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HARMFUL AQUATIC ORGANISMS IN BALLAST WATER

Findings from a study to evaluate the performance of ballast water management systems installed on board ships against the regulation D-2 standard of the Ballast Water Management Convention

Submitted by Australia

SUMMARY

Executive summary:	This document presents the main findings from a study in Australia to evaluate the performance of ballast water management systems (BWMS) fitted on ships that visited the Australian port of Newcastle between March and May 2024. This report follows the report submitted as document MEPC 81/INF.6 that provided data on the use and efficacy of BWMS in Australian ports from 2021 to 2023.
Strategic direction, if applicable:	1
Output:	1.24
Action to be taken:	Paragraph 37
Related documents:	MEPC 76/INF.56; MEPC 78/4/1, MEPC 78/WP.8; MEPC 81/INF.6; resolutions MEPC.125(53), MEPC.174(58), MEPC.252(67), MEPC.279(70), MEPC.290(71), MEPC.300(72), MEPC.387(81); BWM.2/Circ.42/Rev.2 and BWM.2/Circ.61

Introduction

1 Ballast water management systems (BWMS) installed on ships are type approved according to the *Guidelines for Approval of Ballast Water Management Systems (G8)* (resolutions MEPC.125(53), MEPC.174(58), MEPC.279(70)) or the *Code for Approval of Ballast Water Management Systems (BWMS Code)* (resolution MEPC.300(72)).

2 Regulation B-3 of the *International Convention for the Control and Management of Ships' Ballast Water and Sediments* (BWM Convention) requires that any BWMS installed on a ship must meet the regulation D-2 performance standard. The D-2 performance standard specifies maximum concentrations of viable organisms allowed to be discharged by a ship, including specified indicator microbes. The capacity of the BWMS to meet the D-2 performance discharge standard is verified during commissioning tests conducted upon the installation of

the BWMS. Compliance may also be verified during surveys under regulation E-1 or through due diligence studies until it is made mandatory. Compliance may also be verified through port State control (PSC) inspections in accordance with the *Guidelines for port State control under the BWM Convention* (resolution MEPC.252(67)).

3 At the seventy-first session of the Marine Environment Protection Committee (MEPC), the Committee agreed to establish an experience-building phase (EBP) associated with the BWM Convention (resolution MEPC.290(71)), which invited *"port States, flag States and other stakeholders to gather, prepare and submit data to the ballast water experience-building phase".*

4 Member States were encouraged to participate fully in the EBP to maximize information available to the Committee. In support of the EBP, since 2019 Australia has been evaluating the performance of BMWS fitted on ships that visit Australian ports through sampling. An information document summarizing data collected from 2019 to 2020 was submitted as document MEPC 76/INF.56. Data from document MEPC 76/INF.56 and some sampling data from 2021 were included in the supplementary data shared with the World Maritime University (WMU) and presented in document MEPC 78/4/1. An information paper summarizing data collected from 2021-2023 was submitted as document MEPC 81/INF.6. All of this data has also been included in a published paper comparing the results of commissioning testing and compliance sampling for BWMS[*].

5 The mismatch between administrative inspection results and the supplementary data provided in document MEPC 78/4/1 suggested that increased monitoring of ballast water discharges was needed to verify that type approved BWMS do achieve the D-2 standard in practical use. The Committee also agreed to consider any new data or information that might become available (MEPC 78/WP.8). To provide additional information to the IMO, Australia collected ballast water discharge compliance data from an additional 22 ballast water management systems (BWMS) in 2024.

6 Between March and May 2024, sampling was conducted on 19 bulk carriers that were intending to discharge treated ballast water in the Australian port of Newcastle. Of these, 18 ships had a BWMS installed that made use of active substances.

7 Samples of ballast water were taken and tested against the regulation D-2 performance standard using both indicative and detailed analysis methods described in BWM.2/Circ.42/Rev.2 and BWM.2/Circ.61 consistent with document MEPC 76/INF.56. This document presents a summary of findings from this study and follows the previous reports submitted in 2021 (MEPC 76) and March 2024 (MEPC 81). Counts for *Vibrio cholerae* were not undertaken in this study due to lack of access to a suitable incubator.

Summary of findings and experience

***General data: BWMS and ballast water origins* (annex)**

8 Twenty-two ballast water discharge samples were collected and analysed.

9 Ballast water treated using BWMS from 7 manufacturers were sampled; three manufacturers accounted for 73% of the installed BWMS on the sampled ships.

[*] Outinen et al. (2024) Frontiers in Marine Science 11:1334286. doi:10.3389/fmars.2024.1334286

10 Five ships undertook a mid ocean ballast water exchange with treatment (BWE+T) prior to their arrival at the port of Newcastle. Four ships indicated that challenging water quality (CWQ) at the uptake port was the reason for undertaking a bypass and then a mid ocean BWE+T to recover from the bypass. One vessel indicated that the BWMS was bypassed at uptake for safety reasons due to a faulty hydrogen sulfide (H_2S) sensor. It should be noted that BWE+T was not necessarily undertaken by the ship applying the *Interim guidance on the application of the BWM Convention to ships operating in challenging water quality conditions* (resolution MEPC.387(81)) given that the guidance was only endorsed at the eighty-first session of the Committee (March 2024) and has not yet been fully implemented.

11 The average holding time for ballast water in tanks was 18 days (range 8-33 days).

Detailed analysis

12 Of the 22 ballast water samples taken, non-compliances were observed for 6 (27%) detailed tests for compliance in the ≥50 µm size class of the discharge standard (annex).

13 One ballast water sample, which also exceeded the limit in the ≥50 µm size class, failed the Enterococci component of the microbial requirements (annex).

14 Although the proportion of non-compliant samples has generally decreased over time, sampling in 2024 had greater gross (>100 organisms/m^3) non-compliance than vessels in 2021-2023 (data presented in MEPC 81/INF.6) (Figure 1). Of the ships with gross exceedances, two had undertaken a mid ocean exchange (and the BWMS was used during the exchange), one had bypassed the BWMS due to safety reasons, and the other ship indicated that the BWMS had been bypassed (due to CWQ) at previous ports, although not on this voyage. Also, it is important to note that the same vessels were not necessarily sampled across the sampling years. Therefore, figure 1 cannot be interpreted to mean that a particular ship's ballast water, or its appropriately installed BWMS, has improved its performance to the regulation D-2 standard over time.

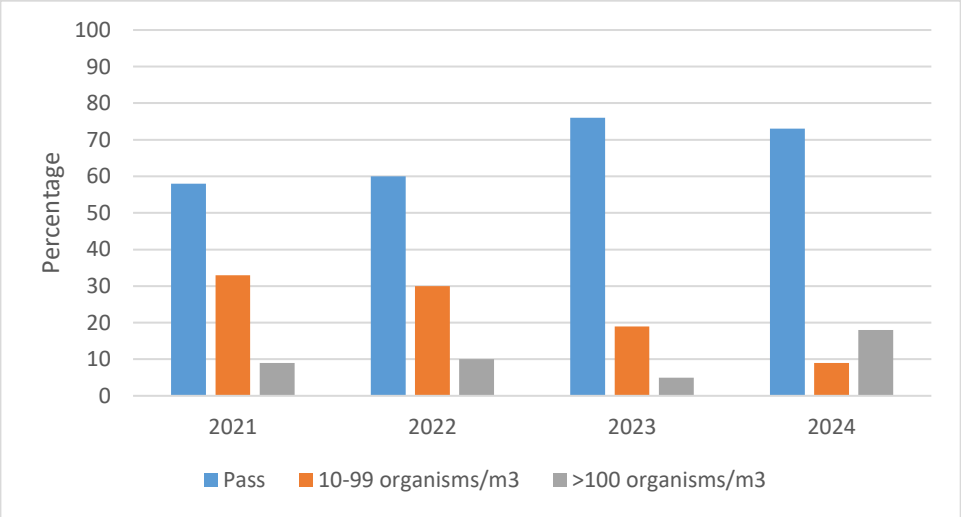

Figure 1: Levels of compliance for ≥50µm size class organisms across 2021-2024 samples

Indicative analysis (ATP)

15 Indicative methods were found to reliably detect gross exceedances (>10x the limit) for the ≥50µm size class (three samples; the fourth sample did not undergo indicative analysis). 5 false positive results were obtained where detailed analyses showed compliant samples in the ≥50µm size class, but the ATP showed a medium risk (which corresponds to a moderate (10-99 organisms/m^3) exceedance).

16 The results of indicative analysis for the 10-50 µm size class (all low risk) corresponded with the results of the detailed analysis (all compliant).

17 Indicative methods used for the bacterial samples showed 9 false positive results, with 2 given a high risk (>5x the limit). There were no false negative results reported.

MADC & disinfection by-products

18 Of the 22 ballast water samples, 20 were collected from BWMS using active substances. Three (15%) samples were not in compliance with the maximum allowable discharge concentration (MADC) measured as Total Residual Oxidant (TRO) (0.1 mg/L expressed as Cl_2) (annex). A further 3 ships had TRO that exceeded the MADC at the commencement of sampling but were able to rectify the issues on board. The level of non-compliance for TRO for the 2024 samples is greater than the levels reported in MEPC 81/INF.6 (2 of 36, 5%), but less than the levels reported in documents MEPC 76/INF.56 (4 of 18, 22%) and MEPC 78/4/1 (23 of 84, 27%).

19 Measurement of disinfection by-products provided a range for total Trihalomethanes (THMs) and Haloacetic Acids (HAAs) (annex). No MADC is established for total THMs and HAAs.

Operational issues

20 Of the 22 BWMS sampling ports assessed, 8 (36%) complied with the ISO 11711-1:2019 standard. Compliance had improved from results in MEPC 81/INF.6 (18% compliant).

21 Except for one sampling port, the remainder of the BWMS samples allowed representative sampling (13, 59%) but were not compliant with ISO 11711. The most common factors preventing compliance with ISO 11711 were inline obstruction such as elbows, T-intersections and probes located within 6x diameter of the discharge line upstream and/or 3x diameter of the discharge line downstream. Non-compliances also occurred where the probe was in a vertical section of ballast line with descending flow.

22 Samples were collected from ships at different times depending upon the ships' schedules. Sampling took 1.5 - 3 hours and required a minimum of two personnel. Ships were sampled without any prior notice; the sampling did not cause any undue delay to the ship or their loading operations.

23 Twenty-one of the 22 BWMS had maintenance records available, with a mean number of 249 (range 16-798) days between the last maintenance and the date of sample; the majority (18) had been serviced within the previous 12 months. Of the 6 ships that were non-compliant for the biological standards (Table 1), two had undertaken recent maintenance on the BWMS and one of those had recently sailed from drydock with a newly installed BWMS.

Table 1: Maintenance and operation history of ships that were found to be non-compliant

Ship # refers to the listing in the annex.

Ship #	Days since maintenance	Reason for maintenance	CWQ at uptake (BWE+T)
1	40	Installation	Yes
10	258	Annual Survey	No (previous ports)
13	27	Annual Survey	No
14	460	Intermediate Survey	No
18	280	Annual Survey	No
21	356	Intermediate Survey	Yes

Discussion and conclusions

24 Six instances of ballast water non-compliances were found in the ≥50µm size class representing 27% of BWMS sampled, and 1 non-compliance was found for Enterococci.

25 Non-compliances were found across three BWMS manufacturers (3 from system #1; two from system #4; and one from system #7). TRO exceedances were also found from three manufacturers (one each from system #3, #4 and #5), where all three systems used the same TRO meter.

26 Two ships had minor non-compliances:

.1 Ship #14 reported never undertaking bypass, even in ports with CWQ, although ballasting operations would slow and the filter would require regular back-flushing. The discharge sample contained fine sediment and analysis of the collected planktonic organisms indicated that there may be a build-up of sediment in the tank providing habitat for the organisms.

.2 Ship #18 reported continued and consistent issues with the installed BWMS, resulting in the reissue of its International Ballast Water Management Certificate (IBWMC) to allow D-1 due to a BWMS malfunction in 2022. The BWMS also showed multiple low TRO alarms at uptake and issues with TRO at discharge which was rectified by the crew during sampling. The sample included a large amount of sediment and mostly benthic copepods, indicating that there may be a build-up of sediment in the tank providing habitat for risk organisms.

27 Four ships had gross exceedances:

.1 Ship #1 had a new (replacement) BWMS installed, successfully passing the D-2 commissioning test using the indicative analysis method but was non-compliant on discharge on its subsequent voyage 40 days later. This ship bypassed the BWMS during uptake due to CWQ and undertook a mid-ocean BWE+T. The crew were unable to confirm if the ballast tank sediments had been removed during installation of the new BWMS, so the cause of the non-compliance is unknown.

.2 Ship #10 presented multiple low TRO alarms during uptake, indicating that chlorine production during ballasting was too low. The diversity and size of organisms in the sample indicated that the filters had been bypassed or that water had entered the tank through incorrect valves, but when this occurred is unknown.

.3 Ship #13 had the BWMS maintained at the annual survey 27 days prior to its non-compliant discharge and did not undertake a bypass at last port of call. Microscopic analysis showed a dominance of copepod nauplii larvae, indicating that in-tank breeding and regrowth was the likely cause of exceedance.

.4 Ship #21 was unable to use the BWMS due to a safety issue and had bypassed the BWMS in port and then exchanged its ballast water mid ocean without treatment.

28 The root cause/s of the failures of the BWMS to meet the D-2 performance standard were difficult to determine in this study.

29 There was no apparent relationship between time since maintenance and non-compliance (Table 1).

30 Analysis of samples found chaetognaths, ciliates, benthic and/or planktonic copepods. Bypass of BWMS probably facilitates entry of organisms into ballast tanks. Many ships also exhibited multiple/continuous low TRO alarms during uptake which were often acknowledged but not rectified by crew. A combination of insufficient filtration and/or dosing with biocides during uptake probably allow these organisms to enter and subsequently survive in ballast tanks.

31 Accumulated sediments in tanks may provide substrates for organisms to inhabit. Failure to remove sediment during installation of new systems and/or during maintenance at annual or intermediate surveys could be a factor in the discharge of non-compliant ballast water.

32 Further monitoring and testing and in-depth analysis of the organisms in the ≥50µm size class is needed to help identify sources of non-compliance.

33 Although only three ships had exceeded TRO limits, another three had problems with TRO measurement that were rectified (e.g. clearing an air lock or adding neutralizer) after the crew was made aware of problems by the sampling team. In many instances, the inline TRO meter reading was showing compliance (with a reading of 0) while the hand-held TRO meter was recording a higher concentration. An audit of inline TRO meter accuracy and variability is needed to ensure that crews are receiving accurate TRO concentration data.

34 A range of measurements for the disinfectant by-products (THMs and HAAs) were reported across the range of BWMS using active substances. Although no MADCs exist for these, the concentrations released across the various BWMS that utilise active substances could be of potential environmental concern. An audit of disinfectant by-product concentrations for comparison with type approval reported concentrations needs to be undertaken. Development of MADCs for these compounds should be considered.

35 More than half of the BWMS sampled were unable to provide an ISO 11711 compliant sample port.

36 The information collected during this study provides important indicators of the performance of properly installed BWMS and inferences on the potential causes of the non-compliant discharges. Further sampling and analysis of ballast water discharges is necessary to allow stronger conclusions to be drawn, however these results indicate that biosecurity risks associated with ballast water discharges still exist based upon the failure rates detected.

Action requested of the Committee

37 The Committee is invited to take note of the findings from this study to evaluate the performance of BWMS installed on board ships against the D-2 standard of the BWM Convention as part of the EBP.

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ANNEX

SUMMARY OF ANALYSIS OF BALLAST WATER DISCHARGED FROM SHIPS SAMPLED IN AUSTRALIA IN 2024

Test #	Date Month/ Year	Management Approach	Organisms ≥50 µm Org/m3	Organisms 10-50 µm Org/m3	*E. coli* MPN/ 100 mL	Enterococci MPN/100 mL	TRO mg/L	THM mg/L	HAA mg/L	Chlorate mg/L	Chlorite mg/L
Discharge Standard Limit			10 Org/m3	10 Org/m3	250 MPN/100mL	100 MPN/100mL	100 mg/L	No Limit	No Limit	No Limit	No Limit
1	Mar/24	Electrolysis (F) [1]	**736**	0	14.5	10.8	42	<2	23	<0.5	<2.5
2	Mar/24	Electrolysis (F) [1]	0	0	<1	1	0	<2	36	<0.5	<2.5
3	Apr/24	Electrolysis (F) [2]	0	0	1	4.1	90	160	20	<0.5	<2.5
4	Apr/24	Electrolysis [3]	0	0	2	<1	80	<2	13	<0.5	<2.5
5	Apr/24	Electrolysis [3]	0	0	<1	2	10	350	68	<0.5	<2.5
6	Apr/24	Electrolysis [3]	0	0	<1	<1	20	350	58	<0.5	<2.5
7	Apr/24	Electrolysis (F) [1]	0	0	<1	21.3	0	200	30	<0.01	<0.05
8	Apr/24	Electrolysis (F) [4]	0	0	<1	1	**1030**	240	67	<0.01	<0.05
9	Apr/24	Chemical Injection (F) [5]	0	0	<1	<1	**370**	<2	36	<0.5	<2.5
10	Apr/24	Electrochlorination (F) [4]	**2250**	0	<1	47.7	20	<2	7	<0.5	<2.5
11	Apr/24	Ultra-Violet (F) [6]	1	0	2	<1	N/A	N/A	N/A	N/A	N/A
12	Apr/24	Ultra-Violet (F) [6]	1	0	<1	<1	N/A	N/A	N/A	N/A	N/A
13	May/24	Electrochlorination (F) [1]	**411**	0	6.3	57.1	70	<2	32	<0.5	<2.5
14	May/24	Electrolysis (F) [4]	**92**	0	<1	7.5	90	96	8	<0.5	<2.5
15	May/24	Electrolysis (F) [1]	0	0	<1	<1	90	330	120	<0.5	<2.5
16	May/24	Electrolysis [3]	0	0	<1	<1	**130**	440	63	<0.5	<2.5
17	May/24	Electrolysis [3]	0	0	<1	<1	70	170	72	<0.5	2.5
18	May/24	Electrochlorination (F) [7]	**16**	0	6	1	90	<2	7	<0.5	<2.5
19	May/24	Electrolysis (F) [7]	4	0	<1	<1	70	<2	4	<0.5	<2.5
20	May/24	Electrolysis (F) [1]	6	0	<1	<1	70	530	28	<0.5	<2.5
21	May/24	Electrolysis (F) [1]	**330**	0	15.3	**103.6**	0	250	14	<0.5	<2.5
22	May/24	Electrochlorination (F) [1]	0	0	<1	<1	90	480	46	<0.5	<2.5

Values shown in bold exceed the limit. F, filter present; [ ], BWMS manufacturer