



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..... Hyde Marine Inc., 2000 McClaren Woods Drive, Coraopolis, Pennsylvania 15108, USA

under type and model designation..... Hyde GUARDIAN® Ballast Water Management System, Model: HG450

and incorporating:

Ballast water treatment system manufactured by..... Hyde Marine Inc.
to equipment/assembly drawing No.....G900307 date..... 06 June 2012

UV disinfection system manufactured by.....Hyde Marine Inc.
to components drawing No.....G900307 date..... 06 June 2012

Filtration system manufactured by..... Arkal Filtration System
To components drawing No.....G200096 date..... 12 April 2012

Treatment rated capacity..... .450 m³/h

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

A copy of this Type Approval Certificate should be carried on board vessels with IMO numbers:

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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 Lloyd's Register as delegated by the Administration of the United Kingdom (Maritime Coastguard Agency) with Type Approval Certificate No. MCA0900032/M2.

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: 03/18/2013 Place of issue: Vienna, USA

Date of Expiry: 03/17/2018

Enc. This certificate consists of 6 pages, including the appendix and summary of the original test results

APPENDIX I

Limiting Conditions

Ballast water salinity range.....Tested in water salinity ranging from 22.1 PSU (low salinity) to 31.9 PSU (high salinity)

During the shipboard tests the water temperature ranged between.....12.1°C – 29.0°C

The water temperature ranged between 8.4°C (high salinity) and between 17.5°C (low salinity) over the period of land based tests.

Ballast water dissolved organic compounds (DOC)..... 4.0 mg/L (high salinity) to 5.82 mg/L (low salinity)

Ballast water particulate organic compounds (POC).....10.2 mg/L (high salinity) to 16.1 mg/L (low salinity)

Ballast water total suspended solids (TSS).....33.9 mg/L (high salinity) to 42.5 mg/L (low salinity)

Minimum holding time.....Not Applicable

Maximum Allowable Discharge Concentration (MADC) of (OH) radical.....Not limited
(OH) radical dissipates immediately upon leaving the UV chamber.

Minimum UV Measured Intensity.....70%

Means to account for changes in UV-transmittanceUV intensity sensor mounted in UV chamber

Information on reduced flow ratesNot applicable

Total Residual Oxidant LevelNot applicable

Maximum treatment rated capacity (TRC).....450 m³/h

(Maximum treatment rated capacity based upon mathematical modeling of UV chamber dose from 300 m³/h to 450 m³/h)

Flow rates during land-based testing ranged from.....250 - 300 m³/h

Flow rates during shipboard testing ranged from 225 to 250 m³/h

Approved for use in explosive atmosphereYes

Conditions for use in explosive atmosphere:

1. Installed with purge system with parameters to be complied with;
2. Skin temperature sensor installed and operated to shut down at 80°C;
3. Intrinsically safe wiring provided;
4. Electrical bonding must be provided;
5. Pumps, UV vessel and all valves, sensors, switches, solenoids are designed for installation in hazardous location;
6. Booster pump supplied with an explosion electric or hydraulic motor

Installation on open deckNo

Operating Parameters during land-based and ship-based testing

Operating Mass Average UV dosage @ 90UVT.....200 mJ/cm²

Energy consumption at 450 m³/hour.....42-50 KW

Current 70 Amperes

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..... Hyde GUARDIAN® Ballast Water Management System, Model: HG450

Manufactured by..... Hyde Marine Inc., 2000 McClaren Woods Drive, Coraopolis, Pennsylvania 15108, USA

Organization conducting the test National Oceanographic Institute of the Netherlands (NIOZ)

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, five and at low 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 ranged between 8.4°C (high salinity) and between 17.5°C (low salinity) 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 µm (/m ³)	1.78E+05	≥ 100 000	1.54E+04	> 90	2.4	< 10
Phyla > 50 µm	10 different	≥ 3 different		-		-
Species > 50 µm	32 different	≥ 5 different		-		-
10-50 µm (/ml)	1,512	> 1000	1245	> 90	1	< 10
Phyla 10-50 µm	38 different	≥ 3 different		-		
Species 10-50 µm	40 different	≥ 5 different		-		
Hetero. bact./ml	3.80E+06	≥10 000	5.70E+06	-	6.40E+05	-
Escherichia Coli (cfu/100 ml)	<0.1	-	<0.1	-	<0.1	< 250
Vibrio cholerae (cfu /100 ml)	ND	-	ND	-	ND	< 1
Enterococcus group (cfu/100 ml)	8.3	-	<1	-	<1	< 100
Temperature ° C	14.3 – 17.5	-		-		-
Salinity (PSU)	31.9	>32		-		-
POC (mg/L)	10.2	> 1	4.8	-	4.5	-
DOC (mg/L)	4	> 1	3.3	-	4.1	-
TSS (mg/L)	33.9	> 1	9.7	-	10.0	-

ND: Not Detected

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)	2.55E+06	$\geq 100\ 000$	3.95E+03	> 90	2.9	< 10
Phyla > 50 μm	10 different	≥ 3 different		-		-
Species > 50 μm	32 different	≥ 5 different		-		-
10-50 μm (/ml)	1,534	> 1000	522	> 90	2.3	< 10
Phyla 10-50 μm	38 different	≥ 3 different		-		
Species 10-50 μm	40 different	≥ 5 different		-		
Hetero. bact./ml	3.90E+06	$\geq 10\ 000$	5.10E+06	-	3.00E+05	-
Escherichia Coli (cfu/100 ml)	<0.1	-	<1	-	<0.1	< 250
Vibrio cholerae (cfu /100 ml)	ND	-	ND	-	ND	< 1
Enterococcus group (cfu/100 ml)	<0.1	-	<1	-	<1	< 100
Temperature °C	8.5-10.4	-		-		-
Salinity (PSU)	22.1	3-32		-		-
POC (mg/L)	16.1	> 5	5.4	-	2.63	-
DOC (mg/L)	5.82	> 5	3.03	-	3.36	-
TSS (mg/L)	42.5	> 50	9.6	-	11.1	-

Reference Methods:

Parameters	Reference Method
Heterotrophic Bacteria (counts/mL)	Total bacteria counts made through flow cytometry, using DNA-specific stains to get more accurate number. Standard plating method used to determine number of colony forming units according to NEN-EN-ISO 6222:1999)
Escherichia coli (cfu/100mL)	Plating analysis in accordance with NEN-EN-ISO 9308-1.
Enterococci (cfu/100 mL)	Plating analysis in accordance with NEN-EN-ISO 7899-2.
Vibrio cholerae (cfu /100 ml)	Plating analysis in accordance with NEN-EN-ISO 9308-1.
Organisms $\geq 10 < 50 \mu\text{m}$ (viable cells/mL)	Samples pre-concentrated with 10 μm mesh net using the 50 μm prefiltered sample. Sample analysis conducted by staining and measurement of PAM fluorometry as a bulk parameter. Flow cytometry used to obtain total organism counts. Direct microscopic count at 200X magnification on samples fixed in Lugols solution made for enumeration of stained organisms for viability measurement.
Organisms $\geq 50 \mu\text{m}$ (viable organisms/m ³)	No preservations; samples pre-concentrated with 50 μm mesh net and stained with Neutral Red vitality stain and enumerate through direct

SUMMARY OF SHIP BASED TEST RESULTS

Organization conducting the test..... Chesapeake Biological Laboratory, Solomons, Maryland 20688, USA

Tests were conducted on board the vessel.....“M/V Coral Princess”, IMO Nr. 9229659

Time of testing.....05.04.2008 – 06.10.2008

Maritime Area of testing..... Caribbean Sea/Western Pacific Ocean

Test 1

Organism Type	Influent Water	IMO req.	Discharge control	Imo req	Discharge treated	IMO req.
> 50 µm (/m3)	453	> 90	494	> 9	0	<10
10-50 µm (/ml)	6.5	> 90	0.133	> 9	0.006	<10
Escherichia coli (cfu /100 ml)	1	-	ND	-	ND	<250
Vibrio cholerae (cfu /100 ml)	ND	-	ND	-	ND	<1
Enterococcus group (cfu /100 ml)	ND	-	ND	-	ND	<100
Temperature (°C)	25.2-29.0	-		-		
Salinity (PSU)	36.4 – 37.1	-		-		-
POC (mg/l)	2.79	-		-		-
TSS [mg/l]	4.36	-		-		

Test 2

Organism Type	Influent Water	IMO req.	Discharge control	Imo req	Discharge treated	IMO req.
> 50 µm (/m3)	15373	> 90	337	> 9	0	<10
10-50 µm (/ml)	9.73	> 90	2.9	> 9	0.19	<10
Escherichia coli (cfu /100 ml)	ND	-	ND	-	ND	<250
Vibrio cholerae (cfu /100 ml)	ND	-	ND	-	ND	<1
Enterococcus group (cfu /100 ml)	ND	-	1.6	-	3.4	<100
Temperature (°C)	12.1-14.0	-		-		
Salinity (PSU)	30.8-31.9	-		-		-
POC (mg/l)	4.97	-		-		-
TSS [mg/l]	6.943	-		-		

Test 3

Organism Type	Influent Water	IMO req.	Discharge control	Imo req	Discharge treated	IMO req.
> 50 µm (/m3)	1,391	> 90	16	> 9	ND	<10
10-50 µm (/ml)	6.5	> 90	2.82	> 9	0.61	<10
Escherichia coli (cfu /100 ml)	ND	-	5	-	ND	<250
Vibrio cholerae (cfu /100 ml)	ND	-	ND	-	ND	<1
Enterococcus group (cfu /100 ml)	ND	-	3	-	ND	<100
Temperature (°C)	23.7-24.3	-		-		
Salinity (PSU)	33.3	-		-		-
POC (mg/l)	2.84	-		-		-
TSS [mg/l]	14.64	-		-		

Official Stamp



Margaret Ansumana

Deputy Commissioner of Maritime Affairs
 Republic of Liberia

Date of issue: 03/18/2013 Place of issue: Vienna, USA



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Ballast water management system supplied by..... Hyde Marine Inc., 2000 McClaren Woods Drive, Coraopolis, Pennsylvania 15108, USA

under type and model designation..... Hyde GUARDIAN® Ballast Water Management System, Model: HG2500X

and incorporating:

Ballast water treatment system manufactured by..... Hyde Marine Inc.

to equipment/assembly drawing No.....G900314 date..... 20 June 2012

UV disinfection system manufactured by.....Hyde Marine Inc.

to components drawing No.....G900314 date..... 20 June 2012

Filtration system manufactured by..... Arkal Filtration System

To components drawing No..... G200060 and G200061 date..... 07 October 2010

Treatment rated capacity.....2500 m³/h

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

A copy of this Type Approval Certificate should be carried on board vessels with IMO numbers:

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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 Lloyd's Register as delegated by the Administration of the United Kingdom (Maritime Coastguard Agency) with Type Approval Certificate No. MCA0900032/M2.

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

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APPENDIX I

Limiting Conditions

Ballast water salinity range.....Tested in water salinity ranging from 22.1 PSU (low salinity) to 31.9 PSU (high salinity)

During the shipboard tests the water temperature ranged between.....12.1°C – 29.0°C

The water temperature ranged between 8.4°C (high salinity) and between 17.5°C (low salinity) over the period of land based tests.

Ballast water dissolved organic compounds (DOC)..... 4.0 mg/L (high salinity) to 5.82 mg/L (low salinity)

Ballast water particulate organic compounds (POC).....10.2 mg/L (high salinity) to 16.1 mg/L (low salinity)

Ballast water total suspended solids (TSS).....33.9 mg/L (high salinity) to 42.5 mg/L (low salinity)

Minimum holding time.....Not Applicable

Maximum Allowable Discharge Concentration (MADC) of (OH) radical.....Not limited

(OH) radical dissipates immediately upon leaving the UV chamber.

Minimum UV Measured Intensity..... 70%

Means to account for changes in UV-transmittanceUV intensity sensor mounted in UV chamber

Information on reduced flow ratesNot applicable

Total Residual Oxidant LevelNot applicable

Maximum treatment rated capacity (TRC).....2500 m³/h

(Maximum treatment rated capacity based upon mathematical modeling of UV chamber dose from 300 m³/h to 2500 m³/h)

Flow rates during land-based testing ranged from.....250 - 300 m³/h

Flow rates during shipboard testing ranged from 225 to 250 m³/h

Approved for use in explosive atmosphereYes

Conditions for use in explosive atmosphere:

1. Installed with purge system with parameters to be complied with;
2. Skin temperature sensor installed and operated to shut down at 80°C;
3. Intrinsically safe wiring provided;
4. Electrical bonding must be provided;
5. Pumps, UV vessel and all valves, sensors, switches, solenoids are designed for installation in hazardous location;
6. Booster pump supplied with an explosion electric or hydraulic motor

Installation on open deckNo

Operating Parameters during land-based and ship-based testing

Operating Mass Average UV dosage @ 90UVT.....200 mJ/cm²

Energy consumption at 2500 m³/hour.....156-228 KW

Current 340 Amperes

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..... Hyde GUARDIAN® Ballast Water Management System, Model: HG2500X

Manufactured by..... Hyde Marine Inc., 2000 McClaren Woods Drive, Coraopolis, Pennsylvania 15108, USA

Organization conducting the test National Oceanographic Institute of the Netherlands (NIOZ)

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, five and at low 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 ranged between 8.4°C (high salinity) and between 17.5°C (low salinity) 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 µm (/m ³)	1.78E+05	≥ 100 000	1.54E+04	> 90	2.4	< 10
Phyla > 50 µm	10 different	≥ 3 different		-		-
Species > 50 µm	32 different	≥ 5 different		-		-
10-50 µm (/ml)	1,512	> 1000	1245	> 90	1	< 10
Phyla 10-50 µm	38 different	≥ 3 different		-		
Species 10-50 µm	40 different	≥ 5 different		-		
Hetero. bact./ml	3.80E+06	≥10 000	5.70E+06	-	6.40E+05	-
Escherichia Coli (cfu/100 ml)	<0.1	-	<0.1	-	<0.1	< 250
Vibrio cholerae (cfu /100 ml)	ND	-	ND	-	ND	< 1
Enterococcus group (cfu/100 ml)	8.3	-	<1	-	<1	< 100
Temperature ° C	14.3 – 17.5	-		-		-
Salinity (PSU)	31.9	>32		-		-
POC (mg/L)	10.2	> 1	4.8	-	4.5	-
DOC (mg/L)	4	> 1	3.3	-	4.1	-
TSS (mg/L)	33.9	> 1	9.7	-	10.0	-

ND: Not Detected

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)	2.55E+06	$\geq 100\ 000$	3.95E+03	> 90	2.9	< 10
Phyla > 50 μm	10 different	≥ 3 different		-		-
Species > 50 μm	32 different	≥ 5 different		-		-
10-50 μm (/ml)	1,534	> 1000	522	> 90	2.3	< 10
Phyla 10-50 μm	38 different	≥ 3 different		-		
Species 10-50 μm	40 different	≥ 5 different		-		
Hetero. bact./ml	3.90E+06	$\geq 10\ 000$	5.10E+06	-	3.00E+05	-
Escherichia Coli (cfu/100 ml)	<0.1	-	<1	-	<0.1	< 250
Vibrio cholerae (cfu /100 ml)	ND	-	ND	-	ND	< 1
Enterococcus group (cfu/100 ml)	<0.1	-	<1	-	<1	< 100
Temperature ° C	8.5-10.4	-		-		-
Salinity (PSU)	22.1	3-32		-		-
POC (mg/L)	16.1	> 5	5.4	-	2.63	-
DOC (mg/L)	5.82	> 5	3.03	-	3.36	-
TSS (mg/L)	42.5	> 50	9.6	-	11.1	-

Reference Methods:

Parameters	Reference Method
Heterotrophic Bacteria (counts/mL)	Total bacteria counts made through flow cytometry, using DNA-specific stains to get more accurate number. Standard plating method used to determine number of colony forming units according to NEN-EN-ISO 6222:1999)
Escherichia coli (cfu/100mL)	Plating analysis in accordance with NEN-EN-ISO 9308-1.
Enterococci (cfu/100 mL)	Plating analysis in accordance with NEN-EN-ISO 7899-2.
Vibrio cholerae (cfu /100 ml)	Plating analysis in accordance with NEN-EN-ISO 9308-1.
Organisms $\geq 10 < 50 \mu\text{m}$ (viable cells/mL)	Samples pre-concentrated with 10 μ mesh net using the 50 μ prefiltered sample. Sample analysis conducted by staining and measurement of PAM fluorometry as a bulk parameter. Flow cytometry used to obtain total organism counts. Direct microscopic count at 200X magnification on samples fixed in Lugols solution made for enumeration of stained organisms for viability measurement.
Organisms $\geq 50 \mu\text{m}$ (viable organisms/m ³)	No preservations; samples pre-concentrated with 50 μ mesh net and stained with Neutral Red vitality stain and enumerate through direct

SUMMARY OF SHIP BASED TEST RESULTS

Organization conducting the test..... Chesapeake Biological Laboratory, Solomons, Maryland 20688, USA

Tests were conducted on board the vessel.....“M/V Coral Princess”, IMO Nr. 9229659

Time of testing.....05.04.2008 – 06.10.2008

Maritime Area of testing..... Caribbean Sea/Western Pacific Ocean

Test 1

Organism Type	Influent Water	IMO req.	Discharge control	Imo req	Discharge treated	IMO req.
> 50 µm (/m3)	453	> 90	494	> 9	0	<10
10-50 µm (/ml)	6.5	> 90	0.133	> 9	0.006	<10
	1	-	ND	-	ND	<250
Escherichia coli (cfu /100 ml)	ND	-	ND	-	ND	<1
Vibrio cholerae (cfu /100 ml)	ND	-	ND	-	ND	<100
Enterococcus group (cfu /100 ml)	25.2-29.0	-		-		
Temperature (°C)	36.4 – 37.1	-		-		-
Salinity (PSU)	2.79	-		-		-
POC (mg/l)	4.36	-		-		
TSS [mg/l]						

Test 2

Organism Type	Influent Water	IMO req.	Discharge control	Imo req	Discharge treated	IMO req.
> 50 µm (/m3)	15373	> 90	337	> 9	0	<10
10-50 µm (/ml)	9.73	> 90	2.9	> 9	0.19	<10
	ND	-	ND	-	ND	<250
Escherichia coli (cfu /100 ml)	ND	-	ND	-	ND	<1
Vibrio cholerae (cfu /100 ml)	ND	-	1.6	-	3.4	<100
Enterococcus group (cfu /100 ml)	12.1-14.0	-		-		
Temperature (°C)	30.8-31.9	-		-		-
Salinity (PSU)	4.97	-		-		-
POC (mg/l)	6.943	-		-		
TSS [mg/l]						

Test 3

Organism Type	Influent Water	IMO req.	Discharge control	Imo req	Discharge treated	IMO req.
> 50 μm (/m3)	1,391	> 90	16	> 9	ND	<10
10-50 μm (/ml)	6.5	> 90	2.82	> 9	0.61	<10
Escherichia coli (cfu /100 ml)	ND	-	5	-	ND	<250
Vibrio cholerae (cfu /100 ml)	ND	-	ND	-	ND	<1
Enterococcus group (cfu /100 ml)	ND	-	3	-	ND	<100
Temperature (°C)	23.7-24.3	-		-		
Salinity (PSU)	33.3	-		-		-
POC (mg/l)	2.84	-		-		-
TSS [mg/l]	14.64	-		-		

Official Stamp



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Date of issue: 03/18/2013 Place of issue: Vienna, USA