

TYPE APPROVAL CERTIFICATE

Certificate No:
TAP0000230
Revision No:
1

This is to certify:**That the Ballast Water Management System**

with type designation(s)

Wärtsilä Aquarius EC BWMS - Model range AQ-250-EC(X) to AQ-4000-EC(X)

Issued to

**Wartsila Water Systems Ltd
Poole, Dorset, United Kingdom**

is found to comply with

IMO Resolution MEPC.300(72) - Code for Approval of Ballast Water Management Systems (BWMS Code)**Resolution MEPC.169(57)****DNV GL class programme DNVGL-CP-0209 – Type approval – Ballast water management systems****DNV GL rules for classification – Ships****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 (MEPC.300(72)) and DNV GL 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 GL, unless otherwise instructed by relevant Maritime Administrations.

Operating media: N/AIssued at **Høvik** on **2021-01-29**for **DNV GL**This Certificate is valid until **2025-06-11**.DNV GL local station: **Southampton**Approval Engineer: **Michael Lehmann**

**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 GL AS, its parent companies and subsidiaries as well as their officers, directors and employees ("DNV GL") 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.



Job Id: **262.1-032758-2**
 Certificate No: **TAP0000230**
 Revision No: **1**

Name of ballast water management system (BWMS)

Wärtsilä Aquarius EC BWMS

Ballast water management system manufactured by

Wartsila Water Systems Ltd

Place of production

Wartsila Water Systems Ltd., Merchant House, Poole, Dorset, BH15 1PH, United Kingdom
 Wartsila Suzhou Ltd., 77, Hongxi Road, New District of Suzhou, 215151, P.R. China

Type and model designations

Wärtsilä Aquarius EC BWMS AQ-250-EC, AQ-300-EC, AQ-375-EC, AQ-430-EC, AQ-500-EC, AQ-550-EC, AQ-750-EC, AQ-850-EC, AQ-1000-EC, AQ-1200-EC, AQ-1500-EC, AQ-1650-EC, AQ-2000-EC, AQ-2250-EC, AQ-2500-EC, AQ-3000-EC, AQ-3300-EC and AQ-4000-EC

Wärtsilä Aquarius EC BWMS models suitable for installation in hazardous area are designated with the suffix X (e.g. AQ-1000-ECX).

Equipment / Assembly drawings

The Wärtsilä Aquarius EC BWMS shall be installed in accordance with the documents listed below.

Type	Drawing no.	Description
Operation, maintenance and safety manual (OMSM)	Wartsila Water Systems Ltd Wärtsilä Aquarius EC AQ-xxxx-EC Operational Maintenance & Safety Manual (OMSM 162.060-38) Ballast Water Management System Using Disinfectant Designed for Compliance with USCG rule 33CFR part 151 and 46CFR part 162 IMO MEPC 300(72) {G8} & 169(57) {G9} Revision 8 – 8 th December 2020	Operational Maintenance & Safety Manual
Piping and instrumentation diagram ⁽¹⁾⁽²⁾ (P&ID)	EC-T-001-171 or EC-T-013-171	Single System
	EC-T-002-171 or EC-T-014-171	Multiple System
	EC-T-004-171 or EC-T-015-171	EX Single System
	EC-T-006-171 or EC-T-017-171	EX Submerged Pumps
	EC-T-007-171 or EC-T-018-171	Single System Loose Kit
	EC-T-008-171 or EC-T-019-171	EX Single System Loose Kit
	EC-T-009-171 or EC-T-020-171	EX Single System Dual Filter
General arrangement (GA) drawings ⁽¹⁾⁽³⁾	H0250FK-xxx-191 to H4000FK-xxx-191	Standard Filter Kits
	H0250FXK-xxx-191 to H4000FXK-xxx-191	Standard EX Filter Kits
	H0250FCK-xxx-191 to H0500FCK-xxx-191	Compact Filter Kits
	H0250FCXK-xxx-191 to H0500FCXK-xxx-191	Compact EX Filter Kits
	H00500FCK-SP-xxx-191 to H4000FK-SP-xxx-191	Super Turbo Filter Kits

Job Id: **262.1-032758-2**
Certificate No: **TAP0000230**
Revision No: **1**

	H00500FCXK-SP-xxx-191 to H4000FXK-SP-xxx-191	Super Turbo EX Filter Kits
	H0300ECMK-xxx-201 to H3600ECMK-xxx-201	Mixer Kits
	H0300ECMXK-xxx-201to H3600ECMXK-xxx-201	EX Mixer Kits
	H0850ECS2-XXA-172 to H4000ECS2-XXA-172 ⁽⁴⁾	Sidestream Pump Modules
	H0550ECC-xxx-201 to H4000ECC-xxx-201	EC Cell Modules
	H0850ECT-xxx-201to H4000ECT-xxx-201	EC Tank Modules
	ECDM-xxx-172	EC Bisulphite Drum Module
	H0250ECBD-xxx-172 to H4000ECBD-xxx-172	Neutralisation ECBD Modules
	Kraft Powercon FlexKraft Marine FKM 1M 50V to FlexKraft Marine FKM 10M 200V	Power Supply Units Alternative 1
	Castlet A201608 to A201611	Power Supply Units Alternative 2
	ECFI-002-172	PS Cooling Spool
	BWCP-GA-02	Control Panel
Bill of materials (BoM)	BD00400 (Rev. 6)	Generic BoM
Electrical wiring diagram ⁽⁵⁾	BWCP20001 to BWCP20025 BWCP25001 to BWCP25025 BWCP20101 to BWCP20125 BWCP25101 to BWCP25125	EC Control Panel
	BWCP40001EX to BWCP40025EX BWCP45001EX to BWCP45025EX BWCP40101EX to BWCP40125EX BWCP45101EX to BWCP45125EX	EC Control Panel Ex
	BWCP90053	EC Remote Console (optional)
	BWCP60001 to BWCP60009 BWCP65001 to BWCP65009 BWCP60101 to BWCP60109 BWCP65101 to BWCP65109	EC Aft Peak Control Panel
	BWCP90071, BWCP90075	EC Aft Peak Remote Console

- (1) -171, -172, -173, -191 or -201 represents the revision number of the P&ID or GA drawings. For any revision resulting in a change of this revision number, the revised P&ID or GA drawings are to be forwarded to DNV GL for evaluation.
- (2) There are two versions of each P&ID where one version (e.g. EC-T-001-171) is for typical installation arrangements while the second version (e.g. EC-T-013-171) is for installations with an alternative hybrid pump arrangement for the dosing module.
- (3) The listed GA drawings are generic and are not used for specific installations. The orientation and voltage/frequency of each installation will be determined to allow for the relevant GA drawing to be created, replacing -xxx with the specific type code. Each GA drawing will reference back to the generic GA drawing number listed in this table. Any significant changes to the BWMS leading to a new generic drawing being created with a new model version number requires submission of that new generic drawing to DNV GL.
- (4) For the sidestream pump module GA drawings, alternative options HXXXXECSA-XXA-172 and HXXXXECSB-XXA-172 can be used in place of the standard offering HXXXXECS2-XXA-172 for some installations, if required.
- (5) Drawing numbers for specific installations may include the installation contract number for traceability purposes (e.g. BWCPxxxx-25xxx). Each drawings will reference back to the electrical drawing number listed in this table.

Job Id: **262.1-032758-2**
Certificate No: **TAP0000230**
Revision No: **1**

Other equipment manufactured by

The Wärtsilä Aquarius EC BWMS applies filter models (in standard, turbo and super-turbo configurations) of the BS series and BS e-series with a 40 µm Smartweave™ sintered filter screen designed by Filtersafe but manufactured by Wartsila under license.

The Wärtsilä Aquarius EC BWMS applies either the electrolysis cells E.HAM.0802 / E.HAM.1001 manufactured by Magneto or the electrolysis cells PermaChlor 6500 / PermaChlor 13500 manufactured by Permascand.

The rectifiers are either supplied by Kraft Powercon or Castlet.

Treatment Rated Capacity

250 – 4,000 m³/h

Product description

Treatment sequence:

- Ballast water uptake: Filtration and injection of active substance generated by electrolysis
- Ballast water discharge: Neutralisation

System design limitations / Water quality parameters

Temperature & salinity

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

System design limitations / Operational parameters

Feed water to electrolysis unit

The salinity of the feed water to the electrolysis unit shall be ≥ 15 PSU. For treatment of ballast water with a salinity of less than 15 PSU, sea water that is stored in a dedicated tank may be used as feed water to the electrolysis unit.

The temperature of the feed water to the electrolysis unit shall be $\geq 15^{\circ}\text{C}$. The feed water to the electrolysis unit shall as necessary be heated to $\geq 15^{\circ}\text{C}$ by use of a heat exchanger.

Holding time

The Wärtsilä Aquarius EC BWMS has demonstrated performance to the discharge standard with a minimum holding time between uptake and discharge of 24 hours in land-based testing. A minimum holding time of 24 hours is required for the Wärtsilä Aquarius EC BWMS.

Dosing

The target TRO of the Wärtsilä Aquarius EC BWMS is 10 mg/L (as Cl₂) within the range of ± 1 mg/L. TRO concentration at discharge shall be ≤ 0.1 mg/L.

Treatment Rated Capacity

The Treatment Rated Capacities (TRC) of the designated Wärtsilä Aquarius EC(X) BWMS models are listed below. The list also specifies the filter and electrolysis cells that shall be installed for a specific model. A Wärtsilä Aquarius EC BWMS model may be used with a larger filter than specified below.

The BWMS flow rates shall not exceed the TRC of a specific Wärtsilä Aquarius EC(X) BWMS model. The BWMS automatically controls filter flow rate and the mixing of injection of active substance into the main ballast line by applying a mixing unit and flow control valve both during ballast water uptake and discharge.

Job Id: **262.1-032758-2**
 Certificate No: **TAP0000230**
 Revision No: **1**

Wärtsilä Aquarius EC model	TRC [m ³ /h]	Filter model ⁽¹⁾	Electrolysis cells	
			Magneto	PermaScand
AQ-250-EC(X)	250	BS-100H/V-08 or BS-101(e)H/V-08	E.HAM.0801	PermaChlor 6500
AQ-300-EC(X)	300	BS-101(e)H/V-T-08	E.HAM.0801	PermaChlor 6500
AQ-375-EC(X)	375	BS-150H/V-10 or BS-151(e)H/V-10	E.HAM.0801	PermaChlor 6500
AQ-430-EC(X)	430	BS-151(e)H/V-T-10	E.HAM.0801	PermaChlor 6500
AQ-500-EC(X)	500	BS-200H/V-12, BS-201(e)H/V-12 or BS-151(e)H/V-ST-12	E.HAM.0801	PermaChlor 6500
AQ-550-EC(X)	550	BS-200H/V-T-12 or BS-201(e)H/V-T-12	E.HAM.0801	PermaChlor 6500
AQ-750-EC(X)	750	BS-300(e)H/V-14	E.HAM.0801 x 2	PermaChlor 6500 x 2
AQ-850-EC(X)	850	BS-300(e)H/V-T-14	E.HAM.0801 x 2	PermaChlor 6500 x 2
AQ-1000-EC(X)	1000	BS-400(e)H/V-14 or BS-300(e)H/V-ST-14	E.HAM.0801 x 2	PermaChlor 6500 x 2
AQ-1200-EC(X)	1200	BS-400(e)H/V-T-14	E.HAM.0801 x 2	PermaChlor 6500 x 2
AQ-1500-EC(X)	1500	BS-603(e)H/V-18 or BS-500eH/V-T-16	E.HAM.0801 x 3	PermaChlor 6500 x 3
AQ-1650-EC(X)	1650	BS-603(e)H/V-T-18	E.HAM.0801 x 3	PermaChlor 6500 x 3
AQ-2000-EC(X)	2000	BS-804(e)H/V-20 or BS-603(e)-H/V-ST-18	E.HAM.1001 x 2	PermaChlor 13500 x 2
AQ-2250-EC(X)	2250	BS-804(e)H/V-T-20	E.HAM.1001 x 2	PermaChlor 13500 x 2
AQ-2500-EC(X)	2500	BS-1004(e)H/V-24 or BS-804(e)H/V-ST-24	E.HAM.1001 x 2	PermaChlor 13500 x 2
AQ-3000-EC(X)	3000	BS-1204(e)H/V-24	E.HAM.1001 x 3	PermaChlor 13500 x 3
AQ-3300-EC(X)	3300	BS-1004(e)H/V-ST-24 or BS-1204(e)H/V-T-24	E.HAM.1001 x 3	PermaChlor 13500 x 3
AQ-4000-EC(X)	4000	BS-1204(e)H/V-ST-24 or BS-1406(e)H/V-T-24	E.HAM.1001 x 4	PermaChlor 13500 x 4

(1) H/V symbolises filters for horizontal or vertical installation. (e) symbolises filters of the BS e-series range.

Job Id: **262.1-032758-2**
Certificate No: **TAP0000230**
Revision No: **1**

Pressure

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

Wärtsilä Aquarius EC model	Minimum ballast water inlet pressure ⁽¹⁾	Maximum ballast water operating pressure	Differential pressure triggering backflushing
AQ-250-EC(X) to AQ-4000-EC(X)	1.6 bar	6 bar	0.5 bar

(1) Minimum pressure required when using a backflush pump to enable effective filter cleaning.

Control and monitoring equipment

Software version

The Wärtsilä Aquarius EC BWMS is type approved with the system control software version R11XX. In the revision number R11XX the first "1" represents the major revision number of the software and the second "1" represents the hardware revision number. XX represents the minor revision number.

Any changes to the software are to be recorded as long as the system is in use onboard. Records of any major software changes or any changes to the hardware, as described in the Control Systems Software Revision Control Process (BD00312), are to be forwarded to DNV GL for evaluation. Major software changes include any change to the control and operating philosophy of the BWMS, which can alter the performance of the system. Testing of the application functions of the revised software may be required.

Safety measures

The Wärtsilä Aquarius EC 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:

- Pressure transducers PT1 and PT4 before and after the filter;
- Flow meter FIT2 for the feed water to the electrolyser unit;
- Temperature sensor TIT1 and pressure sensor PT3 measuring temperature and pressure of feed water to the electrolyser unit;
- Flow switch FS1 installed in the H₂ gas vent duct;
- H₂ gas sensor GS1 installed in the H₂ gas vent duct (arranged with safety function independent of BWMS control);
- H₂ gas sensor GS2 placed above the electrolysis cells (arranged with safety function independent of BWMS control);
- H₂ gas sensor GS3 placed above the hypochlorite buffer tank;
- Cell air purge arrangement (components AFR1, V112 and V113 mounted on a plate) to purge any residual hydrogen from the electrolysis cells in case of power failure and resulting failure of both blowers (safety function independent of BWMS control).

Job Id: **262.1-032758-2**
 Certificate No: **TAP0000230**
 Revision No: **1**

Electrical and electronic components

The Wärtsilä Aquarius EC 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&ID and specified on the BoM. Except for the components listed below, alternate models to the ones specified on 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 a valid type approval certificate or technical documentation demonstrating that the selected component was subject to environmental testing as per IACS UR E10.

For alternate model of the level indicator LT1 and level sensor LS1 installed in the hypochlorite buffer tank and the flow switch FS1 and H₂ gas sensor GS1 installed in the H₂ gas vent duct, documentation shall also be provided that alternate sensors are suitable for installation in zone 1 or are adequately isolated from the inside of the hypochlorite buffer tank or H₂ vent duct.

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

Tag No.	Component name	Manufacturer	Model(s)
MCP3	Main control panel	CMR or Wartsila Suzhou (designed by Wärtsilä)	BWCP2xxxx or BWCP4xxxxEX
	Remote console (optional)	CMR or Wartsila Suzhou (designed by Wärtsilä)	BWCP9xxxx
	Human Machine Interface (HMI)	Beijer	Beijer X2Pro10
Mitsubishi		GOT1675	
ECPS1	EC power supply	Kraft Powercon	Flexkraft
		Castlet	Transformer Rectifier
TRO 1 TRO 2 TRO 3	TRO and chlorine monitor	HF Scientific	CLX-XT2 CLX-EX2 SSR-EX
Xylem Water Solutions		9017	

Hazardous area / Ex-proof

Relevant electrical and electronic components of the EX filter kit and EX mixing kit of the Wärtsilä Aquarius EC BWMS have been found to be in compliance with DNV GL rules for classification of ships Pt.4 Ch.8 Sec.11 and may be installed in hazardous areas. All other units of the BWMS must be located in non-hazardous areas.

Installations in a hazardous area are 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. Ex-certification is not covered by this certificate.

Documents approval

The following documentation is to be submitted for approval for each BWMS installation:

- Piping and Instrumentation Diagram (P&ID) of the ballast system including the treatment system installation;
- Power supply arrangement;
- Commissioning procedure;
- Interface description towards ship's existing systems including alarms for failure;

Job Id: **262.1-032758-2**
Certificate No: **TAP0000230**
Revision No: **1**

- List of Ex-equipment according to DNV GL rules for classification of ships Pt.4 Ch.8 Sec.11 if the system is to be installed in hazardous area zone.

Type approval documentation

Test plan and reports:

- Final approval of AQUARIUS® EC Ballast Water Management System by the Marine Environment Protection Committee (MEPC 65/22)
- DHI Denmark: Performance evaluation in land-based test facility - Aquarius EC, Final test report of 11 September 2015
- DHI Denmark: Performance evaluation of Wärtsilä Aquarius EC Ballast Water Management System in shipboard test - Shipboard test report, Final test report of 4 April 2018
- DHI: Whole Effluent Toxicity Test of the effluents from AQUARIUS EC BMWS - Brackish, high saline and fresh water, Final test report of 8 July 2016
- PHOENIX TESTLAB: Test report (Report Number: U170239E1) - Equipment under Test (EUT): Ballast Water Management System Project Aquarius EC, Rev. 3 of 11 June 2018
- PHOENIX TESTLAB: Test report (Report Number: U181132E1) – Equipment under Test (EUT): 6000 and 6500 Series Purge Unit, Rev. 3 of 12 October 2018
- PHOENIX TESTLAB: Test report (Report Number: U181610E1) - Equipment under Test (EUT): 6500 Purge Unit, Rev. 3 of 12 October 2018
- PHOENIX TESTLAB: Test report (Report Number: E170239E1) – Equipment under Test (EUT): Ballast Water Management System Project Aquarius, Rev. 2 of 13 December 2017
- PHOENIX TESTLAB: Test report (Report Number: E172035E2) – Equipment under Test (EUT): Flow monitor SI5100, Rev. 1 of 12 December 2017
- PHOENIX TESTLAB: Test report (Report Number: E172035E3) – Equipment under Test (EUT): Pressure transmitter, Rev. 1 of 12 December 2018
- PHOENIX TESTLAB: Test report (Report Number: E172035E4) – Equipment under Test (EUT): Gas Sensor MST Satellite XT, Rev. 1 of 17 October 2017
- PHOENIX TESTLAB: Test report (Report Number: E172035E5) – Equipment under Test (EUT): Digital Positioner D3IGU-D23PVA-Z4SX, Rev. 1 of 12 October 2017
- PHOENIX TESTLAB: Test report (Report Number: E172035E6) – Equipment under Test (EUT): Filter Outlet Valve NTE-05EBC, Rev. 1 of 16 October 2017
- PHOENIX TESTLAB: Test report (Report Number: E181132E1) – Equipment under Test (EUT): Purge System 6000 and 6500 Series, Rev. 2 of 5 December 2018
- Retlif Testing Laboratories: USCG Test Report for Marine Ballast Water Analyzer Model Number: 9017 by Xylem Analytics (Test Report No.: R-2820P), Rev. B of 28 June 2018

System documentation:

- Wartsila Water Systems Ltd.: Wärtsilä Aquarius EC AQ-xxxx-EC Operational Maintenance & Safety Manual (OMSM 162.060-38) Ballast Water Management System Using Disinfectant Designed for Compliance with USCG rule 33CFR part 151 and 46CFR part 162 and IMO MEPC 300(72) {G8} & 169(57) {G9}, rev. 8
- Wartsila Water Systems Ltd.: Wärtsilä Aquarius EC BWMS Generic BOM's - USCG (BD00400), rev. 6
- Wartsila Water Systems Ltd.: Aquarius EC BWMS Sizing Document (BD00385), rev. 3
- Wartsila Water Systems Ltd.: EC Operator User Guide (BD00394), rev. 5
- Wartsila Water Systems Ltd.: EC Installation Guidance (BD00252), rev. 8

Job Id: **262.1-032758-2**
Certificate No: **TAP0000230**
Revision No: **1**

- Wartsila Water Systems Ltd.: EC Control and Operating Philosophy (BD00268), rev. 4
- Wartsila Water Systems Ltd.: EC Alarm & Trip Summary (BD00309), rev. 9
- Wartsila Water Systems Ltd.: EC Control System Software Functional Description (BD00358), rev. 5
- Wartsila Water Systems Ltd.: Alarm & Function Test (BD00281), rev. 5
- Wartsila Water Systems Ltd.: Wärtsilä Aquarius EC BWMS basis of process design and scale-up (BD00349), rev. 3
- Wartsila UK Ltd.: Wärtsilä Aquarius EC Temperature Assessment (BD00493), rev. 1
- Wartsila UK Ltd.: EC Shipboard Testing Summary (Revised IMO G8) (BD00491), rev. 1
- Wartsila Water Systems Ltd.: Xylem and HF Scientific TRO Unit Equivalency Report (BD00422), rev. 2
- Wartsila Water Systems Ltd.: Permascand electrolysis cell equivalency report (BD00376), rev 1
- DNV GL: Evaluation Test Report –Xylem TRO Instrument for Aquarius EC BWTS (Report No.: 262.1-017482-J-142), Rev. 0
- DNV GL: Evaluation of functional equivalence of SSR-Ex with CLX-Ex(2) TRO monitor (Report No.: 262.1-029894-J-7), Rev. 1
- DNV GL: Evaluation report - Equivalence of new 'e' type BS filter series with old BS filter series by Filtersafe (Report No.: A0803585-001), Rev. 0

Tests carried out

- Land-based testing at the DHI Maritime Technology Evaluation Facility in Denmark with the Wärtsilä Aquarius EC BWMS AQ-500-EC (TRC of 500 m³/h) with two E.HAM.0802 electrolysis cells manufactured by Magneto in series and one BS-200H filter manufactured by Filtersafe in accordance with Resolution MEPC.279(70)
- Shipboard testing with the Aquarius EC BWMS AQ-1650-ECX (TRC of 1650 m³/h) with three E.HAM.0801 electrolysis cells manufactured by Magneto in series and one BS-603V-T filter manufactured by Filtersafe on board the oil/chemical tanker Maersk Beaufort (IMO No. 9340594) in accordance with Resolution MEPC.279(70)
- Environmental testing in accordance with DNV GL class guidelines for Environmental test specification for electrical, electronic and programmable equipment and systems (DNVGL-CG-0339) and Resolution MEPC.279(70)
- Function tests of the control and monitoring system witnessed by DNV GL
- Bench-scale tests with the electrolysis cells PermaChlor 6500 and PermaChlor 13500 manufactured by Permascand at NIVA, Norway, under the supervision of DNV GL
- Bench-scale tests for the Xylem TRO instrument carried out by Wärtsilä under the supervision of DNV GL.

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

Job Id: **262.1-032758-2**
Certificate No: **TAP0000230**
Revision No: **1**

Periodical assessment

For retention of the Type Approval, DNV GL 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 always be carried onboard a vessel fitted with this ballast water management system. An annex containing the summary reports of the test results of land-based and shipboard tests should be available for inspection onboard the vessel.

Revision history of this certificate

Revision No.	Date of issuance	Description
-	2020-06-12	Initial certificate
1	2021-01-29	Change of manufacturer name from Wartsila UK Ltd to Wartsila Water Systems Ltd.

Job Id: **262.1-032758-2**
 Certificate No: **TAP0000230**
 Revision No: **1**

ANNEX: SUMMARY OF TESTING

Land-based testing

Table 1 Test water conditions and operational parameters in land-based testing of the Wärtsilä Aquarius EC BWMS AQ-500-EC (TRC of 500 m³/h) with E.HAM.0802 electrolysis cells manufactured by Magneto and a BS-200H filter manufactured by Filtersafe at the DHI Maritime Technology Evaluation Facility in Hundested, Denmark, during the period of August to December 2014.

Test cycle	Water temperature [°C]	Salinity [PSU]	DOC [mg/L]	POC [mg/L]	TSS [mg/L]	Holding time	TRO at ballasting ⁽¹⁾ [mg/L]	Flow rate ⁽²⁾ [m ³ /h]
F-1	17	0.31	9.9	7.4	69	24 hours	10.1 (9.1-10.5)	500
F-2	12	0.35	8.6	5.3	50	24 hours	10.6 (10.3-11.0)	501
F-3	12	0.35	8.6	5.3	50	24 hours	10.5 (9.9-11.5)	499
F-4	12	0.34	8.2	6.9	61	5 days	10.6 (9.5-10.9)	498
F-5	12	0.34	8.2	6.9	61	5 days	10.6 (10.0-10.8)	494
F-6	10	0.39	7.8	5.6	60	5 days	10.4 (9.8-10.7)	498
F-7	10	0.39	7.8	5.6	60	5 days	10.5 (9.6-10.)	495
F-8	7.9	0.35	8.5	5.8	52	5 days	10.2 (9.9-10.4)	500
F-9	7.9	0.35	8.5	5.8	52	5 days	10.1 (9.7-10.3)	496
B-1	23	19	6.8	21	74	24 hours	8.6 (8.1-9.0)	497
B-2	23	19	6.8	21	74	24 hours	8.8 (6.9-9.3)	493
B-3	19	18	6.4	7.9	61	24 hours	9.1 (8.5-9.4)	501
B-4	16	18	7.1	6.8	55	5 days	9.3 (8.2-9.5)	497
B-5	16	18	7.1	6.8	55	5 days	9.3 (8.2-9.5)	496
B-6	13	20	7.5	6.5	57	24 hours	10.4 (10.1-10.5)	494
B-7	13	20	7.5	6.5	57	24 hours	10.1 (9.9-10.5)	494
M-1	17	33	7.3	6.6	43	24 hours	9.8 (9.0-10.1)	499
M-2	14	35	7.3	6.7	43	5 days	10.4 (9.5-11.1)	502
M-3	14	35	7.3	6.7	43	5 days	10.5 (9.6-11.4)	500
M-4	13	34	6.2	6.6	44	24 hours	10.5 (9.7-11.4)	497
M-5	13	34	6.2	6.6	44	24 hours	10.5 (9.6-11.1)	499

(1) Average TRO and range of TRO in parenthesis.
 (2) Average flow rate after filtration.

Job Id: **262.1-032758-2**
 Certificate No: **TAP0000230**
 Revision No: **1**

Table 2 Average numbers of live organisms in inlet and treated discharge water during land-based testing of the Wärtsilä Aquarius EC BWMS AQ-500-EC. Live organisms ≥ 10 and $< 50 \mu\text{m}$ were quantified by microscopy counting after staining with CMFDA/FDA. All counts of pathogenic bacteria (*E. coli*, Enterococci and *Vibrio cholerae*) in treated water were below the ballast water discharge standard.

Test cycle	Organism densities in inlet water		Organisms densities in discharge water			
	Organisms $\geq 50 \mu\text{m}$ [organism/m ³]	Organisms $\geq 10- < 50 \mu\text{m}$ [organisms/mL]	Organisms $\geq 50 \mu\text{m}$ [organism/m ³]		Organisms $\geq 10- < 50 \mu\text{m}$ [organisms/mL]	
			Treated	Control	Treated	Control
F-1	197,000	17,585	0	153,017	0.5	2,503
F-2 ⁽¹⁾	233,841	20,469	21 ⁽²⁾	110,212	1.6	2,297
F-3 ⁽¹⁾			30 ⁽²⁾		0.33	
F-4 ⁽¹⁾	306,894	15,175	0	149,193	1	1,807
F-5 ⁽¹⁾			0		0.33	
F-6 ⁽¹⁾	321,532	3,895	0.33	121,574	0.08	929
F-7 ⁽¹⁾			64 ⁽²⁾		0.17	
F-8 ⁽¹⁾	302,778	5,925	0	129,942	0.5	1,170
F-9 ⁽¹⁾			0		0	
B-1 ⁽¹⁾	451,570	3,308	30 ⁽³⁾	229,614	0.33	868
B-2 ⁽¹⁾			16 ⁽³⁾		0.42	
B-3	301,479	1,572	4	113,641	0.67	509
B-4 ⁽¹⁾	216,297	1,714	3	33,478	1	329
B-5 ⁽¹⁾			2.7		0.17	
B-6 ⁽¹⁾	301,000	1,470	0.67	96,516	0	925
B-7 ⁽¹⁾			0		0	
M-1	362,167	1,725	1.7	87,081	0.75	467
M-2 ⁽¹⁾	211,815	1,915	0	49,078	1.1	531
M-3 ⁽¹⁾			0		0	
M-4 ⁽¹⁾	170,518	1,475	0	89,775	0.17	1,500
M-5 ⁽¹⁾			0		0	

(1) Two tests cycles were performed on the same day using the same control water tank.

(2) Invalid test cycle due to contamination resulting from a leaking filter inlet valve.

(3) Test cycles B-1 and B-2 were the first two land-based test cycles conducted, and the BWMS had a target TRO of 9 mg/L. These test cycles were both unsuccessful. Subsequently, the target TRO was increased to 10 mg/L.

Job Id: **262.1-032758-2**
 Certificate No: **TAP0000230**
 Revision No: **1**

Shipboard testing

Table 3 Test water conditions and operational parameters in shipboard testing with the Wärtsilä Aquarius EC BWMS AQ-1650-ECX (TRC of 1650 m³/h) with E.HAM.0801 electrolysis cells manufactured by Magneto and a BS-603V-T filter manufactured by Filtersafe on board the oil/chemical tanker Maersk Beaufort (IMO No. 9340594) during the period of February 2017 to January 2018.

Test cycle	Water temperature [°C]	Salinity [PSU]	DOC [mg/L]	POC [mg/L]	TSS [mg/L]	Holding time [hours]	TRO at ballasting ⁽¹⁾ [mg/L]	Flow rate ⁽²⁾ [m ³ /h]
1 ⁽³⁾	6.2	10	2.0	0.19	8.9	-	8.4 (3.0-9.7)	560
2	21	35	1.0	0.38	18	22	9.3 (6.7-11)	1,340
3	17	34	0.73	0.26	1.4	67	9.6 (6.0-11)	1,628
4	20	1.8	2.3	0.18	6.1	24	9.4 (6.8-11)	1,340
5 ⁽³⁾	15	3.7	-	-	-	-	2.5 (1.1-5.6)	1,256
6	15	3.8	2.2	0.26	20	21	9.0 (6.9-11)	1,408
7	16	5.8	2.4	<0.10	7.6	23	9.3 (5.3-11)	1,527
8	29	31	1.3	<0.10	13	71	8.7 (4.7-9.9)	1,406

(1) Average TRO and range of TRO in parenthesis.

(2) Average flow rate after filtration.

(3) Test cycle 1 was abandoned due to system failure. Test cycle 5 was abandoned due to lack of salt water in the aft peak tank, resulting in the feed water to the electrolysis unit having a salinity of 4 PSU and thus below the system design limitation of 15 PSU. No discharge operation was performed for these two test cycles.

Table 4 Average numbers of live organisms in inlet and treated discharge water during shipboard testing of the Wärtsilä Aquarius EC BWMS AQ-1650-EC. Live organisms ≥10 and <50 µm were quantified by microscopy counting after staining with CMFDA/FDA. All counts of pathogenic bacteria (*E. coli*, Enterococci and *Vibrio cholerae*) in treated water were below the ballast water discharge standard.

Test cycle	Organisms ≥50 µm [organism/m ³]		Organisms ≥10-<50 µm [organisms/mL]	
	Influent water	Treated discharge	Influent water	Treated discharge
1 ⁽¹⁾	255	-	36	-
2	136,511	0	590	0.67
3	21,118	0	435	0.17
4	8,330	0.61	1,328	1.7
5 ⁽¹⁾	9,846	-	113	-
6	8,680	2.3	158	0.33
7	7,229	4.6	156	0
8	31,255	0	110	0

(1) Test cycle 1 was abandoned due to system failure. Test cycle 5 was abandoned due to being outside the performance claim caused by lack of salt water in the aft peak tank resulting in the feed water to the electrolysis unit having a salinity below 15 PSU. No discharge operation was performed on these two test cycles.