

TYPE APPROVAL CERTIFICATE

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

with type designation(s)

Envirocleanse inTank EC BWTS (module range EC01-EC16 and DM065-DM250)

Issued to

Envirocleanse LLC**Katy, TX, USA**

is found to comply with

DNV GL rules for classification – Ships**Resolution MEPC.169(57)****IMO Resolution MEPC.279(70) - 2016 GUIDELINES FOR APPROVAL OF BALLAST WATER MANAGEMENT SYSTEMS (G8)****DNV GL class programme DNVGL-CP-0209 – Type approval – Ballast water management 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 Guidelines contained in Resolution MEPC.279(70) 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 resolution MEPC.279(70), 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.

Issued at **Høvik** on **2018-12-20**for **DNV GL**This Certificate is valid until **2023-12-19**.DNV GL local station: **Houston**Approval Engineer: **Sarah Lasselle**

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.



Name of ballast water management system (BWMS)

Envirocleanse inTank Electrochlorination (EC) BWTS

Ballast water management system manufactured by

Envirocleanse LLC

Place of production

Electrichlor LLC, Laramie, Wyoming USA

Type and model designations

inTank EC BWTS with Electrochlorination modules EC01, EC02, EC04, EC08, EC12, and EC16; and Dosing modules DM065 DM080, DM100, DM150, DM200, and DM250.

Equipment/Assembly drawings

The inTank EC BWTS shall be installed in accordance with the documents listed below:

Description	Title	Dwg. No.	Doc. rev. & date
P&IDs of all modules	Appendix A of the OMSM: Piping and instrumentation diagram (P&ID)	16017-031	D, 2018-12-04
Bill of materials for all modules	Appendix B of the OMSM: Bill of Materials and Certificates	16017-011	D, 2018-10-16
General assembly drawings of all modules	Appendix C of the OMSM: General assembly drawings	16017-020	-, 2018-02-28
Electrical wiring diagrams, block diagrams, panel and device arrangement	Appendix D of the OMSM: Electrical wiring diagrams	16017-050	-, 2018-02-08
Guidelines to place nozzles in any ballast tank for effective disinfectant dispersion	inTank BWTS Nozzle placement guidelines	16017-101	-, 2018-02-08

Other equipment manufactured by

EC generator cell: Electrichlor Models EC1K, EC2K, and EC4K

Total treatment capacity

Up to 200,000 m³

Product description

Treatment sequence:

- Ballast water uptake: No treatment
- inTank treatment: Generation and injection of active substance by electrochlorination and in-tank circulation
- inTank neutralization: Injection of neutralization agent and in-tank circulation
- Ballast water discharge: No treatment

System design limitations / Water quality parameters

Temperature and Salinity

Ballast water salinity and temperature are not limiting conditions for the inTank EC BWTS.

System design limitations / Operational parameters

Feedwater to Electrochlorination module

The EC module is approved for use with feedwater temperatures of $0^{\circ}\text{C} < T \leq 35^{\circ}\text{C}$.

The EC module feedwater conductivity is not a limitation for the type approved system; the EC module is optimized for operation at $\geq 22\ 000\ \mu\text{S}/\text{cm}$. If feedwater conductivity is below the minimum, an alternative water source stored on board can be used, or the same source with low conductivity can be used, but the dosing will take longer.

Dosing and holding time

The target concentration time (CT) must be $\geq 120\ \text{mg}\cdot\text{hr}/\text{L}\ \text{TRO}$, within the boundaries in below table:

Ballast water salinity	Minimum hold time [hr]	Average target TRO concentration [mg/L]
$\geq 4\ \text{PSU}$	24-60	$\frac{120\ [\frac{\text{mg}\cdot\text{hr}}{\text{L}}\ \text{TRO}]}{\text{hold time [hr]}}$ Corresponds to 2-5 mg/L TRO
$< 4\ \text{PSU}$	24	$\frac{120\ [\frac{\text{mg}\cdot\text{hr}}{\text{L}}\ \text{TRO}]}{\text{hold time [hr]}}$ Corresponds to 5 mg/L TRO

The system is type approved with an initial dose setting of $1.25 \times$ target average TRO concentration.

The maximum allowable initial TRO is 8 mg/L.

TRO concentration at in-tank before discharge shall be $\leq 0.1\ \text{mg}/\text{L}$.

Treatment times and ballast volumes

The inTank EC BWTS modules are sized according to the vessel’s typical voyage time, and total volume of ballast water, as determined during the design phase of the installation. See the minimum Electrochlorination module capacity for possible combinations of total ballast volume and available treatment time in the table below. A single or combination of multiple EC modules may be selected to meet the capacity required to achieve the desired treatment time.

Minimum EC module capacity [kg/hr]														
	Available treatment time [hr]													
	36		48		72		96		120		144		168 ¹⁾	
Total ballast volume [m ³]	No. of main ballast water pipelines													
	2	1	2	1	2	1	2	1	2	1	2	1	2	1
5000	3	5	2	3	1	2	1	1	1	1	1	1	1	1
10000	7	10	4	6	3	4	2	2	1	2	1	2	1	1
15000	10	15	6	9	4	6	2	4	2	3	2	2	1	2
20000	13	20	8	11	5	8	3	5	2	4	2	3	2	3
25000	17	25	10	14	6	10	4	6	3	5	3	4	2	3
30000	20	30	12	17	8	11	5	7	4	5	3	5	3	4
35000	23	35	13	20	9	13	6	9	4	6	4	5	3	5
40000	27	40	15	23	10	15	7	10	5	7	4	6	3	5
45000	30	45	17	26	12	17	7	11	5	8	5	7	4	6
50000	33	50	19	29	13	19	8	12	6	9	5	8	4	6
55000	37	55	21	32	14	21	9	14	7	10	6	8	5	7
60000	40	60	23	34	15	23	10	15	7	11	6	9	5	8
65000	44	65	25	37	17	25	11	16	8	12	7	10	6	8
70000	47	70	27	40	18	27	12	17	8	13	7	11	6	9
75000	50	75	29	43	19	29	12	19	9	14	8	11	6	10
80000	54	80	31	46	20	31	13	20	10	14	8	12	7	10
85000	57	85	33	49	22	32	14	21	10	15	9	13	7	11
90000	60	90	35	52	23	34	15	22	11	16	9	14	8	12
95000	64	95	36	54	24	36	16	23	11	17	10	14	8	12
100000	67	100	38	57	26	38	17	25	12	18	10	15	9	13
105000	70	105	40	60	27	40	17	26	13	19	11	16	9	14
110000	74	110	42	63	28	42	18	27	13	20	11	17	9	14
115000	77	115	44	66	29	44	19	28	14	21	12	17	10	15
120000	80	120	46	69	31	46	20	30	14	22	12	18	10	15
125000	84	125	48	72	32	48	20	31	15	22	13	19	10	16
130000	87	130	50	74	33	49	21	32	15	23	13	20	11	16

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Minimum EC module capacity [kg/hr]														
	Available treatment time [hr]													
	36	48	72	96	120	144	168 ¹⁾							
Total ballast volume [m ³]	No. of main ballast water pipelines													
	2	1	2	1	2	1	2	1	2	1	2	1	2	1
135000	90	135	52	77	34	51	22	33	16	24	14	20	11	17
140000	94	140	54	80	35	53	23	34	16	25	14	21	12	18
145000	97	145	55	83	37	55	24	36	17	26	15	22	12	18
150000	100	150	57	86	38	57	24	37	18	27	15	22	12	19
155000	104	155	59	89	39	59	25	38	18	28	16	23	13	20
160000	107	160	61	91	40	61	26	39	19	28	16	24	13	20
165000	110	165	63	94	42	63	27	40	19	29	17	25	14	21
170000	114	170	65	97	43	64	28	42	20	30	17	25	14	21
175000	117	175	67	100	44	66	28	43	20	31	18	26	14	22
180000	120	180	69	103	45	68	29	44	21	32	18	27	15	23
185000	124	185	71	106	47	70	30	45	22	33	19	28	15	23
190000	127	190	72	108	48	72	31	46	22	34	19	28	16	24
195000	130	195	74	111	49	74	32	48	23	35	20	29	16	24
200000	134	200	76	114	50	76	32	49	23	35	20	30	16	25

1) Available treatment times longer than 168 hours are acceptable where hold time and average TRO concentration to achieve target CT are aligned with the ranges provided in this certificate.

Electrochlorination module capacity

The EC module is designed for the capacities in kg/hr below:

Module	TRO production capacity [kg/hr]	Electrolysis cell configuration
EC01	1	EC1K
EC02	2	EC2K
EC04	4	EC4K
EC08	8	EC4K x 2
EC12	12	EC4K x 3
EC16	16	EC4K x 4

Control and monitoring equipment

Software version

The Envirocleanse inTank EC BWTS is type approved with the system control software version vBeta 23A-16017-01.XX Any changes to the software are to be recorded as long as the system is in use on board. The records of all changes are to be forwarded to DNV GL for evaluation. 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 Envirocleanse inTank EC BWTS is type approved with the following instruments for monitoring the safe operation of the treatment system:

- EC module flow control valve (FCV-01)
- EC module flow indicator/transmitter (FIT-01)
- H₂ Gas detector (GD-02), in the H₂ de-gas line, arranged with independent shutdown functionality
- H₂ Gas detector (GD-02B), above de-gasser, arranged with independent shutdown functionality
- H₂ Gas detector (GD-02A), optional if GD-02B does not cover EC module space, arranged with independent shutdown functionality
- Low level switch (LSL-01 and LSL-01A) in EC cell, one switch per pair of EC module cells
- High level switch (LSH-02) in H₂ de-gas line
- Pressure switch (PS-01) in EC cell, one per EC module, arranged with independent shutdown functionality
- Pressure switch (PS-02) in H₂ dilution line
- Pressure transmitter (PT-01) in EC module feedwater

Electrical and electronic components

The Envirocleanse inTank EC BWTS is type approved with the electrical and electronic components (including the above listed instruments for monitoring safe operation of the treatment system) indicated on the P&IDs and specified in the Bill of Materials (Appendix A and B to the OMSM). Except for the components listed below, alternate models to the ones specified in 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.

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

Tag No.	Component name	Manufacturer	Model(s)
EC-01	EC module cell	Electrichlor	EC1K, EC2K, EC4K
XIT-07	Residual oxidant monitor – DPD	HF Scientific	CLX-Ex
CP1	Control Panel	Envirocleanse	CP1
RHMI	Remote HMI	Envirocleanse	RHMI

Hazardous area / Ex-proof

Some parts of the Envirocleanse inTank EC BWTS are designed for installation in a hazardous area. Dosing modules with the model number ending in "X" meet the requirements for use in hazardous area Zone 1 (when properly configured) in accordance with DNV GL rules Pt. 4 Ch. 8 Sec. 11.

Ex-certification is not covered by this certificate. 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.

Documents approval

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

- Power supply arrangement (including power supply to dilution blowers)
- Interface description towards ship's existing systems including alarms for failure, arrangement of tank valves and override functionality in case of emergency
- List of Ex equipment according to Pt. 4 Ch. 8 Sec.11 if the system is to be installed in hazardous Zone 1
- Piping and Instrumentation Diagram (P&ID)
- inTank EC BWTS Bill of materials
- Nozzle placement and sizing document
- Commissioning procedure

Type approval documentation

- Basic Approval, Report of the Marine Environmental Protection Committee, MEPC 71/17 dated 2017-07-24
- Final Approval, Report of the Marine Environmental Protection Committee, MEPC 73/19 dated 2018-10-26

System documentation

- Operation, Maintenance and Safety Manual, inTank Ballast Water Treatment System (OMSM), Electrochlorination (EC) and Bulk Chemical (BC), General Service and Explosion-Proof Versions, Enivorlceanse, File No. 16017-081, Rev. E, 4 December 2018
- inTank BWTS Nozzle Placement Guidance, Enivorlceanse, Doc. No. 16017-101, Rev. -, 2018-02-28
- inTank BWTS Scaling Appliances Document, Enivorlceanse, File No. 16017-110, Rev. -, 2018-02-28
- inTank BWTS Scaling Document, CFD Analysis, Enivorlceanse, File No. 16017-111, Rev. -, 2018-02-28
- inTank BWTS Functional Specification, Enivorlceanse, File No. 16017-061, Rev. B, 2018-06-26
- inTank BWTS Safety Assessment, Enivorlceanse, File No. 16017-071, Rev. -, 2018-02-28
- inTank BWTS Commissioning Test Procedure, Enivorlceanse, Doc. No. 16017-082, Rev. B, 2018-11-16
- inTank BWTS Installation Instructions, Enivorlceanse, Dwg. No. 16017-100, Rev. -, 2018-02-28

Test reports

- Final land-based ballast water management report according to USCG final rule – Envirocleanse inTank BWTS, Golden Bear Research Center, Rev. 1, 2018-12-12
- Final shipboard ballast water management report according to USCG final rule – Envirocleanse inTank BWTS, Golden Bear Research Center, Rev. -, 2018-07-10
- EMC and Environmental testing of selected parts of Envirocleanse, Applica Test & Certification, Report No. 21246, Rev. 2, 2018-08-30
- Mineral New York inTank BWTS Install Mixing Study Report, Glosten, Doc. 16017.12.01-11, Rev. -, 2018-02-13

Tests carried out

- Land-based testing using 2 kg TRO/hr capacity in accordance with Resolution MEPC.279(70)
- Shipboard testing using 2 kg TRO/hr capacity in accordance with Resolution MEPC.279(70)
- Type test of the control and automation system witnessed by DNV GL
- Testing in accordance with environmental test specification for instrumentation and automation equipment, DNV GL CG-0339 and Resolution MEPC.279(70)
- Scaling type test of the control and automation system using the 8 kg/hr EC module, witnessed by DNV GL
- Scaling test mixing capacity on board the bulk carrier, Mineral New York, using dosing module DM150G, witnessed by DNV GL

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, a 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 shall be carried on board a ship fitted with this ballast water management system, for inspection on board the ship. A reference to the test protocol and a copy of the test results should be available for inspection on board the vessel.

ANNEX 1 SUMMARY OF TESTING

Summary of land-based testing for the Envirocleanse inTank BWTS using the 2 kg TRO/hr capacity. Tests were performed with the electrochlorination (EC) and bulk chemical (BC) variations.

For the purposes of biological efficacy testing, the EC variation was deemed to be equivalent to, or more effective than the BC variation, and testing of the two variations was combined. A minimum of five tests per salinity were required for the BC variation, and a minimum of two additional tests per salinity were required for the EC variation. A minimum of two tests per holding time per salinity using either EC or BC were required to prove efficacy of each holding time.

Table 1 Land-based challenge water conditions in fresh, brackish, and marine water test cycles for the electrochlorination (EC) and bulk chemical (BC) variations of the Envirocleanse inTank BWTS, in 2017-2018 at the Golden Bear Research Center.

Test cycle	inTank variation	Salinity [PSU]	Temp [°C]	Highest residual TRO [mg/L]	DOC [mg/L]	POC [mg/L]	TSS [mg/L]	Holding time [hr]
Fresh water tests								
LLB23	BC	1.1	13.3	9.0	7.9	8.0	48.2	24.5
LLB24	EC	1.1	13.3	7.2	7.9	8.0	48.2	24.5
LLB25	BC	0.7	11.9	7.1	10.0	10.0	53.7	24.5
LLB26	BC	0.7	11.9	8.6	10.0	10.0	53.7	25.5
LLB27	EC	0.5	12.5	4.7	8.3	12.3	65.3	61.3
LLB29	BC	0.7	9.5	7.9	9.2	10.8	52.7	24.6
LLB30	BC	0.7	9.5	8.3	9.2	10.8	52.7	24.7
Brackish tests								
LLB5	BC	7.7	14.7	7.5	8.0	8.7	72.4	24.7
LLB6	BC	7.7	14.7	7.2	8.0	8.7	72.4	24.6
LLB14	EC	15.8	19.8	6.4	6.6	10.4	87.5	24.4
LLB15	BC	17.0	17.0	7.5	8.2	8.5	52.7	24.5
LLB16	EC	17.0	17.0	6.6	8.2	8.5	52.7	24.4
LLB21	BC	14.5	15.4	5.2	7.8	8.0	49.8	61.3
LLB22	BC	14.5	15.4	4.2	7.8	8.0	49.8	61.1
Marine tests								
LLB8	BC	24.2	19.8	6.6	6.6	9.4	50.1	27.2
LLB11	BC	22.9	21.4	6.6	5.5	7.8	52.6	24.5
LLB12	EC	22.9	21.4	6.5	5.5	7.8	52.6	24.4
LLB17	BC	25.7	15.1	7.9	8.4	9.7	57.4	24.9
LLB18	EC	25.7	15.1	6.6	8.4	9.7	57.4	24.4
LLB19	BC	27.0	15.5	4.2	7.6	9.0	65.6	61.2
LLB20	BC	27.0	15.5	4.3	7.6	9.0	65.6	61.1

Table 2 Summary of land-based test results for the Envirocleanse inTank BWTS: Average density of live organisms in inlet, treated, and control discharge waters. Live organisms in the ≥ 10 and $< 50 \mu\text{m}$ size group were quantified using CMFDA. All counts of pathogenic bacteria (*E. coli*, *Enterococci* and *Vibrio cholerae*) in the test cycles were below the ballast water discharge standard.

Test cycle	Organisms $\geq 50 \mu\text{m}$ [orgs/m ³]	Organisms ≥ 10 & $< 50 \mu\text{m}$ [orgs/mL]	Organisms $\geq 50 \mu\text{m}$ [orgs/m ³]		Organisms ≥ 10 - $< 50 \mu\text{m}$ [orgs/mL]	
	Inlet	Inlet	Treated	Control	Treated	Control
Fresh water tests						
LLB23	105253	3648	0.4	174546	6.0	2527
LLB24	105253	3648	0.5	174546	3.3	2527
LLB25	212323	1407	0.6	197374	0.3	983
LLB26	212323	1407	<0.3	197374	0.3	983
LLB27	94748	1260	4.7	74141	1.2	1040
LLB29	106667	1250	1.3	55354	1.0	1030
LLB30	106667	1250	0.3	55354	1.5	1030
Brackish tests						
LLB5	1836970	1628	0.4	1663030	0.7	1960
LLB6	1836970	1628	0.2	1663030	5.0	1960
LLB14	423030	3167	4.7	206465	4.3	1060
LLB15	172727	7533	0.8	61212	0.3	2590
LLB16	172727	7533	1.4	61212	0.7	2590
LLB21	109091	3237	0.7	67273	1.5	1357
LLB22	109091	3237	1.5	67273	1.8	1357
Marine tests						
LLB8	422626	4600	8.5	179293	2.2	782
LLB11	499394	1178	3.5	188283	2.3	592
LLB12	499394	1178	4.9	188283	1.8	592
LLB17	180808	1757	0.4	64242	2.8	1630
LLB18	180808	1757	0.6	64242	9.7	1630
LLB19	583030	3460	0.6	56389	3.3	1803
LLB20	583030	3460	0.4	56389	8.7	1803

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Table 3 Summary of shipboard test conditions and results for the (EC) and bulk chemical (BC) variations of the Envirocleanse inTank BWTS, 2017-2018 on board the USTS GOLDEN BEAR. All counts of pathogenic bacteria (*E. coli*, *Enterococci* and *Vibrio cholerae*) in the test cycles were below the ballast water discharge standard.

Test cycle	inTank variation	Test volume [m ³]	Highest residual TRO [mg/L]	Holding time [hr]	Salinity [PSU]	DOC [mg/L]	Temp. [°C]	Organisms ≥50 µm [orgs/m ³]		Organisms ≥10 - <50 µm [orgs/mL]	
								Inlet	Discharge	Inlet	Discharge
LSB1	BC	477	9.0	24.6	5.5	7.1	14.5	358207	2.1	553	0.2
LSB2	BC	244	7.4	23.2	0.3	4.0	17.4	268081	5.2	948	0.2
LSB3	BC	810	6.3	23.9	26.8	1.5	11.1	101010	1.7	441	1.8
LSB4	BC	440	6.1	24.5	6.3	2.7	19.7	322083	4.3	695	2.7
LSB5	EC	222	6.4	24.3	16.5	6.6	19.8	423030	4.7	3167	4.3