



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..... Samkun Century Co., Ltd, SPOREX B/D 8F, Hwamyeong-dong, Buk-gu, Geumgok-daero 258 beon-gil, Republic of Korea

under type and model designation..... ARA Plasma BWTS ARA-063

and incorporating:

Ballast water management system manufactured by..... Samkun Century Co., Ltd

to equipment/assembly drawing No..... ARA-063N-00-MG0000 date..... 2013-03-11

Plasma Module manufactured by..... Samkun Century Co., Ltd.

to components drawing No..... ARA-063N-PL-MG0000 date..... 2013-03-11

MPUV Reactor manufactured by..... Samkun Century Co., Ltd.

to components drawing No..... ARA-063N-UV-MG0000 date..... 2013-03-11

Filtration system manufactured by..... Samkun Century Co., Ltd.

To components drawing No..... ARA-063N-FM-MG0000 date..... 2013-03-11

Treatment rated capacity..... 550 m³/h

Active Substance..... Photon

Relevant Chemical..... Chlorobenzene, Bromobenzene, 4-Chlorotoluene

Final approval granted by IMO for systems using active substances MEPC 61/2/15 Annex 8, para 8.4

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 Ministry of land, Transport and Maritime Affairs, Republic of Korea with Type Approval Certificate No. 2012-10.

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



Margaret Ansumana

Deputy Commissioner of Maritime Affairs

Republic of Liberia

Date of issue: 10/31/2014 Place of issue: Vienna, USA

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Enc. This certificate consists of 7 pages, including the appendix and summary of the original test results

APPENDIX I

Limiting Conditions for operation of the BWMS

Maximum treatment rated capacity (TRC).....	550 m ³ /h
Measured Minimum UV Dose	250 mJ/cm ²
(Corresponding to a minimum UV transmittance of 75%)	
Salinity range.....	Brackish and Marine Water
Temperature.....	minimum 0°C
Max system operating pressure.....	6.6 Bar
Max differential pressure across filter	1.6 Bar
Min Plasma Module power level	1.2 kW
Minimum holding time.....	Not Applicable
Maximum Allowable Discharge Concentration (MADC) of relevant chemicals.....	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 22.0 PSU (low salinity) to 34.0 PSU (high salinity)
Ballast water salinity range during ship board tests.....	Tested in water salinity ranging from 31.0 PSU (low salinity) to 34.0 PSU (high salinity)
During the shipboard tests the water temperature ranged between.....	12.0°C – 29.0°C
During the land based tests the water temperature ranged between.....	3.0°C – 16.0°C
Ballast water dissolved organic compounds (DOC).....	9.0 mg/L (low salinity) to 1.6 mg/L (high salinity)
Ballast water particulate organic compounds (POC).....	16.5 mg/L (low salinity) to 1.2 mg/L (high salinity)
Ballast water total suspended solids (TSS).....	52.0 mg/L (low salinity) to 23.0 mg/L (high salinity)
Minimum holding time.....	Not Applicable
Maximum Allowable Discharge Concentration (MADC) of relevant chemicals.....	Not limited
(All relevant chemicals met the NOEC criterion of <0.01 mg/L)	
Minimum UV transmittance	75%
Minimum UV measured Dose	250 mJ/cm ²
Means to account for changes in UV-transmittance.....	UV intensity sensor mounted in MPUV 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).....	550 m ³ /h
Flow rates during land-based testing averaged.....	250 m ³ /h
Flow rates during shipboard testing averaged.....	250 m ³ /h
(Maximum treatment rated capacity based upon mathematical modeling of MPUV Reactor dose from 250 m ³ /h to 550 m ³ /h)	

Operating Parameters during ship-based testing

Operating UV Dose at 90 % UVT.....	300 mJ/cm ²
Energy consumption at 250 m ³ /hour.....	28-33 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.....ARA Plasma BWTS ARA-063

Manufactured by..... Samkun Century Co., Ltd

Organization conducting the test..... Korea Marine Equipment Research Institute, Republic of Korea

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 high salinity, seven and at low salinity, seven 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.

High salinity test results (> 32 PSU):

Organism Type	Influent Water	IMO req.	Discharge control	IMO req.	Discharge treated	IMO req.
>50 um (/m ³)	128,000 ~ 509,100	≥ 100 000	8,000 ~ 154,500	> 90	0 ~ 8	< 10
Phyla > 50 um	Min. 3 different	≥ 3 different		-		-
Species > 50 μm	Min. 6 different	≥ 5 different		-		-
10-50 μm (/ml)	1,483 ~ 3,077	> 1000	104 ~ 1828	> 90	0 ~ 8	< 10
Phyla 10-50 μm	Min. 3 different	≥ 3 different		-		
Species 10-50 μm	Min. 7 different	≥ 5different		-		
Hetero. Bact./ml	9,409 ~ 32,500	≥10 000	15,318~46,863	-	3~310	-
Escherichia Coli (cfu/100 ml)	0~10	-	0~1	-	0	<250
Vibrio cholerae (cfu /100 ml)	0	-	0	-	0	< 1
Enterococcus group (cfu/100 ml)	0	-	10~192	-	0	< 100
Temperature (°C)	11.07~16.71	-	8.17~16.73	-	7.94~16.90	-
Salinity (PSU)	34.09~34.57	>32	33.83~34.47	-	34.14~34.70	-
POC (mg/L)	1.22 ~ 2.25	> 1	0.10~1.99	-	0.13~2.16	-
DOC (mg/L)	1.67 ~ 2.85	> 1	1.73~2.15	-	2.11~2.55	-
TSS (mg/L)	23.30~34.10	> 1	14.10~30.40	-	8.90~34.70	-

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)	301,000~436,500	$\geq 100,000$	4,917~63,000	> 90	0~1	< 10
Phyla > 50 μm	Min. 3 different	≥ 3 different		-		-
Species > 50 μm	Min. 5 different	≥ 5 different		-		-
10-50 μm (/ml)	1,358~3,132	> 1000	550~1828	> 90	1~8	< 10
Phyla 10-50 μm	Min. 3 different	≥ 3 different		-		-
Species 10-50 μm	Min. 3 different	≥ 5 different		-		-
Hetero. Bact./ml	11,954~20,227	$\geq 10,000$	16,545~93,818	-	7~320	-
Escherichia Coli (cfu/100 ml)	0~2	-	0~1	-	0	< 250
Vibrio cholerae (cfu /100 ml)	0	-	0	-	0	< 1
Enterococcus group (cfu/100 ml)	0	-	1~361	-	0	< 100
Temperature (°C)	4.62~10.00	-	2.97~8.88	-	3.02~9.18	-
Salinity (PSU)	22.09~23.62	3-32	22.01~23.57	-	22.13~23.53	-
POC (mg/L)	13.70~16.50	> 5	0.57~9.23	-	1.31~7.30	-
DOC (mg/L)	9.13~10.3	> 5	2.48~5.40	-	2.47~5.25	-
TSS (mg/L)	51.30~61.60	> 50	14.00~37.30	-	11.10~33.70	-

Reference Methods:

Parameters	Reference Method
Heterotrophic Bacteria (counts/mL)	APHA Standard Method 9215
Escherichia coli (cfu/100mL)	US EPA 1603:2009
Enterococci (cfu/100 mL)	US EPA 1600:2009
Vibrio cholerae (cfu /100 ml)	HA Standard Method 9260 H
Organisms $\geq 10 < 50 \mu\text{m}$ (viable cells/mL)	Anja et al. (2005) ^d APHA Standard Method 10200 C Manual and Guide, UNESCO (2005) UNESCO 4 (2003) US EPA 445.0:1997
Organisms $\geq 50 \mu\text{m}$ (viable organisms/m ³)	Fleming & Coughlan (1978) ^b US EPA 600/R-10/146 (2010) ^c APHA Standard Method 10200 C

a Standard Methods. 2005. In: A.D Eaton, L.S Clesceri, E.W Rice, A.E Greenberg (eds), *Standard Methods for the Examination of Water and Wastewater*. Baltimore, Maryland. APHA, AWWA and WEF.

b Fleming, J.M., Coughlan, J. 1978. Preservation of vitally stained zooplankton for live/dead sorting. *Estuaries* (1) 135-137.

c US EPA 600/R-10/146. 2010. Protocol for the Verification of Ballast Water Treatment Technologies. Section 5.4.6.4. p45.

d Anja S, T. Cheryl, S. James, S. Kristin. 2005. Application of Alamar blue/5-carboxyfluorescein diacetate acetoxymethyl ester as a noninvasive cell viability assay in primary hepatocytes from rainbow trout. *Analytical Biochemistry*. (344) 76-85.

Summary of Ship Based Test Results

Organization conducting the test..... Korea Marine Equipment Research Institute, Republic of Korea

Tests were conducted on board the vessel..... "M/V "TY GLORIA",IMO Nr. 9472050

Time of testing..... 12 August 2011 – 18 March 2013

Maritime Area of testing..... Saganoseki, Fukuyama, Dalian, Hong Kong, Gwangyang

Test 1

Organism Type	Influent Water	IMO req.	Discharge control	IMO req.	Discharge treated	IMO req.
> 50 µm (/m3)	21,844~39,800	> 90	875~3,634	> 9	2~7	<10
10-50 µm (/ml)	116~140	> 90	14~15	>9	0	<10
Escherichia coli (cfu /100 ml)	73~113	-	-	-	0~2	<250
Vibrio cholerae (cfu /100 ml)	0	-	-	-	0	<1
Enterococcus group (cfu /100 ml)	0	-	-	-	0	<100
Temperature (°C)	8.42~8.48	-	28.84~28.90	-	28.75~29.04	-
Salinity (PSU)	24.89~25.91	-	33.99~34.01	-	33.44~33.50	-
POC (mg/l)	0.14	-	-	-	-	-
TSS (mg/l)	10.50	-	-	-	-	-

Test 2

Organism Type	Influent Water	IMO req.	Discharge control	IMO req.	Discharge treated	IMO req.
> 50 µm (/m3)	25,850~29.650	>90	14,250~15~750	>9	0~2	<10
10-50 µm (/ml)	133~185	> 90	19~24	>9	0	<10
Escherichia coli (cfu /100 ml)	TNTC	-	-	-	0	<250
Vibrio cholerae (cfu /100 ml)	0	-	-	-	0	<1
Enterococcus group (cfu /100 ml)	TNTC	-	-	-	0	<100
Temperature (°C)	25.66~25.91	-	12.02~12.83	-	12.25~12.59	-
Salinity (PSU)	33.63~33.72	-	31.17~31.25	-	30.42~31.09	-
POC (mg/l)	0.03	-	-	-	-	-
TSS (mg/l)	9.20	-	-	-	-	-

TNTC, Too Numerous To Count

Test 3

Organism Type	Influent Water	IMO req.	Discharge control	IMO req.	Discharge treated	IMO req.
> 50 μm (/m ³)	1,820~2,114	>90	1,647~1,720	>9	0~1	<10
10-50 μm (/ml)	111~150	> 90	20~36	>9	0~1	<10
Escherichia coli (cfu /100 ml)	22~41	-	-	-	0	<250
Vibrio cholerae (cfu /100 ml)	0	-	-	-	0	<1
Enterococcus group (cfu /100 ml)	5~12	-	-	-	0	<100
Temperature (°C)	17.06~17.18	-	12.34~12.52	-	12.07~12.31	-
Salinity (PSU)	32.97~33.26	-	32.94~33.11	-	33.14~33.24	-
POC (mg/l)	0.06	-	-	-	-	-
TSS (mg/l)	12.40	-	-	-	-	-

Official Stamp



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