TYPE APPROVAL CERTIFICATE

Certificate No:
TAP0000271
Revision No:
2

This is to certify:

That the Ballast Water Management System

with type designation(s)
Optimarin Ballast System 167/72BK3 – 3000/3100BK3, 167/65BK4-3000/2600BK4 and 167/87FX2 – 3000/3000FX2

Issued to
Optimarin AS
SANDNES, **Norway**

is found to comply with
IMO Resolution MEPC.300(72) - Code for Approval of Ballast Water Management Systems (BWMS Code)
DNV rules for classification – Ships Pt.6 Ch.7 Sec.1 Ballast water management – BWM
DNV class programme DNV-CP-0209 – Type approval – Ballast water management systems
DNV class guideline DNV-CG-0339 – Environmental test specification for electrical, electronic and programmable equipment and systems

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.

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

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

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 **2022-07-07**

for **DNV**

This Certificate is valid until **2025-10-23**.
DNV local station: **Stavanger**

Approval Engineer: **Tone Knudsen Fiskeseth**

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Dag Sæle-Nilsen
Head of Section

Name of ballast water management system (BWMS)

Optimarin Ballast System (OBS), Optimarin Ballast System Ex (OBS Ex)

Ballast water management system manufactured by

Optimarin AS

Place of production

Sandnes, Norway

Type and model designations

OBS BWMS model designation: xxxx/yyyyBK3, xxxx/yyyyBK4 or xxxx/yyyyFX2
where xxxx designates the below listed UV model and yyyy the below listed filter model of either the filter series manufactured by Boll & Kirch (BK3 or BK4) or the filter series manufactured by Filtrex (FX2).

UV models:	167, 334, 500, 667, 834, 1000, 1167, 1334, 1500, 1667, 1834, 2000, 2167, 2334, 2500, 2667, 2834 and 3000
BK3 filter models:	72, 94, 204, 378, 518, 614, 1274, 1384, 2040 and 3100
BK4 filter models:	65, 125, 220, 430, 770, 1000, 1350, 1900 and 2600
FX2 filter models:	87, 135, 190, 255, 340, 515, 770, 1040, 1500, 2100 and 3000

A OBS BWMS model suitable for installation in hazardous area are designated with the suffix EX (e.g. xxxx/yyyyBK3EX).

Equipment / assembly drawings

The OBS BWMS shall be installed in accordance with the documents listed below.

Type	Title		Dwg No.	Rev.
Piping and instrumentation diagram (P&ID)	Optimarin Ballast Treatment System Flow Diagram	Flow Diagram	300000 (1)	Rev. 7 2022-05-10
		Flow Diagram EX		
		Flow Diagram (stripping with filter)		
		Flow Diagram (stripping without filter)		
Electrical wiring diagram	Internal Wiring Diagram	Wiring diagram with UV POWER CABINET TYPE ETA	500000 (2)	Rev. 6 2022-05-10
		Wiring diagram with UV POWER CABINET TYPE NED MK3		
		Wiring diagram with UV POWER CABINET TYPE UVA		
General arrangement (GA) drawings	Filter BK MK3 (10 sizes): FILTER 72M³H DN80 PN10 TYPE BK MK3 to FILTER 3100M³H 600A 10K TYPE BK MK3		1xxxxx (3)	See BOM
	Filters BK MK3 Ex (10 sizes): FILTER 72M³H DN80 PN10 IIB EX TYPE BK MK3 to FILTER 3100M³H 600A 10K IIB EX TYPE BK MK3			
	Filter BK MK4 (9 sizes): FILTER 65M³H DN80 PN10 TYPE BK MK4 to FILTER 2600M³H DN500 PN10 TYPE BK MK4			
	Filters FX MK2 (11 sizes): FILTER 87M³H DN100 PN10 TYPE FX MK2 to FILTER 3000M³H DN600 PN10 TYPE FX MK2			

Type	Title		Dwg No.	Rev.
General arrangement (GA) drawings	Filters FX MK2 EX (11 sizes): FILTER 87M³H DN100 PN10 IIB EX TYPE FX MK2 to FILTER 3000M³H DN600 PN10 IIB EX TYPE FX MK2		1xxxxx (3)	See BOM
	Manifold system 1 (13 sizes): MANIFOLD DN150 PN10 SYSTEM1-1 to MANIFOLD DN500 PN10 SYSTEM1-15			
	Manifold system 2 (13 sizes) MANIFOLD DN200 PN10 SYSTEM2-2 to MANIFOLD 600A 10K SYSTEM2-18 Including alternative material; CuNiFe			
	UV chambers (10 variants): UV CHAMBER DN150 4 SOCKETS to UV CHAMBER DN150 4 SOCKETS WELDED EX MK3			
	Flow pressure valve (3 variants): FLOW PRESSURE VALVE DN100 PN10 TYPE GA to FLOW PRESSURE VALVE DN500 PN10 TYPE GA FLOW PRESSURE VALVE DN100 PN10 TYPE GA EX to FLOW PRESSURE VALVE DN500 PN10 TYPE GA EX FLOW PRESSURE VALVE DN100 PN10 TYPE BER to FLOW PRESSURE VALVE DN400 PN10 TYPE BER FLOW PRESSURE VALVE DN150 PN10 WAF or LUG TYPE ELT to FLOW PRESSURE VALVE DN600 PN10 WAF or LUG TYPE ELT FLOW PRESSURE VALVE DN150 PN10 WAF or LUG TYPE ELT EX to FLOW PRESSURE VALVE DN500 PN10 WAF or LUG TYPE ELT EX			
Bill of materials (BOM)	OBS complete BOM		-	Rev. 3 2022-05-22
Operation, maintenance and safety manual (OMSM)	Operation, maintenance and safety manual for Optimarin Ballast System	Template OMS for BK3	3xxxx-xx-xx- (4)	Rev. 8 2022-05-16
		Template OMS for BK3 EX		
		Template OMS for FX2		
		Template OMS for FX2 EX		

(1) This is a template Dwg No. Project specific P&ID will be numbered 3xxxxx. Each project specific document shall reference back to the template Dwg No and Rev. as listed in this table.
(2) This is a template Dwg No. Project specific electrical wiring will be numbered 5xxxxx. Number of cabinets in project specific may vary from template. Each project specific document shall reference back to the template Dwg No and Rev. as listed in this table.
(3) All GA drawings have a unique sequence number (1xxxxx) automatically generated by the Optimarin PDM system.
(4) All project specific manuals will be indexed with a unique project number (3xxxx-xx-xx-xx) automatically generated by the ERP system. Revision of project specific manuals will start at Rev. 1, and each manual will reference back to the template revision as listed in this table.

Other equipment manufactured by

The OBS BWMS applies one of the following self-cleaning screen filters:

- aquaBoll 6.18.3 filter series with 25 µm mesh manufactured by Boll & Kirch (BK3 or BK3 EX)
- aquaBoll BWT filter series with 25 µm mesh manufactured by Boll & Kirch (BK4)
- ACB filter series with 20 µm mesh manufactured by Filtrex (FX2 or FX2 EX)

Treatment Rated Capacity

- 65 – 3000 m^3/h

Product description

Treatment sequence:

- Ballast water uptake: Filtration and UV treatment
- Ballast water discharge: UV treatment

System design limitations / Water quality parameters

Temperature and Salinity

Temperature and salinity of the ballast water are not a limiting condition for the ballast water treatment system.

System design limitations / Operational parameters

Holding time

The OBS BWMS has demonstrated performance to the performance standard with a minimum holding time between uptake and discharge of 24 hours in land-based testing for the IMO mode. UV treatment is instant and does not require any hold time in a ballast tank to render organisms inviable. Therefore, holding time is not found to be a limiting condition for the ballast water management system.

Dosing

The BWMS has demonstrated performance to the performance standard when the UV intensity (UVI) and flow rate is measured above the below parameters.

Operation mode	**TRC** [m^3/h]	**UVI lower limit at 24% of full flow** [W/m^2]	**UVI lower limit at full flow (TRC)** [W/m^2]
IMO	167 per chamber	150 (1)	400 (2)

(1) UVI below lower limit implies that the ballast water is not treated in accordance with this certificate. When targeting this UVI limit in land-based testing, the measured UVT was 45-46%. UVT may vary depending on the water quality parameters, i.e. particles and dissolved organic carbon.
(2) When targeting this UVI limit in land-based testing, the measured UVT was 54-56%.

The system also includes UV-lamp power optimization control based on measured UV-intensity. Lamp power can be reduced when UVI measures above 800 W/m^2.

The system has a USCG mode of operation which applies a higher UV dose than the described IMO mode above. This type approval therefore also applies to operation in the USCG mode.

Treatment Rated Capacity of the BWMS

The Treatment Rated Capacities (TRC) of the designated OBS BWMS models during ballasting is limited to either the maximum flow rate (TRC) of the UV system or the maximum flow rate (TRC) of the selected filter model, whichever is lowest. During de-ballasting, the TRC is limited to the maximum flow rate of the UV system only.

The UV system is formed by several UV chambers installed in parallel configuration, using specific manifolds, with the TRC as listed below. The TRC of the filter models, BK MK3 (EX), BK MK4 and FX MK2 (EX) are also listed in tables below. The minimum flow rate at which designated OBS BWMS model can be operated is the minimum flow rate of the selected filter model + (10m³/h x number of UV chambers).

The 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.

Manifold model	Number of UV chambers	TRC [m³/h]
Type 1, DN150	1	167
Type 1, DN200	2	334
Type 1, DN250	3	500
Type 1, DN300	4	667
Type 1, DN300	5	834
Type 1, DN350	6	1000
Type 1, DN400	7	1167
Type 1, DN400	8	1334
Type 1, DN400	9	1500
Type 1, DN500	10	1667
Type 1, DN500	11	1834
Type 1, DN500	12	2000
Type 1, DN500	13	2167
Type 1, DN500	14	2334
Type 1, DN500	15	2500

Manifold model	Number of UV chambers	TRC [m³/h]
Type 2, DN200	2	334
Type 2, DN250	3	500
Type 2, DN300	4	667
Type 2, DN300	5	834
Type 2, DN350	6	1000
Type 2, DN400	7	1167
Type 2, DN400	8	1334
Type 2, DN400	9	1500
Type 2, DN500	10	1667
Type 2, DN500	11	1834
Type 2, DN500	12	2000
Type 2, DN500	13	2167
Type 2, DN500	14	2334
Type 2, DN500	15	2500
Type 2, DN500	16	2667
Type 2, DN600	17	2834
Type 2, DN600	18	3000

Boll & Kirch aquaBoll 6.18.3	Model designation	Flow range [m³/h]
aquaBoll 273	72BK MK3 (EX)	19 - 72
aquaBoll 324	94BK MK3 (EX)	19 - 94
aquaBoll 356	204BK MK3 (EX)	24 - 204
aquaBoll 419	378BK MK3 (EX)	33 - 378
aquaBoll 521	518BK MK3 (EX)	33 - 518
aquaBoll 600	614BK MK3 (EX)	34 - 614
aquaBoll 750	1274BK MK3 (EX)	50 - 1274
aquaBoll 900	1384BK MK3 (EX)	47 - 1384

Filtrex ACB	Model designation	Flow range [m³/h]
ACB-906-100	87FX MK2 (EX)	15 - 87
ACB-910-150	135FX MK2 (EX)	25 - 135
ACB-915-150	190FX MK2 (EX)	35 - 190
ACB-935-200	255FX MK2 (EX)	35 - 255
ACB-945-200	340FX MK2 (EX)	45 - 340
ACB-955-250	515FX MK2 (EX)	50 - 515
ACB-985-300	770FX MK2 (EX)	65 - 770
ACB-999-350	1040FX MK2 (EX)	95 - 1040
ACB-9100-400	1500FX MK2 (EX)	126 - 1500

Boll & Kirch aquaBoll BWT	Model designation	Flow range [m³/h]
aquaBoll BWT 240x230 DN80	65BK MK4	8 - 65
aquaBoll BWT 330x300 DN100	125BK MK4	15 – 125
aquaBoll BWT 400x410 DN150	220BK MK4	23 – 220
aquaBoll BWT 430x730 DN200	430BK MK4	51 – 430
aquaBoll BWT 540x840 DN250	770BK MK4	59 – 770

Boll & Kirch aquaBoll BWT	Model designation	Flow range [m³/h]
aquaBoll BWT 580x1150 DN300	1000BK MK4	88 – 1000
aquaBoll BWT 700x1250 DN350	1350BK MK4	109 - 1350
aquaBoll BWT 800x1235 DN400	1900BK MK4	136– 1900
aquaBoll BWT 1000x1535 DN500	2600BK MK4	152 – 2600

Pressure

The minimum and maximum system operating pressure and the differential pressure triggering backflushing are listed below.

Filter type	Minimum inlet pressure (back-pressure)	Differential pressure triggering backflushing	Maximum operating pressure
Filtrex ACB, FX2	1.5 bar	≥0.3 bar	10 bar
aquaBoll 6.18.3, BK3 aquaBoll BWT, BK4	1.5 bar	≥0.38 bar	10 bar

Control and monitoring equipment

Software version

The OBS BWMS is type approved with system control software version: 2.2x

Any change to the software is to be recorded as long as the system is in use on board. Major changes in the software, as defined in the Optimarin checklist, OM-C-59, require approval by DNV. Testing of the application functions of a revised software may be required.

Safety measures

The 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:

- Temperature sensor (TTxx) installed in each UV chamber
- Temperature switch (TSxx) installed in each UV chamber and arranged with safety function independent of BWMS control
- Pressure sensor (PT01) installed after the filter
- Flow meter (FM01) installed after the filter

Electrical and electronic components

The OBS BWMS is type approved with the electrical and electronic components indicated on the P&ID and as specified in the BOM.

Except for the components listed in the table below, alternate components of the ones given in the BOM, 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 below shall be used:

Tag ID	Description	Item	Manufacturer
+CP	CONTROL PANEL MK3	150876	Optimarin AS
+SCP	SUB-CONTROL PANEL MK3	152052	Optimarin AS
+FC	FILTER CONTROL MK3	150737	Optimarin AS
	FILTER CONTROL EX MK3	151199	Optimarin AS
	FILTER CONTROL EX MK3 MTL	152706	Optimarin AS
+SBx	SENSOR BOX 0VA MK3	151128	Optimarin AS
	SENSOR BOX 250VA MK3	151114	Optimarin AS
	SENSOR BOX 700VA MK3	151058	Optimarin AS
	SENSOR BOX MK3	151135	Optimarin AS
	SENSOR BOX 0VA EX MK3	151215	Optimarin AS
	SENSOR BOX 250VA EX MK3	151231	Optimarin AS
	SENSOR BOX 700VA EX MK3	151763	Optimarin AS
	SENSOR BOX EX MK3	151207	Optimarin AS
	SENSOR BOX 0VA EX MK3 MTL	152695	Optimarin AS
	SENSOR BOX 250VA EX MK3 MTL	152700	Optimarin AS
	SENSOR BOX 700VA EX MK3 MTL	152702	Optimarin AS
	SENSOR BOX EX MK3 MTL	152704	Optimarin AS
+EXIP	EX INTERFACE PANEL MK3	151142	Optimarin AS
+IP	INTERLOCK PANEL MK3	151859	Optimarin AS
	FLOW INTERLOCK PANEL MK3	155943	Optimarin AS
+FWP	FRESH WATER PANEL MK3	151779	Optimarin AS
+ACP	ACTUATOR CONTROL PANEL 700VA MK3	151822	Optimarin AS
	ACTUATOR CONTROL PANEL 1600VA MK3	151813	Optimarin AS
	ACTUATOR CONTROL PANEL 3600VA MK3	151804	Optimarin AS
+PDP	POWER DISTRIBUTION PANEL SMALL MK3	152053	Optimarin AS
+GPS	GPS JUNCTION BOX MK3	152057	Optimarin AS
	GPS JUNCTION BOX 230VAC MK3	152058	Optimarin AS
+UVPxx	UV POWER CABINET TYPE NED MK3	145923	Nedap N.V.
	UV POWER CABINET TYPE ETA	145128	Eta plus electronic GmbH
	UV POWER CABINET TYPE UVA	150431	Uvantech AS
	UV POWER CABINET TINY TYPE ETA VER	157849	Eta plus electronic GmbH
	UV POWER CABINET TINY TYPE ETA HOR	157850	Eta plus electronic GmbH
+TBxx	TERMINAL BOX MK3	148644	Optimarin AS
	TERMINAL BOX MK2 TYPE TRA	148540	R. Stahl Tranberg AS
	TERMINAL BOX MK2 EX TYPE TRA	145956	R. Stahl Tranberg AS
+EXJBxx	JUNCTION BOX EX TYPE TRA	148640	R. Stahl Tranberg AS
	JUNCTION BOX EX TYPE BAR	145466	Bartec Technor AS
UVxx	UV SENSOR 2300W_m2 TYPE ILM	117079	IL Metronic Sensortechnik GmbH
	UV SENSOR 2300W_m2 EX2C EX TYPE ILM	149352	IL Metronic Sensortechnik GmbH
	LAMP CONNENTION BOX KIT	155639	Ex-Tech
	LAMP CONNENTION BOX KIT EX	155637	Ex-Tech

Hazardous area / Ex-proof

The OBS Ex BWMS has been evaluated and found to be in compliance with DNV GL Rules Pt.4 Ch.8 Sec.11 for hazardous area installations. Electrical and electronic components with an Ex-certification can be installed in hazardous area zone 1, gas group IIB and temperature class T4. Ex-certification is not covered by this certificate. Installation in a hazardous area is to be approved in each case according to the Rules and Ex-certification / Special Condition for Safe Use, listed in a valid Ex-certificate issued by a notified/recognized Certification Body.

Documents approval

The following documentation are to be submitted for each BWMS installation:

- Interface description towards the ship's existing systems including alarms for failure
- List of Ex equipment according to Pt.4 Ch.8 Sec.11 if the system is to be installed in hazardous area zone
- Piping and instrumentation diagram (P&ID) of the ballast system including the treatment system. All piping material shall be indicated and conform to class requirements.
- Commissioning procedure

Type Approval documentation

Biological test reports

NIVA, Land-based testing of OBS 334 Ballast Water Management system of Optimarin AS – Final Report, Report SNO 6921-2015, Final report v2.1, June 2016

NIVA, Shipboard testing of the Ballast Water Management System OBS1000 of Optimarin AS, Report SNO 7063-2016, Final report v2.0, June 2016

NIVA, Land-based testing of OBS 334 Ballast Water Management system of Optimarin AS – Final Report, Report SNO 7523-2020, Final report, August 2020

DHI, Biological comparison tests of three filters manufactured by BollFilter in land-based test - Land-based test report, project 11824919, Final test report, 11 January 2021

Environmental test reports

Applica EMC and Environmental testing of Gönnheimer Elektronic GmbH Control unit F850S and power supply for Optimarin AS, Report 20226, Rev. 1

Applica Technical Report, Optimarin AS Environmental testing of Temperatures Switches, Report No. 21250 Rev. 1

Applica Technical Report, Optimarin AS Environmental testing of Sensor Box +EXSB01 and temperature transmitter TR-34, Report No. 21356 Rev. 0

Applica Technical Report, Optimarin AS Environmental testing, Report No. 20597 Rev. 0

Applica Technical Report, Optimarin AS Environmental testing of Environmental testing of TB (Terminal Boxes) Report No. 20984 Rev. 0

Applica Technical Report, Optimarin AS EMC and Environmental testing of new components to Optimarin BWMS, Report No. 30486 Rev. 0

DNV GL Type Approval Certificate, TAE000037U issued to UVANTECHAS for UV Power Cabinet Type UVA

Applica Technical Report, Optimarin AS EMC and Environmental testing of Optilink Panel 4G, Report No. 30732 Rev. 0

Applica Technical Report, Optimarin AS Environmental testing of Lamp connection box, Report No. 30906 Rev. 1

Applica Technical Report, Optimarin AS EMC and Environmental testing of Flow interlock panel, Report No. 30972 Rev. 0

Phoenix Technical Reports, Optimarin AS EMC and Environmental testing of Flow interlock panel, Report No. U211234E1, Rev. 0 Report No E211234E1 Rev. 0 and

Treco Laboratory Test Report – Inclination test of X36B Tiny Cabinet, 22-04-26/Rev. 1.

System descriptive documentation

Installation Manual for Optimarin Ballast System, Rev. 8, Template dated 2022-05-16. This manual is prepared specific to BK MK3, BK MK4, FX MK2, BK MK3 EX or FX MK2 EX filters

Optimarin, OBS, PLC revision history, v2-20

Optimarin, UV chamber with instrumentation, Illustration for DNVGL dual safety layer requirement, Drawing No. 100000, Rev. -

DNV GL, Flow balance calculation, Flow Distribution in Parallel UV chambers, 2015-0885, Rev. 1, dated 2015-09-25

DNV GL, Filter comparison of Boll & Kirch filter model 6.18.2 and 6.18.3, file 385FIST130315-2

Optimarin, Filter Comparison Data TYPE BK, 2020

Optimarin, Filter Comparison Data TYPE FX, 2020

Optimarin, Flow pressure valve replacement report, Rev. 1

DNV, Evaluation test report, Equivalence of the aquaBoll BWT, BWT RB and 6.18.3 filter designs, file 262.1-034941-J-3, Rev. 0

DNV, Evaluation test report, - Increase of maximum flow rate for the aquaBoll BWT filter, 262.1-037442-1, Rev.1

Commissioning procedure

Class survey checklist for Optimarin Ballast System, Rev. 8, template dated 2022-05-16

Tests carried out

- Land-based testing in accordance with Resolution MEPC.279(70) and 46 CFR 162.060-26 using Optimarin OBS model 334 and Boll & Kirch 6.18.2 filter with 40 µm mesh
- Shipboard testing in accordance with Resolution MEPC.279(70) and 46 CFR 162.060-28 using Optimarin OBS model 1000 and Boll & Kirch 6.18.2 filter with a 40 µm mesh
- Additional land-based testing in accordance with Resolution MEPC.300(72) and 46 CFR 162.060-26 using Optimarin OBS model 334 and Boll & Kirch aquaBoll 6.18.3 filter with 25 µm mesh filter
- Additional land-based testing in accordance with Resolution MEPC.300(72) and 46 CFR 162.060-26 using Optimarin OBS model 334 and Filtrex filter ACB 945-200 with 20 µm mesh
- Biological comparison testing using Boll & Kirch aquaBoll 6.18.3 and aquaBoll BWT filter with 25 µm mesh filter
- Type tests of the control and automation system witnessed by DNV
- Testing in accordance with environmental test specification for instrumentation and automation equipment, DNV Standard for Certification, DNVGL-CG-0339 (December 2019), Resolution MEPC.300(72) and 46 CFR 162.060-30
- Additional testing of Optimarin OBS model 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 (Jan 2020) and Resolution MEPC.174(58)
- Type test of the control and automation system for optimized flow control, witnessed by DNV

Marking of product

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

- Manufacturer's name or trade mark
- Type designation
- Serial number

Periodical assessment

For retention of the type approval (TA) certificate, DNV surveyor shall perform periodical assessments to verify that the conditions of the type approval 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 the type approval certificate

A copy of this type approval certificate should always be carried on board a vessel fitted with this ballast water management system. The annex containing the summary reports of the test results of land-based and shipboard tests should be available for inspection on board the vessel.

Revision history of this certificate

Rev.	Date of issuance	Description
-	2020-10-23	Initial certificate in compliance with Resolution MEPC.300(72). INF Report MEPC 76/INF.15 dated 10 March 2021
1	2021-10-26	Inclusion of the following components: Filter type Filtrex ACB Ex version (FX BK2 EX) based on Ex certification and TAA0000123, Rev. 3 for the pressure transmitter. Filter type Boll & Kirch aquaBoll BWT (MK BK4) based on DNV report 262.1-034941-J-3. Optilink cabinet (for optional connection to shore) based on Applica Report No. 30732 and a technical specification.
2	2022-07-07	Inclusion of the following components: • a new lamp connection box • a new lamp power cabinet, type tiny manufactured by ETA plus • a modified UV chamber without end cap designed for the lamp connection box and a EX d kit when required in hazardous area • a new interlock panel for the new EX installation • two new filter sizes of the aquaBoll BWT filter series manufactured by Boll & Kirch Filterbau (Bollfilter) • increased rated capacity for the full range of BK4 filters based on separate DNV evaluations • improved software control logic corresponding with the above updates and including filter and UV flushing • new alternate flow and water level monitoring instruments

ANNEX: SUMMARY OF TESTING

Land-based and shipboard testing were carried out with the OBS BWMS including a Boll & Kirch 6.18.2 self-cleaning filter with 40 µm mesh candles as per IMO requirements. Additional land-based testing for the type approval has been carried out with the OBS BWMS including two new filters: a Filtrex ACB filter with a 20 µm mesh screen (FX2) and aquaBoll 6.18.3 with 25 µm mesh (BK3). The 40 µm mesh filter is considered conservative compared with the new filters and therefore the test results are included in this annex, forming the basis for type approval of the Optimarin OBS with either FX2 or BK3.

Land-based testing

Table 1 Test water conditions and operational parameters in land-based testing of the Optimarin OBS BWMS (TRC of 334 m3/h) with a Boll & Kirch 6.18.2 filter (BK, 40 µm screen) and two UV chambers at the NIVA Test Facility in Drøbak, Norway, during the period of May 2015 to June 2016.

Test cycle	salinity	Water temp. [°C]	Salinity [PSU]	UVT [%]	DOC [mg/L]	POC [mg/L]	TSS (1) [mg/L]	Holding time [hours]	UVI range ballasting [W/m^2]	Average flow rate after filtration [m^3/h]
1	FW	10.2	0	61	5.4	5.8	36.6	69	381-400	333
3	FW	10.7	0	65.2	6.3	7.3	44.3	120	319-327	331
4	FW	11.6	0	65.9	6.4	5.8	35.5	119	290-294	333
6	FW	11.8	0	61.8	6.9	5.1	30.5	117	289-290	334
7	FW	13.8	0	67	6.9	4.9	28.3	118	263-264	337
8	FW	14.1	0	69.1	7.7	5.5	27.8	67	405-408	336
15	FW	13.8	0	90	6.8	7.8	36.3	74	1141-1206	328
16	FW	14.5	0	75.5	7.3	5.4	34.0	120	714-749	333
17	FW	16.0	0	73.5	7.2	6.9	33.9	120	641-674	332
10	BW	5.8	19.0	81.1	13.4	6.8	34.9	75	1115-1155	333
11	BW	7.1	19.3	77.1	8.1	4.8	31.1	75	932-971	332
12	BW	8.5	19.1	73.9	8.0	6.3	30.4	124	646-712	333
13	BW	7.5	19.1	71.4	7.7	6.3	33.2	124	713-637	333
14	BW	8.9	18.7	76.9	7.5	6.2	33.0	127	1199-1353	333
1	MW	14.3	31.3	69.5	6.3	5.7	29.5	70	718-738	334
2	MW	14.9	28.4	67.2	6.9	4.9	26.0	64	420-436	334
3	MW	13.0	28.5	63.7	6.7	4.4	28.6	117	362-375	338
4	MW	10.3	29.3	62.9	6.7	5.6	31.3	117	385-392	335
5	MW	12.2	27.6	65	5.9	4.9	27.0	119	434-446	333
6	MW	10.4	29.4	66.8	5.2	5.3	27.3	120	465-477	333
7	MW	9.8	28.1	70.6	6.0	4.9	26.0	117	617-631	333
8	MW	9.0	27.6	73.9	6.6	4.2	26.0	120	717-741	333
9	MW	8.2	28.2	83.5	6.7	4.7	27.0	120	1334-1377	333

(1) Too low TSS in the prepared test water for all fresh and brackish water test cycles. The tests were therefore considered invalid, hence repeated with the upgraded filter from Boll & Kirch, type 6.18.3 aquaBoll with 25 µm screen (BK3). Although the marine water test cycles are valid test cycles, two additional marine water test cycles were performed using the BK3 with shorter hold time. See Table 3.

Table 2 Average numbers of live organisms in inlet and treated discharge water during land-based testing of the Optimarin OBS BWMS with the filter BK1, 40 µm screen. Live organisms ≥10 and <50 µm were quantified by microscopy counting after staining with CMFDA/FDA. Treated samples and control discharge were also quantified by MPN+Motility for organisms in size group ≥10 and <50 µm. Results from using MPN+Motility was basis or determining a successful test. All counts of pathogenic bacteria (E. coli, Enterococci and Vibrio cholerae) in treated water were below the ballast water performance standard.

Test cycle	salinity	Organism densities in influent water		Organism densities in discharge water			
		Organisms ≥50 µm [org/m³]	Organisms ≥10-<50 µm (FDA/CMFDA) [org/mL]	Organisms ≥50 µm [org/m³]		Organisms ≥10-<50 µm [org/mL]	
				Treated	Control	Treated (MPN)	Control (MPN)
1	FW	129,427	1,633	1.3	151,813	<0.06	2,700
3	FW	166,940	3,696	2.0	200,523	0.45	310
4	FW	155,992	3,788	1.3	362,779	<0.06	330
6	FW	149,742	1,729	1.3	355,650	0.27	790
7	FW	156,096	2,471	2.0	354,263	<0.06	1,100
8	FW	135,283	2,420	0.5	260,075	0.78	350
15	FW	361,508	2,004	0.3	371,437	<0.06	>2,700
16	FW	362,175	2,083	<0.3	272,674	0.2	930
17	FW	159,161	13,917	<0.3	211,619	0.65	1,300
10	BW	599,453	1,813	<0.3	323,654	<0.06	15 (1)
11	BW	289,113	1,525	0.3	472,900	<0.06	310
12	BW	598,422	2,179	<0.3	243,529	<0.06	67 (1)
13	BW	813,679	1,458	<0.3	777,958	<0.06	430
14	BW	308,857	2,871	<0.3	667,444	<0.06	350
1	MW	161,917	1,946	1.2	61,846	<0.06	430
2	MW	141,267	5,008	3.7	7,875	<0.06	230
3	MW	94,133	3,879	0.6	66,007	0.45	290
4	MW	115,308	3,429	1.7	74,619	<0.06	230
5	MW	138,740	2,104	<0.3	57,707	<0.06	290
6	MW	232,633	2,146	1.4	111,792	0.06	>230
7	MW	145,239	3,413	<0.3	162,222	<0.06	330
8	MW	159,883	1,158	<0.3	117,139	<0.06	570
9	MW	136,033	1,158	<0.3	70,171	<0.06	990

(1) In BW Test Cycle no 10 and 12, the plankton community was dominated by *Thalassiosira nordenschioeldii*. This algae species does not grow in the medium used in MPN method. The test results are considered invalid based on MPN, but valid based on FDA/CMFDA results which was <1 and 1 org/mL respectively in the discharge and 1788 and 263 org/mL respectively in the control discharge.

Table 3 Test water conditions and operational parameters in additional land-based testing of the Optimarin OBS BWMS (TRC of 334 m³/h) with a Boll &Kirch filter (BK3, 25 µm screen) and two UV chambers at the NIVA Test Facility in Drøbak, Norway, during the period of Oct 2019 to June 2020.

Test cycle (1)	Water temp. [°C]	Salinity [PSU]	UVT [%]	DOC [mg/L]	POC [mg/L]	TSS [mg/L]	Holding time [hours]	UVI range at ballasting [W/m²]	Average flow rate after filtration [m³/h]
1/1B	10	0	47	10	5	53	22.0	188-207	180
3/5B	9	0	46	11	5	58	22.5	157-173	88
25/5B	10	0	51	8	8	63	24.0	189-236	120
29/2B	14	0	53	10	6	64	23.0	424-456	330
31/1B	17	0	50	8	7	63	22.5	236-258	168
32/3B	15	0	51	8	6	62	119.5	268-284	199
33/4B	16	0	52	8	7	62	119.0	276-293	207
4/10B	9	18	48	8	7	66	23.5	230-251	162
5/8B	10	19	49	8	6	62	118.5	247-271	177
6/9B	10	19	49	8	5	66	118.0	242-266	174
7/7B	10	18	54	11	6	61	23.0	396-432	322
9/6B	9	19	46	8	5	57	23.5	158-175	90
11/11B	6	31	56	8	6	65	22.5	444-500	332
13/12B	7	30	55	8	7	66	23.5	426-482	327

(1) Two consecutive valid successful tests were performed for all salinities in the USCG mode. Only results from test cycles in the IMO mode are shown here.

Table 4 Average numbers of live organisms in inlet and treated discharge water during additional land-based testing of the Optimarin OBS BWMS with the filter BK3, 25 µm screen. Live organisms ≥10 and <50 µm were quantified by microscopy counting after staining with CMFDA/FDA. Treated samples and control discharge were quantified by MPN+Motility and CMFDA/FDA for organisms in size group ≥10 and <50 µm. Results from using MPN+Motility was basis or determining a successful test. All counts of pathogenic bacteria (*E. coli*, Enterococci and *Vibrio cholerae*) in treated water were below the ballast water performance standard. Testing during the period Oct 2019 to June 2020.

Test cycle	salinity	Organism densities in influent water		Organism densities in discharge water			
		Organisms ≥50 µm [org/m³]	Organisms ≥10-<50 µm (FDA/CMFDA) [org/mL]	Organisms ≥50 µm [org/m³]		Organisms ≥10-<50 µm [org/mL]	
				Treated	Control	Treated (MPN)	Control (MPN)
3/5B	FW	28,954 (1)	3,067	<1	25,738	2.3	2,700
25/5B	FW	156,513	2,139	<1	144,279	0.29	1,300
29/2B	FW	149,895	2,506	3.2	134,937	<0.07	2,700
31/1B	FW	671,824	3,959	<1	415,497	<0.07	2,000
32/3B	FW	1,392,036	1,204	<1	1,065,633	<0.07	190
33/4B	FW	1,298,360	1,100	0.3	1,065,633	<0.07	190
4/10B	BW	184,954	7,300	3.0	222,117	0.49	1,600
5/8B	BW	129,063	3,875	<1	96,654	<0.07	350
6/9B	BW	130,363	4,158	<1	96,654	<0.07	350
7/7B	BW	251,646	5,133	4.0	247,533	0.72	>2,700
9/6B	BW	1,107,967	1,050	<1	499,033	<0.07	1,300
11/11B	MW	140,388	1,800	0.7	192,250	<0.07	2,000
13/12B	MW	276,000	1,367	1.3	276,621	0.14	>2,700

(1) For test cycle no 3/5B the inlet counts of organisms ≥50 µm was below target of 100,000 org/m³, hence the test was repeated as test cycle no 25.

Table 5 Test water conditions and operational parameters in additional land-based testing of the Optimarin OBS BWMS (TRC of 334 m^3/h) with a Filtrex (FX2, 20 µm screen) and two UV chambers at the NIVA Test Facility in Drøbak, Norway, during the period of Oct 2019 to June 2020.

Test cycle (1)	salinity	Water temp. [°C]	Salinity [PSU]	UVT [%]	DOC [mg/L]	POC [mg/L]	TSS [mg/L]	Holding time [hours]	UVI range ballasting [W/m^2]	Average flow rate after filtration [m^3/h]
28/2F	FW	13	0	53	11	6	66	23	419-448	330
30/1F	FW	16	0	49	8	6	62	22.5	232-253	164
36/2F	FW	20	0	60	7	8	58	23.5	472-501	332
8/4F	BW	10	18	53	10	6	62	23.5	395-428	323
10/3F	BW	9	19	46	9	5	55	23.5	154-173	85
12/5F	MW	6	31	56	8	6	66	22.5	451-508	331
14/6F	MW	7	29	55	8	7	64	23	436-493	330

(1) Two consecutive valid successful tests were performed for all salinities in the IMO mode and three consecutive valid successful tests were performed for all salinities in the USCG mode. Only results from test cycles in the IMO mode are shown here.

Table 6 Average numbers of live organisms in inlet and treated discharge water during additional land-based testing of the Optimarin OBS BWMS with the filter FX2, 20 µm screen. Live organisms ≥10 and <50 µm were quantified by microscopy counting after staining with FDA/CMFDA. All counts of pathogenic bacteria (*E. coli*, Enterococci and *Vibrio cholerae*) in treated water were below the ballast water performance standard.

Test cycle	salinity	Organism densities in influent water		Organism densities in discharge water			
		Organisms ≥50 µm [org/m^3]	Organisms ≥10-<50 µm (FDA/CMFDA) [org/mL]	Organisms ≥50 µm [org/m^3]		Organisms ≥10-<50 µm [org/mL]	
				Treated	Control	Treated (MPN)	Control (MPN)
28/2F	FW	172,651	2,478	3.1	134,937	160 (1)	>2,700
30/1F	FW	650,300	5,283	<1	415,497	<0.07	2,000
36/2F	FW	262,292	1,413	1.3	439,850	<0.07	1,600
8/4F	BW	221,525	5,367	0.7	247,533	0.39	>2,700
10/3F	BW	1,437,675	1,042	0.3	499,033	0.39	1,300
12/5F	MW	152,713	1,867	<1	192,250	<0.07	2,000
14/6F	MW	230,646	1,413	<1	276,621	<0.07	>2,700

(1) The sample was contaminated, and further microscopic counts found that the sample including only 5.4 org/mL in the size above ≥10 µm. The test cycle was anyway repeated as test cycle no 36/2F.

Shipboard testing

Table 7 Test water conditions and operational parameters in shipboard testing with OBS BWMS (TRC of 1000 m^3/h) including a Boll & Kirch 6.18.2 filter (BK1, 40 µm screen) and 6 UV chambers installed in parallel on board the ship Saga Future (IMO No. 9613836) during the period of October 2015 to June 2016.

Test cycle	Water temp. [°C]	Salinity [PSU]	UVT [%]	DOC [mg/L]	POC [mg/L]	TSS [mg/L]	Holding time [hours]	UVI range at ballasting [W/m^2]	Average flow rate after filtration [m^3/h]
1 (1)	16.3	33.90	98	1.37	0.15	1.73	22	1652	991
3	11.2	30.30	67	1.43	0.81	41.93	28	473	995
6	31.6	32.4	94	1.70	0.05	17.33	35	1497	999
7	27.2	18.1	91	1.73	<0.1	6.27	45	801	997
8	29.7	33.1	95	1.50	<0.1	5.87	37	1882	997
10	31.9	31.6	96	1.80	<0.1	3.60	26	1589	992

(1) Test cycles no 1, 2, 4 and 5 are invalid tests due to low algae inlet counts and therefore some of these tests were aborted before all samples were analysed. Test cycle no 9 was invalid due to a maintenance performed outside the specifications (filter damage).

Table 8 Average numbers of live organisms in inlet and treated discharge water during shipboard testing of the OBS BWMS (TRC of 1000 m^3/h). Live organisms ≥10 and <50 µm were quantified by microscopy counting after staining with CMFDA/FDA in influent and treated water. All counts of pathogenic bacteria (*E. coli*, Enterococci and *Vibrio cholerae*) in treated water were below the ballast water performance standard.

Test cycle	Organisms ≥50 µm [org/m^3]		Organisms ≥10-<50 µm [org/mL]	
	Influent water	Treated discharge	Influent water	Treated discharge
1	6,403	25 (2)	32 (1)	1.7
3	57,250	7.2	138	0.2
6	12,118	2.6	95 (1)	1.2
7	23,239	<1	121	5.7
8	20,498	0.17	120	<0.2
10	3,044	0.88	90.3 (1)	<0.2

(1) Test cycles no 1, 2, 4 and 5 are invalid tests due to low algae counts at inlet. For test cycles no 6 and 10, the inlet count is between 90 and 95% of the test requirement which is considered an acceptable deviation.
(2) In shipboard test cycle no 1 the number of organisms ≥50 µm in the treated discharge did not meet the performance standard due to a leaking bypass valve which was replaced after test cycle no 5.