most common response from this stakeholder group, which is in line with the feedback from BWMS manufacturers.*

Q9 – Is treatment dose monitored and recorded (e.g. TRO levels, UV intensity, etc.)?

- **83% (5) answered Yes** and 17% (1) answered No.
- No respondents provided details on how treatment dose was monitored.
- Answered: 6, Skipped: 2

Q10 – Does the BWMS require a minimum holding time in tank for treatment to meet the D-2 discharge standard?

- **100% (5) answered Yes**.
- Answered: 5, Skipped: 3

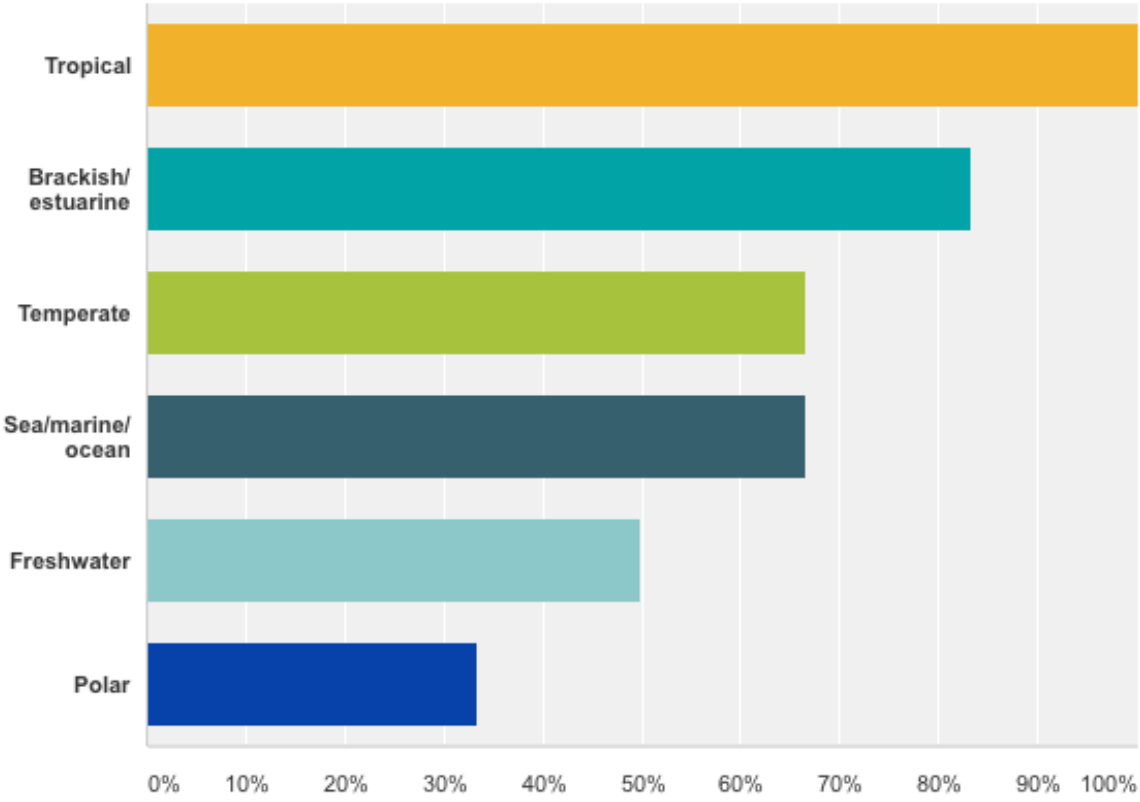
Q11 – What are the flow rate operating parameters for the BWMS (e.g. minimum and maximum flow rates required for effective use)?

- 50% (3) answered below 500 m^3/h.
- Ballasting flow rates for the BWMS tested were not provided.
- Answered: 6, Skipped: 2

Study analysis: *It appears that the great majority of BWMS have built-in measurement of treatment dose and there also appears to be an understanding of dose and holding time requirements needed to meet the D-2 discharge standard. Although the number of responses is low, it appears that BWMS, when operated, are used under a wide range of flow rates.*

3.34 BWMS operation and evaluation

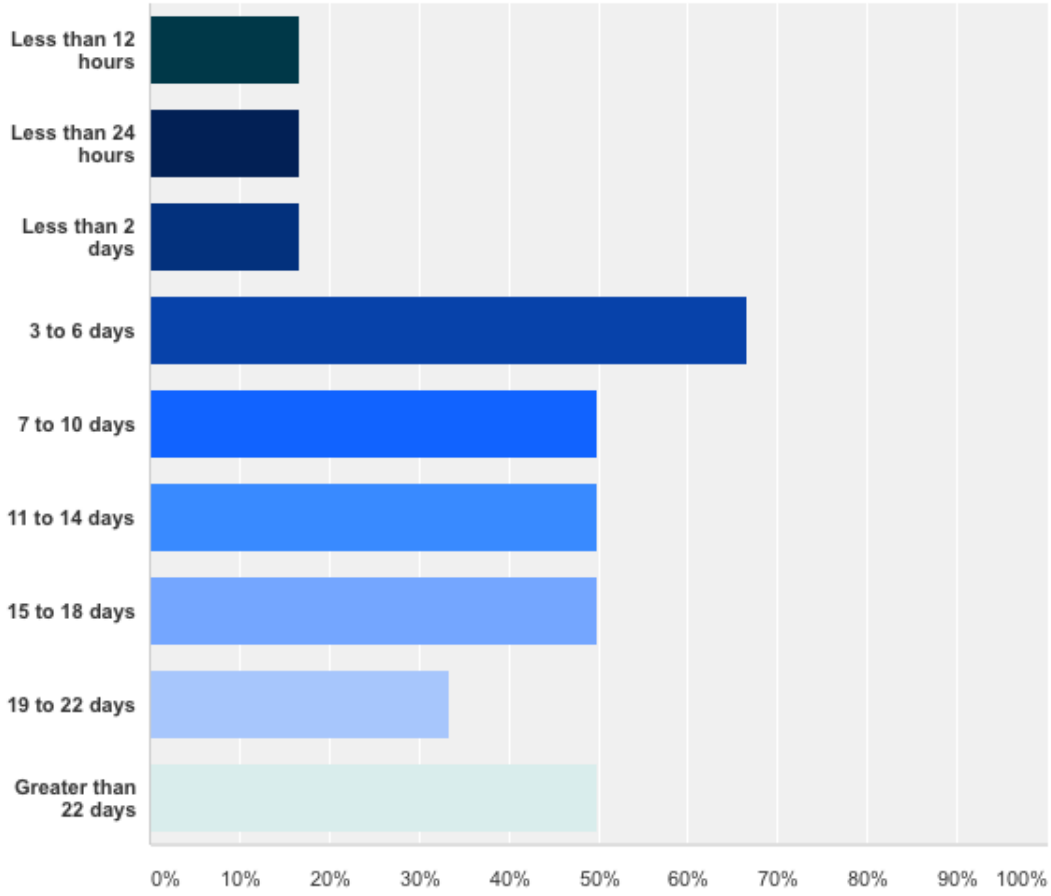
Q12 – Select the sources of water the ship with a commissioned BWMS encounters during normal operation according to general location, salinity and temperature. These are general categories, please use your best judgement and select all that apply per ship.



Answer Choices	Responses	
Tropical	100.00%	6
Brackish/estuarine (low salinity)	83.33%	5
Temperate	66.67%	4
Sea/marine/ocean (high salinity)	66.67%	4
Freshwater	50.00%	3
Polar	33.33%	2
Total Respondents: 6		

- Answered: 6, Skipped: 2

Q13 – What is the range of the voyage time for this ship?



Answer Choices	Responses	
Less than 12 hours	16.67%	1
Less than 24 hours	16.67%	1
Less than 2 days	16.67%	1
3 to 6 days	66.67%	4
7 to 10 days	50.00%	3
11 to 14 days	50.00%	3
15 to 18 days	50.00%	3
19 to 22 days	33.33%	2
Greater than 22 days	50.00%	3
Total Respondents: 6		

- Answered: 6, Skipped: 2

Study analysis: *Ships with commissioned BWMS appear to have very diverse operational patterns, including several with relatively short voyages of three to six days and others with long voyages of over 22 days. It is interesting to note that several of the ships had a holding time that exceeds the minimum required by Guidelines (G8) for land-based tests, which is five days.*

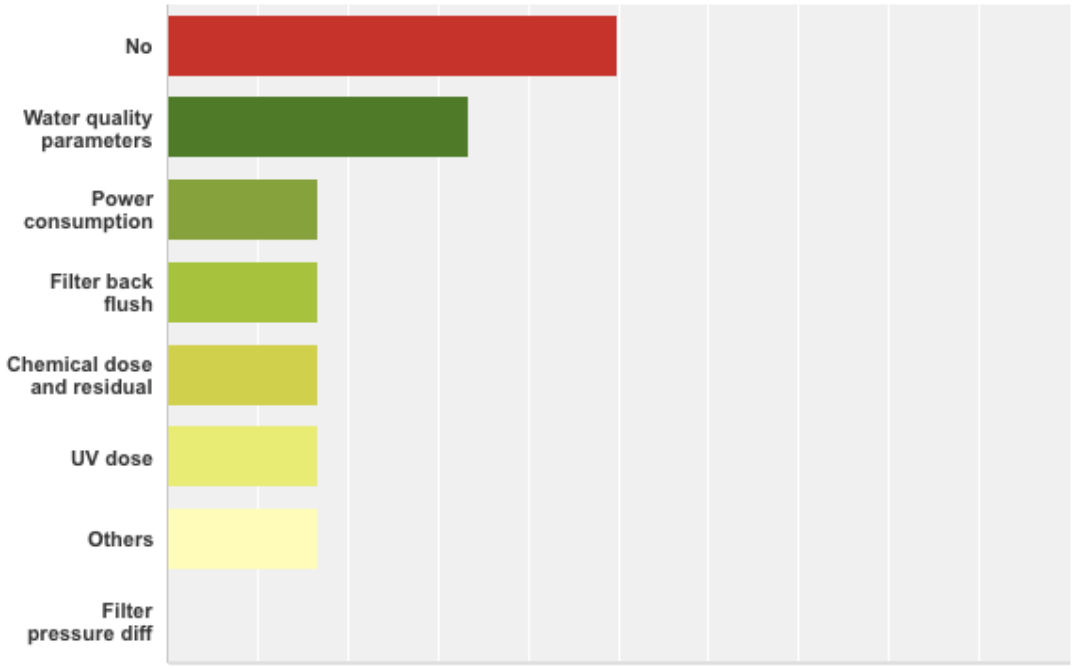
Q14 – Was/is the BWMS installed and maintained according to manufacturer´s requirements?

- **50% (3) answered Yes**, 17% (1) answered No and 33% (2) answered Unknown.
- Answered: 6, Skipped: 2

Study analysis: *While it is not the responsibility of the independent third-party evaluators to properly install or maintain the BWMS, documenting the systems' basic operational status (properly installed, commissioned, maintained) would be valuable in assessing the results from any performance evaluations.*

3.35 Evaluation of mechanical performance

Q15 – Did you evaluate the technical/mechanical performance of the BWMS?



Answer Choices	Responses	
No	50.00%	3
Yes, Water quality parameters (e.g. dissolved oxygen, temperature, pH, salinity)	33.33%	2
Yes, BWMS power consumption	16.67%	1
Yes, Filter back flush frequency	16.67%	1
Yes, Dose and residual of Active Substances (specific chemicals and/or TRO)	16.67%	1
Yes, Dose of UV	16.67%	1
Others, (please specify) Responses	16.67%	1
Yes, Filter pressure differential / filter integrity	0.00%	0
Total Respondents: 6		

- The one respondent that selected "Other" simply stated "D2 and U.S. ETV standards/guidelines".
- Answered: 6, Skipped: 2

Q16 – If Yes to the previous question, what were the measured BWMS technical/mechanical failure rates?

- The total number of ballasting events or operational cycles listed ranged from zero (0) to 9.
- Total number of observed failures, alarms, problems and/or issues requiring corrective action ranged from zero to 2.
- Answered: 4, Skipped: 4

Study analysis: *The information provided was limited and difficult to interpret.*

3.36 Evaluation of biological performance

Q17 – Did you evaluate the biological performance of the monitored BWMS (i.e. compliance or non-compliance with the D-2 standard)?

- **67% (4) answered Yes** and 33% (2) answered No.
- Answered: 6, Skipped: 2

Q18 What were the measured biological failure rates (number of discharge events found non-compliant versus the total number sampled/monitored for the D-2 standard) for each of the following? (Note: various options had been listed in the questionnaire)

- One response indicated that the biological performance was evaluated during 2 ballasting events and both were in compliance with all parameters of the D-2 standard. A second response indicated that the biological performance was evaluated during 4 ballasting events and was found to be in compliance with all parameters of the D-2 standard in only 1 of the events.
- Answered: 3, Skipped: 5

Study analysis: *The information provided was extremely limited and difficult to interpret.*

3.37 Evaluation of environmental safety

Q19 – Did you evaluate the environmental safety of treated water discharge?

- **67% (4) answered No** and 33% (2) answered Yes.
- Answered: 6, Skipped: 2

Q20 – What environmental parameters were monitored/recorded?

- Answered: 0, Skipped: 8

Q21 – What are the measured environmental safety failure rates (number of discharge events found above required limits)?

- Incomplete and insufficient information was received to allow any meaningful analysis.
- Answered: 2, Skipped: 6

Study Analysis: *The information provided was extremely limited and difficult to interpret.*

4 CONCLUSIONS

4.1 A number of stakeholders, representing all relevant sectors (testing facilities, Administrations, shipowners/operators, BWMS manufacturers, independent evaluators), contributed information to the Study and the available data provides valuable insight on the current status of implementation of regulation D-2 of the BWM Convention and Guidelines (G8) and on the performance of type approved BWMS. It should be kept in mind that, as with most voluntary survey-based studies, complete or comprehensive collection of data was not always possible to achieve.

4.2 In summary, the Study indicates that, for the most part, testing and type approval approaches and processes currently employed do follow the Guidelines (G8). However, as the Guidelines (G8) leave certain opportunities for interpretation and use of "best judgement", several significant differences do exist in how BWMS testing is carried out and how type approval is granted. In particular, differences in testing methodologies can result in differing conclusions on the performance of BWMS.

4.3 Study results also suggest that there are many BWMS, with Type Approval Certificates, which have been installed and commissioned on board ships. However, relatively few BWMS appear to be operated with any regularity and even fewer have been monitored or evaluated for performance after commissioning.

4.4 Data for 122 ships were submitted to the Study, representing 5% of the estimated 2,410 ships equipped with BWMS (based on information provided by IACS to the Study in July 2015). Based on these data, it appears that very few assessments of biological performance have been conducted in general on board ships to determine if the BWMS was meeting the ballast water performance standard in regulation D-2 of the Convention and in particular only four ships were reported to have performed independent biological performance testing or monitoring (i.e. with independent third-party evaluators). While this lack of monitoring does not currently allow for an extensive and definitive assessment of the reliability and performance of BWMS in routine operation, the overall information presented in this report represents the most current and comprehensive assessment to date, based on information from a variety of stakeholders (shipowners/operators, BWMS manufacturers, independent evaluators), which could support the Committee in its current deliberations.

4.5 Specific conclusions that can be drawn from the results of the various tracks and questionnaires include:

(A) Track 1 (similarities/differences in testing and certification)

.1 While transparency is critical for confidence in and credibility of the BWMS testing and approval regime, it is lacking in some cases. Indeed, few testing facilities provide publicly available documentation on their conflict of interest policies, quality assurance and standard operating procedures.

.2 While the majority of test facilities use validated procedures, some may also use methods that have yet to be reviewed or validated. Moreover, not all facilities have been audited by an accredited body.

.3 The survey shows that not all facilities offer testing under all of the three categories of salinity, as this is not required by Guidelines (G8), so in some cases a combination of test facilities may be required for BWMS to be tested under three salinity conditions.

.4 The ways challenge conditions of test waters are achieved vary significantly, which could lead to differences in testing results. Some test facilities do not manipulate biological challenge conditions while others do in varying ways and to varying levels. It also appears that most test facilities manipulate physical/chemical challenge conditions to some extent but the specific parameters differ and the methods used to make adjustments also vary greatly.

.5 While the majority of test facilities apply standard methods for sampling, the approaches described in Guidelines (G8) are not used by all facilities. It is important to note that the sampling approaches described in Guidelines (G2), which are used by many test facilities, and those described in Guidelines (G8) are very different.

.6 While the responses in the survey indicate a high degree of consistency between test facilities in applying standard methods for analysis of organisms more than 50 µm in size and bacteria, a much larger number of very different methods of analysis are used amongst the test facilities and organizations to determine viability of organisms between 10 and 50 µm in size.

.7 A variety of operational parameters are monitored and considered during land-based and shipboard testing (e.g. power consumption, flow rate, UV intensity, etc.) but there is no consistency with regard to which parameters are monitored or how they are quantified.

.8 The survey responses indicated that in land-based testing Administrations require five successful trials on at least two of the three salinity ranges; however, many do not require these five successful trials to be consecutive, as this is not required by Guidelines (G8). The survey responses also indicated that in shipboard testing Administrations require a minimum six-month period and three consecutive successful trials, in accordance with Guidelines (G8).

4.6 Based on the above, the main conclusion from Track 1 is that there are significant differences in how Guidelines (G8) are interpreted and implemented, which can result in significantly different standards for type approval certification and operational performance of BWMS.

(B) Track 2 (operational performance of BWMS)

.1 The survey responses indicate that a relatively small proportion of the BWMS installed on board ships are currently used in routine ballasting operations.

.2 The absence of current requirements to monitor BWMS performance affects the willingness to systematically monitor BWMS in operation. Regular monitoring could provide valuable feedback on the functioning of these systems.

.3 Training and documentation are in most cases provided by the BWMS manufacturer to support operation and maintenance of BWMS. However, it is not possible to determine the quality and quantity of training and documentation, nor the training follow-up and handover after crew change. Although relatively uncommon, it is important to note that in some cases no training or manual seems to have been provided by the BWMS manufacturer.

.4 It appears that crew and self-monitoring equipment installed on BWMS are the main means of monitoring. It is not possible to determine if there are specific policies to monitor the BWMS and systemize data collection. A small proportion of systems are monitored by the BWMS manufacturer and an even smaller part by third parties.

.5 The majority of the attempts to monitor BWMS focused on technical/mechanical performance, with much fewer assessments of ability or reliability in meeting the D-2 standard (biological efficacy) and environmental safety.

.6 Several technical/mechanical malfunctions were reported. It appears that sensors/controls and piping/valve systems, as well as problems associated with filtration, constitute the major sources of difficulties during routine ship operation.

.7 Based on the responses received as part of the Study, it appears that too few assessments of ability or reliability in meeting the D-2 standard (biological efficacy) and environmental safety have been conducted on board ships with installed BWMS to allow a definitive analysis of BWMS performance under routine operation.

4.7 In accordance with the Committee's instructions, the Study has been factual, avoiding subjective opinions and suggestions. Therefore, the findings listed above reflect the data collected and analysed as part of the Study without making any interpretations. These findings are presented to the Committee for its consideration.