



THE REPUBLIC OF LIBERIA
LIBERIA MARITIME AUTHORITY

TYPE APPROVAL CERTIFICATE OF BALLAST WATER MANAGEMENT SYSTEM

This is to certify that the ballast water management system listed below has been examined and tested in accordance with the requirements of the specifications contained in the Guidelines contained in IMO resolution MEPC.174 (58) adopted on 10 October 2008. This certificate is valid only for the ballast water management system referred to below.

Ballast water management system supplied by..... Trojan Marinex, 3020 Gore Road, London, ON
Canada N5V 4T7

under type and model designation..... Trojan Marinex BWT™ 150, 250, 500, 750, 1000, 1250, 1500
and incorporating:

Ballast water management system manufactured by..... Trojan Marinex

to equipment/assembly drawing No.....MX0305 Date: 2016-07-13

Treatment Unit manufactured by..... Trojan Marinex

to components drawing No..... MX0399 (vertical inline) Date: 2016-05-19

to components drawing No MX0415 (Horizontal inline) Date: 2016-05-12

UV-sensor manufactured by..... IL Metronic Sensortechnik GmbH

Treatment rated capacity..... 150 - 1500 m³/hour

Active Substance..... N/A Relevant Chemical..... N/A

Whole Effluent Toxicity (WET) tests carried out in accordance with Resolution MEPC. 169(57) with negligible effect

A copy of this Type Approval Certificate should be carried on board vessels 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. This Type Approval Certificate is issued based on approval by the Norwegian Maritime Directorate with Type Approval Certificate No. TAP000001C/Rev.2

Limiting Conditions imposed and operating parameters are described in the Appendix to this document.

Official Stamp

Margaret Ansumana

Deputy Commissioner of Maritime Affairs
Republic of Liberia

Date of issue: 10 February 2017 Place of issue: Vienna, USA

Date of Expiry: 27 October 2020



Enc. This certificate consists of 8 pages, including the appendix and summary of the original test result

APPENDIX

Limiting Conditions for operation of the BWMS

Maximum treatment rated capacity (TRC) (per installed UV-Reactor).....	150 - 1500 m ³ /h
Measured Minimum UV Intensity	2.0 mW/cm ²
(Corresponding to a minimum UV transmittance of 44%)	
Salinity range.....	Fresh, Brackish and Marine Water
Temperature.....	minimum 0°C
Max system operating pressure.....	6 bar
Filter Backwash Trigger Setpoint.....	0.25 bar
Minimum holding time.....	Not Applicable
Maximum holding time.....	Not Applicable (UV treatment upon discharge)
Maximum Allowable Discharge Concentration (MADC) of (OH) radical.....	Not limited
Total Residual Oxidant Level	Not Applicable
Approved for use in explosive atmosphere	No
Installation on open deck	No

Summary of conditions during land and ship-based testing

Ballast water salinity range during land based tests.....	Tested in water salinity ranging from 0.4 PSU (fresh water) to 34.0 PSU (high salinity)
Ballast water salinity range during ship board tests.....	Tested in water salinity ranging from 16.5 PSU (low salinity) to 35.0 PSU (high salinity)
During the shipboard tests the water temperature ranged between.....	13.0°C – 18.0°C
During the land based tests the water temperature ranged between.....	3.4°C – 22.0°C
Ballast water dissolved organic compounds (DOC).....	8.3 mg/L (low salinity) to 6.0 mg/L (high salinity)
Ballast water particulate organic compounds (POC).....	5.5 mg/L (low salinity) to 7.9 mg/L (high salinity)
Ballast water total suspended solids (TSS).....	74 mg/L (low salinity) to 42 mg/L (high salinity)
Minimum holding time.....	Not Applicable
Maximum Allowable Discharge Concentration (MADC) of (OH) radical.....	Not limited
((OH) radical dissipates immediately upon leaving the AOT Reactor.)	
Minimum UV transmittance	44%
Minimum UV measured Intensity	2.0 mW/ m ²
Means to account for changes in UV-transmittance.....	UV intensity sensor mounted in UV- reactor
Information on reduced flow rates	Flow rates are controlled by changes in intensity value
Total Residual Oxidant Level	Not Applicable
Maximum treatment rated capacity (TRC).....	150 - 1500 m ³ /h
Flow rates during land-based testing averaged.....	500 m ³ /h
Flow rates during shipboard testing averaged.....	250 m ³ /h
(Maximum treatment rated capacity based upon mathematical modeling of the Treatment Unit dose for 500 m ³ /h)	

Operating Parameters during ship-based testing

Operating UV Intensity at	8.5-10 mW/cm ² (79% UVT – 91% UVT)
Energy consumption at 250 m ³ /hour.....	12.68 KW

The system is to be operated according to the manual provided by the manufacturer.

A plate or durable label containing the manufacturer's name, the type, the serial number, the date of manufacture and the treatment rated capacity must be attached to each system.

Summary of Land Based Test Results

For Ballast Water Management System, Type.....

Trojan Marinex BWT™ 150 - 1500

Manufactured by.....

Trojan Marinex, 3020 Gore Road, London, ON Canada N5V 4T7

Organization conducting the test.....

DHI Environmental Laboratory, Denmark

The test results of the tested Ballast Water Management System are valid for the System that is given type approval with this document.

Notes:

At marine salinity, seven; at brackish salinity, eight; and at fresh salinity, five independent experiments were carried out. A reference and a treated sample were taken with a minimum of 200 m³ at each sampling time. Samples were taken as triplicates.

The water temperature averaged 12 °C over the period of land based tests.

High salinity test results (> 32 PSU):

Organism Type	Influent Water	IMO req.	Discharge control	IMO req.	Discharge treated	IMO req.
>50 um (/m ³)	Average 298870 Min. 204418	≥ 100 000	Average 20168 Min. 9568	> 100	Average 1.0 Max. 2.3	< 10
Phyla > 50 um	8	≥ 3 different	-	-		-
Species > 50 µm	14	≥ 5 different	-	-		-
10-50 µm (/ml)	Average 10200 Min. 4767	> 1000	Average 478 Min. 240	> 100	Average 0.25 Min. 0.35	< 10
Phyla 10-50 µm	4	≥ 3 different	-	-		
Species 10-50 µm	9	≥ 5 different	-	-		
Hetero. Bact./ml	Average 55546 Min. 31667	≥10 000	Average 16040 Min. 2000	-	-	-
Escherichia Coli (cfu/100 ml)	Average <10	-	-	-	Average <10 Max. <10	<250
Vibrio cholerae (cfu /100 ml)	-	-	-	-	-	< 1
Enterococcus group (cfu/100 ml)	Average >2420	-	-	-	Average <1 Max. 1.7	< 100
Temperature ° C	Average 4.3	-	-	-		-
Salinity (PSU)	Average 34 Min. 33	>32	-	-	-	-
POC (mg/L)	Average 8.7 Min 7.9	> 1	-	-	-	-
DOC (mg/L)	Average 6.8 Min.5.6	> 1	-	-	-	-
TSS (mg/L)	Average 46 Min. 42	> 1	-	-	-	-

Low salinity test results (3-32 PSU):

Organism Type	Influent Water	IMO req.	Discharge control	IMO req.	Discharge treated	IMO req.
>50 μm (/m ³)	Average 459041 Min. 233601	$\geq 100,000$	Average 83168 Min. 47288	> 100	Average 3.2 Max 5	< 10
Phyla > 50 μm	Average 7.5 Min. 7	≥ 3 different	-	-	-	-
Species > 50 μm	Average 19 Min. 14	≥ 5 different	-	-	-	-
10-50 μm (/ml)	Average 8341 Min 2400	> 1000	Average 8341 Min. 452	> 100	Average 1.1 Max 4	< 10
Phyla 10-50 μm	Average 3 Min.3	≥ 3 different	-	-	-	-
Species 10-50 μm	Average 10.5 Min. 7	≥ 5 different	-	-	-	-
Hetero. bact./ml	Average 342658 Min.32883	$\geq 10,000$	Average 188042 Min. 152167	-	-	-
Escherichia Coli (cfu/100 ml)	Average 116	-	-	-	Average <10 Max.<10	< 250
Vibrio cholerae (cfu /100 ml)	-	-	-	-	-	< 1
Enterococcus group (cfu/100 ml)	Average 148	-	-	-	Average <1 Max. 1.2	< 100
Temperature ⁰ C	Average 15.7	-	-	-	-	-
Salinity (PSU)	Average 18 Min 17	3-32	-	-	-	-
POC (mg/L)	Average 6.2 Min. 5.5	> 5	-	-	-	-
DOC (mg/L)	Average 6.9 Min. 6	> 5	-	-	-	-
TSS (mg/L)	Average 61 Min. 57	> 50	-	-	-	-

Fresh water test results (<3 PSU):

Organism Type	Influent Water	IMO req.	Discharge control	IMO req.	Discharge treated	IMO req.
>50 um (/m ³)	Average 342823 Min. 233983	≥ 100,000	Average 177662 Min. 136133	> 100	Average 1.7 Max 6.7	< 10
Phyla > 50 um	Average 3 Min. 3	≥ 3 different	-	-	-	-
Species > 50 μm	Average 9 Min. 8	≥ 5 different	-	-	-	-
10-50 μm (/ml)	Average 9365 Min 7300	> 1000	Average 1459 Min. 1247	> 100	Average 2.8 Max 9.6	< 10
Phyla 10-50 μm	Average 3 Min. 3	≥ 3 different	-	-	-	-
Species 10-50 μm	Average 20.8 Min. 16	≥ 5 different	-	-	-	-
Hetero. bact./ml	Average 45779 Min. 25700	≥10,000	Average 42646 Min. 29333	-	-	-
Escherichia Coli (cfu/100 ml)	Average 18.6	-	-	-	Average <10 Max. <10	< 250
Vibrio cholerae (cfu /100 ml)	-	-	-	-	-	< 1
Enterococcus group (cfu/100 ml)	Average 2420	-	-	-	Average <1 Max. <1	< 100
Temperature ° C	Average 13.5	-	-	-	-	-
Salinity (PSU)	Average 0.4 Min 0.4	< 3	-	-	-	-
POC (mg/L)	Average 6 Min. 5.7	> 5	-	-	-	-
DOC (mg/L)	Average 8.1 Min. 8	> 5	-	-	-	-
TSS (mg/L)	Average 59 Min. 56	> 50	-	-	-	-

Reference Methods:

Parameters	Reference Method
Heterotrophic Bacteria (counts/mL)	In accordance with ETV Protocol
Escherichia coli (cfu/100mL)	In accordance with ETV Protocol
Enterococci (cfu/100 mL)	In accordance with ETV Protocol
Vibrio cholerae (cfu /100 ml)	In accordance with ETV Protocol
Organisms $\geq 10 < 50$ μm (viable cells/mL)	Algal Re-growth (MPN) + Motile heterotrophs
Organisms ≥ 50 μm (viable organisms/m ³)	In accordance with ETV Protocol

Summary of Ship Based Test Results (Most Probable Number (MPN) methodology)

Organization conducting the test..... Golden Bear Test Facility, USA
 Tests were conducted on board the vessel..... "M/V GOLDEN BEAR", IMO Nr. 8834407
 Time of testing..... March' 2012– March' 2013
 Maritime Area of testing..... San Francisco Bay area

Test 1

Organism Type	Influent Water	IMO req.	Discharge control	IMO req.	Discharge treated	IMO req.
> 50 µm (/m3)	66513	> 90	32168	> 9	1.6	<10
10-50 µm (/ml)	320	> 90	57	>9	.055	<10
Escherichia coli (cfu /100 ml)	0.22	-	0	-	ND	<250
Vibrio cholerae (cfu /100 ml)	-	-	-	-	ND	<1
Enterococcus group (cfu /100 ml)	181.4	-	109.4	-	0.13	<100
Temperature (°C)	13	-	14	-	14	-
Salinity (PSU)	29	-	29	-	29	-
POC (mg/l)	0.84	-	0.37	-	0.47	-
TSS [mg/l]	59	-	48	-	48	-

ND- Not Determined

Test 2

Organism Type	Influent Water	IMO req.	Discharge control	IMO req.	Discharge treated	IMO req.
> 50 µm (/m3)	82849	>90	49290	>9	0	<10
10-50 µm (/ml)	1233	> 90	367	>9	0.06	<10
Escherichia coli (cfu /100 ml)		-	0.33	-	ND	<250
Vibrio cholerae (cfu /100 ml)	-	-	-	-	ND	<1
Enterococcus group (cfu /100 ml)	-	-	16.8	-	ND	<100
Temperature (°C)	14	-	18	-	18	-
Salinity (PSU)	16.37 –30.5	-	31	-	29	-
POC (mg/l)	0.45	-	0.55	-	0.47	-
TSS [mg/l]	32.5	-	17.4	-	14.7	-

ND – Not Determined

Test 3

Organism Type	Influent Water	IMO req.	Discharge control	IMO req.	Discharge treated	IMO req.
> 50 µm (/m3)	47659	>90	22826	>9	2	<10
10-50 µm (/ml)	100	> 90	12	>9	0.06	<10
Escherichia coli (cfu /100 ml)	0.67	-	0.33	-	ND	<250
Vibrio cholerae (cfu /100 ml)	-	-	-	-	ND	<1
Enterococcus group (cfu /100 ml)	200.5	-	200.5	-	1	<100
Temperature (°C)	14.5	-	15.7	-	15.7	-
Salinity (PSU)	29	-	28	-	28	-
POC (mg/l)	0.59	-	0.3	-	0.3	-
TSS [mg/l]	40.6	-	39.4	-	39.4	-

ND- Not Determined

Official Stamp



M. Ansumana

Margaret Ansumana

Deputy Commissioner of Maritime Affairs

Republic of Liberia

Date of issue: 10 February 2017 Place of issue: Vienna, USA