Certificate No:
TAP00002F6

TYPE APPROVAL CERTIFICATE

This is to certify:

That the Ballast Water Management System

with type designation(s)
CleanBallast - Ocean Barrier System (models: CB-OBS-051D / CB-OBS-101D / CB-OBS-102D / CB-OBS-151D / CB-OBS-201D / CB-OBS-251D / CB-OBS-301D)

Issued to
RWO GmbH
Bremen, **Germany**

is found to comply with
DNV rules for classification – Ships
DNV class programme DNV-CP-0209 – Type approval – Ballast water management systems
Resolution MEPC.169(57)
IMO Resolution MEPC.300(72) - Code for Approval of Ballast Water Management Systems (BWMS Code)

Application :

This is to certify that the Ballast Water Management System listed above has been examined and tested in accordance with the requirements of the specifications contained in the BWMS Code and DNV Rules stated above. This Certificate is valid only for the Ballast Water Management System referred to above.

System Design Limitations / Limiting Operating Conditions imposed are described in this document.

For the compliance with the BWMS Code, the Certificate is issued on behalf of the Norwegian Maritime Authority.

Product(s) approved by this certificate is/are accepted for installation on all vessels classed by DNV, unless otherwise instructed by relevant Maritime Administrations.

Issued at **Høvik** on **2022-01-07**
This Certificate is valid until **2027-01-06**.
DNV local station: **Germany, CMC**

Approval Engineer: **Qinglan Wu**

for **DNV**

Dag Sæle-Nilsen
Head of Section

This Certificate is subject to terms and conditions overleaf. Any significant change in design or construction may render this Certificate invalid.
The validity date relates to the Type Approval Certificate and not to the approval of equipment/systems installed.

LEGAL DISCLAIMER: Unless otherwise stated in the applicable contract with the holder of this document, or following from mandatory law, the liability of DNV AS, its parent companies and their subsidiaries as well as their officers, directors and employees ("DNV") arising from or in connection with the services rendered for the purpose of the issuance of this document or reliance thereon, whether in contract or in tort (including negligence), shall be limited to direct losses and under any circumstance be limited to 300,000 USD.

Name of ballast water management system (BWMS)

CleanBallast® - Ocean Barrier System BWMS

Ballast water management system manufactured by

RWO GmbH

Place of production

RWO GmbH, Bremen, Germany

Type and model designations

CleanBallast®-OBS BWMS:
CB-OBS-051D, CB-OBS-101D, CB-OBS-102D, CB-OBS-151D, CB-OBS-201D, CB-OBS-251D, CB-OBS-301D

Equipment / assembly drawings

The CleanBallast®-OBS BWMS shall be installed in accordance with the documents as listed below.

Description	Title	Dwg No.	Rev.
Operation, maintenance and safety manual (OMSM)	Instructions for Installation, Operation and Maintenance CleanBallast® - Ocean Barrier System (OMSM)	Generic OMSM	Rev. 2.1 (2021-12-08)
Bill of Materials (BoM)	Bill of Materials (OMSM Appendix I)	RWO_CB_OBS_BoM	Rev.1.0 (2021-06-21)
Piping and instrumentation diagram (P&ID)	Piping and Instrumentation diagrams (OMSM Appendix II)	550-BWT0500D-0001-F_P_ID 550-BWT1000D-0001-F_P_ID 550-BWT1000D-0002-F_P_ID 550-BWT1500D-0001-F_P_ID 550-BWT2000D-0001-F_P_ID 550-BWT2500D-0001-F_P_ID 550-BWT3000D-0001-F_P_ID	Rev. F (2021-06-14)
General arrangement and Installation drawings	CB-OBS: Drawings Overview Table (OMSM Appendix III)	n.a.	2021-11-15
	CB-OBS Installation Overview drawing (OMSM Appendix III)	550-BWT00000-0001	Rev. B (2021-11-15)
	General Arrangement drawings (OMSM Appendix III)	150-BWT0500D-0001-A 150-BWT1000D-0001-A 150-BWT1000D-0002-A 150-BWT1500D-0001-A 150-BWT2000D-0001-A 150-BWT2500D-0001-A 150-BWT3000D-0001-A	Rev. A (2021-03-16)
	Installation drawings: Electrochemical reactor (OMSM Appendix III)	350-0001766-A_BWT3000_Installation_Instruction 350-0001793-A_BWT6000_Installation_Instruction	Rev. A (2018-06-15) Rev. A (2018-07-24)

Description	Title	Dwg No.	Rev.
General arrangement and Installation drawings (continued)	Installation drawings: Flow meter (OMSM Appendix III)	350-0002441--_Flowmeter_DN250 350-0002442--_Flowmeter_DN350 350-0002443--_Flowmeter_DN450 350-0002444--_Flowmeter_DN500 350-0002445--_Flowmeter_DN600	Rev. - (2021-01-12)
	Installation drawings: Disc Filter vessel (OMSM Appendix III)	350-0900-908_C Disc_Filter_Maintenance 350-0001663-- _Filter_Unit_D900_DN250	Rev. C (2012-11-16) Rev. - (2018-03-09)
	Installation drawing: System main control board (OMSM Appendix III)	350-0001762-- _Inst_Main_Control_Board	Rev. - (2021-02-15)
	Installation drawing: Multiparameter sensor (OMSM Appendix III)	350-0002447-- Inst_Measurement_Sensor	Rev. - (2021-02-03)
	Installation drawings: Neutralization station (OMSM Appendix III)	350-0002380- B_Dechlorination_Unit_100l 350-0002381- B_Dechlorination_Unit_300l 350-0002382- B_Dechlorination_Unit_500l	Rev. B (2021-03-16)
	Installation drawings: Rectifier (OMSM Appendix III)	350-0002410-A_Inst_Rectifier_4M 350-0002413-A_Inst_Rectifier_2M	Rev. A (2020-02-27) Rev. - (2020-03-10)
Wiring diagram	Electric wiring diagrams (OMSM Appendix IV))	CB-OBS-051D-CID-03-210325 CB-OBS-101D-CID-02-210325 CB-OBS-102D-CID-01-210325 CB-OBS-151D-CID-01-210325 CB-OBS-201D-CID-01-210325 CB-OBS-251D-CID-01-210325 CB-OBS-301D-CID-01-210325 CB-OBS-051D-CID-01-EXT-190225	Rev. 3 (2021-03-25)

Other equipment manufactured by

The CleanBallast®-OBS applies electrochemical reactor, BWT 3000 and BWT 6000, manufactured by Permascand.

Treatment Rated Capacity

500-3000 m^3/h

Product description

Treatment sequence:

- Ballast water uptake: Filtration and electro-chlorination
- Ballast water discharge: Neutralization

System design limitations / Operational parameters

Salinity and Temperature
The minimum electrolyte feed salinity shall be ≥0.9 PSU (the system control is based on conductivity, and the system is limited to operation at ≥1.87 mS/cm, which corresponds to ≥0.9 PSU at a temperature ≥12°C).

Uptake water salinity is not a limiting condition if the BWMS is fitted with a brine/sea water injection unit (optional).

The BWMS may treat ballast water with a temperature down to 0°C provided the measured conductivity of the water is ≥1.87 mS/cm. The maximum temperature of the ballast water shall not exceed 35°C.

Holding time
The CleanBallast® -OBS BWMS has demonstrated performance to the discharge standard with a minimum holding time between uptake and discharge of 24 hours in marine and fresh water and 2 hours in brackish water in land-based testing.

Holding time is therefore ≥24 hours for treatment of marine and fresh water in the salinity range of 0.9-10 PSU and >20 PSU.

Holding time is not a practical limitation for treatment in brackish water in the salinity range of 10-20 PSU, but the treated ballast water shall be kept in ballast tanks for at least 2 hours before being neutralized and discharged.

Dose
The CleanBallast®-OBS BWMS has demonstrated performance to the discharge standard with the target TRO of 6.0 mg/L during ballast water uptake. The TRO level during ballast water uptake shall not exceed 8.0 mg/L.

The TRO concentration at discharge shall be ≤0.1 mg/L.

Treatment Rated Capacity (TRC) of the BWMS
The CleanBallast®-OBS BWMS controls the flow rate in the ballast water line by using a flow control valve to ensure that flow rates are kept within the TRC of a specific model.

The Treatment Rated Capacity (TRC) of the designated BWMS models depend on the number and model of the electrochemical (EC) units and the number of filter units installed in parallel. The 55 µm disk filter has only one size with a TRC of 500 m^3/h (model: D900-250). The EC unit has two sizes with a TRC of 500 m^3/h (BWT 3000) or 1000 m^3/h (BWT 6000).

The TRC of the BWMS model and number of filter and EC units are listed in the table below. The table also specifies the major components that shall be installed for a specific CleanBallast®-OBS BWMS model.

Model name	TRC (1) (m^3/h)		Filter units (number)	EC units (x number)
	Marine and brackish water	Fresh water (0.9 PSU)		
CB-OBS-051D	500	100	2	BWT 3000 x 1
CB-OBS-101D	1000	200	3	BWT 6000 x 1
CB-OBS-102D	1000	200	3	BWT 3000 x 2
CB-OBS-151D	1500	300	4	BWT 3000 x 3
CB-OBS-201D	2000	400	5	BWT 6000 x 2
CB-OBS-251D	2500	500	6	BWT 6000 x 3
CB-OBS-301D	3000	600	8	BWT 6000 x 3

(1) TRC will be linearly reduced when the electrolyte salinity is <5 PSU.

RWO GmbH may also supply special customized solutions of the CleanBallast®-OBS with a higher TRC during discharge.

Minimum installed ballast pump capacity
The CleanBallast®-OBS shall be installed with a minimum ballast water pump capacity to ensure a minimum flow during the treatment start-up process and sufficient flow for filter backflushing. The minimum ballast water pump capacity for each BWMS model size is given in the table below:

CB-OBS model	051D	101D	102D	151D	201D	251D	301D
Minimum installed ballast pump capacity: (m^3/h)	≥350	≥430	≥430	≥430	≥430	≥500	≥600

Pressure
The minimum/maximum system operating pressure during ballasting and the differential pressure setpoint for filter backflushing are listed below.

Minimum system inlet pressure (back-pressure)	Differential pressure setpoint for filter backflushing	Max operating pressure
>0.8 Bar	≥0.5 Bar	6 Bar

Control and monitoring equipment

Software version
CleanBallast®-OBS BWMS is type approved with the system control software versions: CB-OBS-xxxD-PLC- 01-210715, where xxx represent the BWMS model number. The last six digits, given as the build date, represent the minor revision number. Any changes to the software are to be recorded as long as the system is in use on board. Major changes in the software, which can alter the performance of the system, require approval. Testing of the application functions of the revised software may be required.

Safety measures
The CleanBallast®-OBS BWMS is type approved with the following instruments for monitoring the safe operation of the BWMS, and for activating, as necessary, an automatic shutdown of the BWMS:

- EC unit ballast water flow meter (FIT 01.01, installed after the EC unit).
- Flow and temperature switch for each EC cell (FISA 02.1x and TSA 02.1x, installed at the EC cell outlet), arranged with safety function independent of the BWMS control.
- The same flow switch with flow indicator is arranged for monitoring flow distribution when parallel EC cells are installed (FISA 02.0x).
- Pressure indicator transmitters (PIT 01.01, PIT 01.02, PIT 02.01, installed at the inlet and the outlet of the filters and at the outlet of the EC cells).
- Hydrogen gas sensor (QIT 03.01, installed in close vicinity above the EC unit(s)).

Electrical and electronic components
The CleanBallast®-OBS BWMS is type approved with the electrical and electronic components (including the above listed instruments for monitoring safe operation of the BWMS) indicated on the P&IDs and specified on the Bill of Materials. EMC in the range 2 GHz to 6 GHz according to DNV-CG-0339 (August 2021) has not been documented for the flow and temperature switch (FISA 02.xx and TSA 02.1x) and the temperature sensor (TIT 01.01). Therefore, EMC up to 6 GHz must additionally be documented for these components for installation on ships contracted for construction on or after 2022- 01-01.

Except for the components listed in the table below, alternate models to the ones specified on the Bill of Materials may be used provided that information regarding the selected components is part of the documentation related to the specific installation, by providing either a reference to valid type approval certificate or technical documentation demonstrating that the selected component was subject to environmental testing as per IACS UR E10.

For the following electrical and electronic components, the models specified in the table shall be used:

Tag No.	Component name	Manufacturer	Model(s)
QIT 05.01, QIT 05.02, QIT 05.03, TIT 05.01	Multiparameter sensor (Including TRO sensor, pH, conductivity and temperature)	Halogen Systems Inc.	SWN-P+
CON-0001	System control board	RWO GmbH	CB-OBS-xxxD-CID-xx PLC: SIMATIC ET200SP
CON-2X0X	Power supply EC cell / rectifier	Kraft Powercon	ECKraft 2M, ECKraft 4M
CON-0001 (sub-component)	Remote control panel (optional)	RWO GmbH	CV-112H
CON-0001 (sub-component)	Power module (optional)	RWO GmbH	CB-OBS-051D-CID-01-EXT-190225

The CB-OBS BWMS shall not be installed on open decks or enclosed spaces without controlled environmental conditions.

Hazardous area / Ex-proof

The CleanBallast®-OBS BWMS has no Ex-proof models and is not suitable for installation in a hazardous area.

Documents approval

The following documentation is to be submitted for each BWMS installation and approved by the relevant class society:

- Piping and Instrumentation Diagram (P&ID) of the ballast system, including the treatment system installation and bypass arrangement (the diverter valve of CB-OBS BWMS, BUV-1V01V1, shall not be used as a system bypass valve). The P&ID shall include connection to/from the EC unit which is made of plastic/composite material. All piping material shall be indicated and conform to class requirements, including isolation arrangement to override the ballast water treatment system in case of emergency.
- Power supply arrangement
- Interface description towards the ship’s existing systems including alarms for failure
- Commissioning procedure

Type Approval documentation

Test plans and reports

- DHI, Biological efficacy performance evaluation of CleanBallast Ocean Barrier System (CB-OBS) in land-based test - Test Plan, dated 2018-10-04
- DHI, Biological efficacy performance evaluation of CleanBallast Ocean Barrier System in land-based test - Land-based test report, dated 2021-05-07
- DHI, Performance evaluation of CleanBallast Ocean Barrier System (CB-OBS) in shipboard test - Test Plan, dated 2020-07-29
- DHI, Biological efficacy performance evaluation of CleanBallast Ocean Barrier System in shipboard test - Shipboard test report, dated 2021-06-11
- Basic Approval of the CleanBallast® - Ocean Barrier System by the Marine Environment Protection Committee (MEPC 74/18), dated 2019-06-09
- Final Approval of the CleanBallast® - Ocean Barrier System by the Marine Environment Protection Committee (MEPC 75/18), dated 2020-12-15
- RWO GmbH, Reports of additional tests: 1. Performance Claim Verification - Full flow feed salinity vs. TRO production, dated 2019-07-19
- Phoenix Testlab, Test planning and monitoring description - Equipment under test - Type “CB-OBS” (test plan), Rev.04, dated 2019-08-23
- Phoenix Testlab, Test report No. U190846E1 Equipment under Test: BWMS by Veolia Water Technologies Deutschland GmbH, Rev.3, dated 2021-06-07
- Phoenix Testlab, Test report (EMC) No. E190846E1 Equipment under Test: CleanBallast-OBS, CB-OBS 500 m3/h disc-filter by Veolia Water Technologies Deutschland GmbH, dated 2021-06-07

System descriptive documentation

- RWO GmbH Instructions for Installation, Operation and Maintenance CleanBallast - Ocean Barrier System (OMSM), Rev. 2.1, dated 2021-12-08
- RWO GmbH, Functional Description, Rev. 3.1, dated 2021-11-29
- RWO GmbH, CleanBallast - Ocean Barrier System (CB-OBS) Scaling Document, Rev. 1.2, dated 2021-06-25
- RWO GmbH, CleanBallast-OBS: Risk- and Safety Assessment including HAZID matrixes, Rev. 4.1, dated 2021-03-26
- RWO GmbH, Ocean Barrier System (CB-OBS) Software - Change Handling Procedure, Rev. 1, dated 2021-04-13
- RWO GmbH, RWO GmbH Quality control document (ISO 9001:2015), dated 2021-03-05

Tests carried out

- Land-based testing using CB-OBS-051D model in accordance with Resolution MEPC.300(72) (BWMS Code) and USCG 46 CFR 162.060-26
- Shipboard testing using CB-OBS-101D model in accordance with Resolution MEPC.300(72) (BWMS Code) and USCG 46 CFR 162.060-28
- Type tests of the control and automation system witnessed by DNV
- Environmental testing in accordance with environmental test specification for instrumentation and automation equipment, DNVGL-CG-0339 Environmental test specification for electrical, electronic and programmable equipment and systems (December 2019), Resolution MEPC.300(72) (BWMS Code), USCG 46 CFR 162.060-30 and IACS E10 (2018-10 Rev.7)

A summary of the test results from land-based and shipboard tests are given in the annex to this certificate.

Marking of product

For Traceability of this type approval, each treatment system is to be marked with:

- Manufacturer's name or trademark
- Type designation
- Serial number

Periodical assessment

For retention of the Type Approval, DNV Surveyor shall perform periodical assessments to verify that the conditions of the TA are not altered since the certificate was issued.

The scope of periodical assessment includes:

- Review of the TA documentation and verification that the documentation is still used as basis for the production
- Review of possible changes in design, material and performance of the product
- Verification of the company's production and quality systems ensuring continued consistent production of the type approved products to the required quality
- Verification that the product marking for identification and traceability to the TA Certificate is not altered

Copy of type approval certificate

A copy of this type approval certificate should be carried on board a vessel fitted with this ballast water management system at all times. A reference to the test protocol and a copy of the test results should be available for inspection on board the vessel.

Revision history of this certificate

Revision	Date of issuance	Description
Rev. 0	2022-01-07	First issue

ANNEX 1: SUMMARY OF TESTING

Land-based testing

Table 1 Test water conditions and operational data obtained during land-based testing of the CB-OBS-051D BWMS, performed in 2018 and 2019 at DHI in Denmark. All water quality data are inlet samples and operational data are from ballasting operations.

Test cycle	Salinity (PSU)	Temp. (°C)	POC (mg/L)	DOC (mg/L)	TSS (mg/L)	UVT (%)	TRO [2] (mg/L)	Flow rate [1] (m^3/h)	Holding time (hours)
M-1	29	13	4.9	6.8	63	78	1.3 - 7.0 5.6 ± 1.2	468	24
M-2	28	9	6.9	6.5	75	68	0.86 - 9.3 4.1 ± 2.1	418	24
M-3	29	7.1	6.8	6.7	55	71	1.3 - 7.8 4.2 ± 1.9	416	24
M-4	29	5.5	7.6	6.6	54	70	1.1 - 6.5 3.8 ± 1.7	412	24
M-5	29	18	6.6	7.3	53	72	0.12 - 8.0 5.5 ± 1.9	479	24
M-6 [3]	29	18	6.4	7.4	38	71	0.10 - 7.6 5.6 ± 1.4	466	120
M-7	29	18	6.4	7.4	38	71	1.0 - 8.0 5.5 ± 1.7	477	120
M-8	28	18	7.2	7.2	45	72	1.3 - 7.5 5.8 ± 1.3	418	120
B-1	21[4]	12	8.5	6.6	69	61	0.76 - 6.6 3.7 ± 1.9	416	24
B-2	21[4]	12	7.3	6.7	83	67	0.81 - 6.5 4.8 ± 1.8	448	24
B-3 [3]	18	11	6.1	6.8	43[5]	66	0.50 - 7.9 5.3 ± 2.0	469	2 and 24
B-4	18	11	6.1	6.8	43[5]	66	0.10 - 8.0 5.3 ± 2.2	451	24
B-5 [3]	18	20	7.7	6.8	59	61	0.25 - 8.0 5.3 ± 1.8	460	120
B-6	18	20	7.7	6.8	59	61	0.14 - 7.1 4.9 ± 2.0	460	120
B-7 [3]	17	18	8.7	7.3	64	59	1.7 - 8.0 5.8 ± 2.0	447	24
B-8	17	18	8.7	7.3	64	59	2.6 - 8.0 6.0 ± 2.0	444	24
B-9	19	12	7.1	7.1	58	62	2.7 - 8.0 5.8 ± 1	493	2 and 120
B-10 [3]	18	8.5	7.8	6.6	58	64	3.3 - 8.0 5.8 ± 0.7	469	2 and 24
B-11	18	8.5	7.8	6.6	58	64	2.7 - 8.0 5.7 ± 0.8	458	24

Test cycle	**Salinity** (PSU)	**Temp.** (°C)	**POC** (mg/L)	**DOC** (mg/L)	**TSS** (mg/L)	**UVT** (%)	**TRO** (2) (mg/L)	**Flow rate** (1) (m^3/h)	**Holding time** (hours)
F-1	0.89	19	7.4	6.4	58	56	0.11 - 8.0 6.0 ± 0.7	97	24
F-2 (3)	0.89	21	6.4	7.8	61	52	0.08 - 8.0 6.0 ± 0.8	95	120
F-3	0.89	22	6.4	7.8	61	52	0.08 - 8.0 5.9 ± 0.8	100	120
F-4 (3)	0.90	18	7.2	7.0	62	55	0.10 - 7.2 5.9 ± 0.7	101	24
F-5	0.90	18	7.2	7.0	62	55	0.10 - 7.7 5.9 ± 0.9	100	24
F-6	0.96	21	6.9	7.4	70	51	0.11 - 8.0 5.9 ± 1.0	100	120
F-7	0.93	12	5.4	7.1	62	59	0.60 - 7.2 4.6 ± 0.5	100	120

(1) Calculated flow rate (as processed volume by operation time) after filtration.
(2) TRO recorded from the BWMS (range, average ± standard deviation) during ballast operation. The TRO production is reduced during filter backflush events and therefore leads to a wide range of TRO values.
(3) This test cycle and the following test cycle were run consecutively by use of the same test water and the same control.
(4) The PSU in the prepared test water for B-1 and B-2 was above 20 PSU and less than 10 PSU lower than the average of the marine water tests, but the small deviation of 1 PSU is considered acceptable. Test cycle B-1 was anyway repeated as it was concluded invalid.
(5) The TSS in the prepared test water for B-3 and B-4 was below 50 mg/L, but both test cycles were anyway repeated as they were concluded invalid.

Table 2 Average densities of live organisms in inlet and treated discharge water during land-based testing of the CB-OBS-051D BWMS. Live organisms ≥10 and <50 µm in inlet water were quantified based on FDA/CMFDA. All counts of pathogenic bacteria (*E. coli, Enterococci* and *Vibrio cholerae)* in treated water were below the ballast water discharge standard. Tests were performed in 2018 and 2019 at DHI in Denmark.

Test #	Organism densities in inlet water		Organism densities in discharge water			
	≥50 µm (org/m³)	≥10-<50 µm (org/mL)	≥50 µm (org/m³)		≥10-<50 µm (org/mL)	
			Treated	Control	Treated	Control (1)
M-1 (1)	198,528	1,464	10	64,543	2.5	1,071
M-2(1)	132,345	1,998	20	55,196	3.5	1,529
M-3	132,361	3,700	1.3	69,985	0.67	1,909
M-4	123,458	2,560	2.0	34,059	0	1,540
M-5	174,931	1,867	6	77,493	0.5	1,413
M-6 (1)(2)	891,742	2,706	11	299,872	0	1,490
M-7	987,783	2,689	2.0	299,872	0	1,490
M-8	140,650	6,256	4.3	41,803	0	1,203
B-1 (1)	110,517	1,383	21	66,505	2	718
B-2	165,281	1,689	7.3	86,328	0	582
B-3 (1)(3)	341,458	1,873	72 (7.0(4))	274,988	0 (1.8)	1,301
B-4 (1)	321,472	1,689	26	274,988	0.17	1,301
B-5 (1)	203,514	1,544	14	48,382	33	188
B-6	247,542	1,560	5.7	48,382	1.2	188
B-7 (1)	350,014	1,390	255	136,480	0.17	1,721
B-8 (1)	328,153	1,529	171	136,480	0.33	1,721
B-9 (3)	243,792	1,280	2.3 (0.68)	146,662	0.83 (2.5)	824
B-10 (3)	226,736	1,828	0.33 (0.50)	69,469	0.17 (0.33)	1,892
B-11	200,222	2,498	0	69,469	0.17	1,892
F-1	224,097	1,953	1.1	137,482	2.3	1,430
F-2	361,172	1,920	2.0	82,082	0.33	1,300
F-3 (1)	313,736	1,876	1.0	82,082	17	1,300
F-4	470,469	2,150	0.69	312,710	0.67	1,530
F-5	482,028	2,100	0	312,710	1	1,530
F-6 (1)	232,375	2,082	0	211,347	12	1,324
F-7	179,494	1,833	0.33	151,198	0.17	959

(1) Invalid test cycle due to contamination from remaining untreated water in BWMS pipe and due to conservative system control preventing delivery of the target average TRO dose during filter backflushing.
(2) Test cycle M-6 is invalid due to operational errors at the test facility.
(3) Results from Compliance T2h in parentheses; the analyses applied for Compliance T2h sampling were identical to that applied for the treated discharge water and included microscopy counting of live organisms ≥10 and <50 µm after staining with FDA/CMFDA.
(4) The results of the statistical test showed that there was not enough confidence (<95%) that the concentration of live organisms in the ≥ 50 µm size range from the compliance T2h samples during BE test cycle B-3 was lower than 10 organisms/m³.

Shipboard testing

Table 3 Results from shipboard testing of the CB-OBS-101D BWMS on board MAERSK GIBRALTAR in the period 7 August 2020 to 23 February 2021. Live organisms ≥10 and <50 µm in discharge water were quantified based on FDA/CMFDA method.

Test #	Flow rate (1) (m^3/h)	Salinity (PSU)	TRO (2) (mg/L)	Temp. (˚C)	Holding time (hours)	Inlet density		Discharge density	
						≥50 µm (org/m^3)	≥10-<50 µm (org/mL)	≥50 µm (org/m^3)	≥10-<50 µm (org/mL)
No. 1	852	36	5.9 (2.4 - 7.1)	19	32	8,562	250	0.26	0
No. 2	950	42	6.0 (4.6 - 6.9)	27	20	24,467	172	0	2.5
No. 3	937	39	6.0 (5.4 - 6.4)	26	25	31,097	164	0	2.3
No. 4	938	39	6.0 (5.1 - 6.3)	24	26	47,542	651	0.23	1.2
No. 5	944	36	6.0 (5.4 - 6.2)	15	23	17,889	356	2.3	0.17

(1) Average flow rate after filtration during ballast operation, measured by the BWMS flow meter located after the filter, extracted from BWMS log.
(2) TRO average and range (minimum to maximum); during ballast water uptake extracted from BWMS log.