Certificate No:
TAP00002R4

TYPE APPROVAL CERTIFICATE

This is to certify:

That the Ballast Water Management System

with type designation(s)
Cyeco BWMS (model range B200U to B1600U)

Issued to
Shanghai Electric Cyeco Environmental Technology Co., Ltd.
Shanghai, **China**

is found to comply with
IMO Resolution MEPC.300(72) – Code for Approval of Ballast Water Management Systems (BWMS Code)
DNV rules for classification – Ships Pt.6 Ch.7 Sec.1 Ballast water management – BWM
DNV class programme DNV-CP-0209 – Type approval – Ballast water management systems
DNV class guideline DNV-CG-0339 – Environmental test specification for electrical, electronic and programmable equipment and 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 the BWMS Code and DNV 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, unless otherwise instructed by relevant Maritime Administrations.

Issued at **Høvik** on **2023-04-20**
This Certificate is valid until **2028-04-19**.
DNV local unit: **Shanghai**

for **DNV**

Approval Engineer: **Martin Olofsson**

Dag Sæle-Nilsen
Head of Section

Name of ballast water management system (BWMS)

Cyeco BWMS

Ballast water management system manufactured by

Shanghai Electric Cyeco Environmental Technology Co., Ltd.

Place of production

Shanghai Electric Cyeco Environmental Technology Co., Ltd., 2748 Pudong Avenue, Shanghai, China

Type and model designations

B200U, B300U, B400U, B500U, B600U, B800U, B1000U, B1200U and B1600U

Equipment/Assembly drawings

The Cyeco BWMS shall be installed in accordance with the documents listed below:

Description	Title	Dwg. No.	Rev.
Operation, maintenance and safety manual (OMSM)	Operation, Maintenance and Safety Manual	Cyeco/TD04-400U1-D008	Rev.2.5 / 2023-01-15
Piping and instrumentation diagram (P&ID)	Piping & Instrumentation diagram	Cyeco/TD04-400U1-D007	Rev.07 / 2023-03-07
Bill of materials (BOM)	Bill of materials (all models)	Cyeco/TD04-400U1-D006	Rev.1.4.1 / 2023-03-07
	BOM-ECC-101 Control Cabinet	Cyeco/TD04-400U1-D006-DC1	Rev.1.2 / 2022-04-15
	BOM-ECP-8 Power Cabinet	Cyeco/TD04-400U1-D006-DP2	Rev.1.0 / 2022-04-15
	BOM-ECP-10 Power Cabinet	Cyeco/TD04-400U1-D006-DP3	Rev.1.0 / 2022-04-15
	BOM-ECR-102 Remote Cabinet	Cyeco/TD04-400U1-D006-DR1	Rev.1.0 / 2022-04-15
General arrangement drawings (GA)	Specification and General Arrangement	Cyeco/TD04-400U1-D005	Rev.1.4 / 2023-03-05
Specifications	Auto backflush filter (CF) specification	Cyeco/TD04-400U1-D001	Rev.2.5.1 / 2023-03-10
	UV unit (CU) specification	Cyeco/TD04-400U1-D003	Rev.2.4.1 / 2023-03-07
	Electrical cabinet specification	Cyeco/TD04-400U1-D012	Rev.2.5 / 2022-11-22
	Control cabinet ECC-101	Cyeco/TD04-400U1-D012-DC1	Rev.06 / 2022-08-15
	Power cabinet ECP-8	Cyeco/TD04-400U1-D012-DP2	Rev.04 / 2022-04-01
	Power cabinet ECP-10	Cyeco/TD04-400U1-D012-DP3	Rev.05 / 2022-08-15
	Remote cabinet ECR-102	Cyeco/TD04-400U1-D012-DR1	Rev.05 / 2022-08-15
Electrical wiring diagrams	Electrical wiring diagrams	Cyeco/TD04-400U1-D002	Rev.2.2.1 / 2023-01-05
Marking	Name plate	Cyeco/TD04-400U1-D009	Rev.02 / 2021-04-12

Other equipment manufactured by

None

Treatment Rated Capacity

200 – 1,600 m^3/h

Product description

Treatment sequence:

- Ballast water uptake: filtration and inactivation by UV treatment
- Ballast water discharge: inactivation by UV treatment

System design limitations / Water quality parameters

Temperature and Salinity
Ballast water salinity and temperature are not limiting conditions for the Cyeco BWMS.

System design limitations / Operational parameters

Holding time
The Cyeco BWMS has demonstrated performance to the ballast water performance standard in land-based testing with a minimum holding time between uptake and discharge of 2 hours in marine and brackish water, and 24 hours in fresh water. UV treatment is instant and does not require any holding time to render organisms inviable. Therefore, holding time is not found to be a limiting condition for the ballast water management system. The limitless holding time must be in a ballast water tank before the ballast water is being discharged to sea.

Dosing
The system is designed for operation at maximum ballast water flow (TRC) constantly. There is no flow reduction and no dimming of lamps by the system. The UV intensity (UVI) limit at which the BWMS can be operated at its TRC corresponds to an UV transmittance (UVT) of approximately 70%. A treatment alarm is given if the minimum UVI cannot be maintained by the system. The applicable UVI limits are listed in the table below.

Cyeco BWMS model	TRC [m^3/h]	Filter model	UV unit model	geometric UV model	minimum UVI [W/m^2]
B200U	200	CF200	CU200U	GM-A-400-8	563
B300U	300	CF300	CU300U	GM-B-400-10	518
B400U	400	CF400	CU400U	GM-A-400-12	547
B500U	500	CF500	CU500U	GM-B-400-10	863
B600U	600	CF600	CU600U	GM-B-400-10	863
B800U	800	CF800	CU800U	GM-C-500-14	795
B1000U	1,000	CF1000	CU1000U	GM-D-550-20	616
B1200U	1,200	CF1200	CU1200U	GM-D-550-20	770
B1600U	1,600	CF1600	CU1600U	GM-D-550-24	884

Treatment Rated Capacity
The Treatment Rated Capacities (TRC) of the designated Cyeco BWMS models are listed in the table above. The table also specifies the filter and the UV unit that shall be installed for a specific model. The BWMS control the flow rate (after the filter and UV unit) in the ballast water line with the flow control valve (FV101-02) to ensure that the flow rate is kept within the TRC of a specific model. The system gives an alarm if the ballast water flow rate exceeds the TRC specified for the Cyeco BWMS installation.

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

Minimum ballast water inlet pressure	Maximum ballast water operating pressure	Filter differential pressure triggering backflushing	Maximum filter differential pressure
0.1 MPa	1.0 MPa	continuous backflushing	0.08 MPa

Control and monitoring equipment

Software version
The Cyeco BWMS is type approved with the system control software, version 3.x (where x shall be 1 or higher). Any changes to the software are to be recorded as long as the system is in use on board. Records of any major software changes or any changes to the hardware, as described in the document *Software Change Handling and Revision Control Document* (Cyeco/TD04-400U1-D011) are to be forwarded to DNV 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 Cyeco BWMS is type approved with the following arrangements for monitoring the safe operation of the treatment system:

- Temperature sensor (TT102-01) mounted in the UV unit, giving alarm for high temperature
- Temperature switch (TS102-01) mounted in the UV unit, cutting power to the UV lamps at high temperature
- Pressure sensors (PT101-03 and PT101-04) mounted at the inlet and outlet of the filter unit, giving alarms for high differential pressure and for high inlet pressure
- Flow meter (FIQ101-01) mounted after the UV unit, giving alarm for high ballast water flow rate

Electrical and electronic components
The Cyeco BWMS is type approved with the electrical and electronic components indicated on the P&ID and specified in the Bill of Materials (Appendices 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 (Rev.7 or later).

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

Tag No.	Component name	Manufacturer	Model(s)
ECC-101	Control cabinet	Cyeco	ECC-101
ECR-102	Remote cabinet (optional)	Cyeco	ECR-102
ECP-8 ECP-10	Power cabinet	Cyeco	ECP-8 ECP-10
UVT102-01	UV intensity sensor	IL Metronic Sensortechnik GmbH	SUV 20.2 Y2 C
	UV lamp	UV-Technik Speziallampen GmbH	UVF MP W6000 UVF MP W10000

Hazardous area / Ex-proof

Cyeco BWMS is not intended to be installed in hazardous area zones.

Document approval

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

- Piping and Instrumentation Diagram (P&ID) of the ballast system including the treatment system installation
- Interface description towards the ship's existing systems including alarms for failure
- Description confirming the arrangement of alarms for bypass of the BWMS system (as part of the ship specific Ballast Water Management Plan)
- Commissioning procedure

Type approval documentation

System documentation

- Cyeco: Operation, Maintenance and Safety Manual, Cyeco/TD04-400U1-D008, Rev.2.5, dated 2023-03-15
- Cyeco: Bill of Materials (all models), Cyeco/TD04-400U1-D006, Rev.1.4.1, dated 2023-03-07
- Cyeco: System Design Limitations and Operational Limitations, Cyeco/TD04-400U1-D013, Rev.1.2.1, dated 2023-03-05
- Cyeco: Safety assessment HAZOP/HAZID report, Cyeco/TD04-400U1-D014, Rev.1.1, dated 2022-12-07
- Cyeco: Scaling document, Cyeco/TD04-400U1-D015, Rev.1.3.1, dated 2023-03-09
- Cyeco: UVI limitation for UV unit, Cyeco/TD04-400U1-D022, Rev.2.0.1, dated 2023-02-15
- Cyeco: Functional test plan, Cyeco/TD04-400U1-D010, Rev.2.3, dated 2023-03-16
- Cyeco: Software change handling and revision control document, Cyeco/TD04-400U1-D011, Rev.2.1, dated 2022-03-12

Commissioning procedure

- Cyeco: Factory/Site acceptance test report (Commissioning Checklist), Cyeco/TD04-400U1-D018, Rev.1.3, dated 2023-03-15

Test reports

- SHOU-BWDL(1): Land-based test report for the Cyeco Ballast Water Management System, document SHOU-SHDQ-2022002, Revision V1.1, dated 2022-04-01
- SHOU-BWDL(1): Shipboard test report for the Cyeco Ballast Water Management System, document SHOU-SHDQ-2022003, Revision V1.1, dated 2022-10-15
- SMERI(2): EMC and Environmental Test Report Cyeco BWMS, Report No. S078A-2022, dated 2022-10-26
- SMERI(2): EMC and Environmental Test Report CU800U, Report No. S062A-2023, dated 2023-02-15
- R&R Consult(3): CFD analysis of UV units - summary report, dated 2023-02-20
- Cyeco: Test report for CFD verification test, Cyeco/TD04-400U1-D021, Rev.1.2.1, dated 2023-02-12

(1) Ballast Water Detecting Lab of Shanghai Ocean University
(2) Shanghai Marine Auxiliary Mechanical & Electric Equipment Performance Environment Test Centre
(3) R&R Consult - Thermo & Fluid Mechanics Engineering, Denmark

Tests carried out

- Land-based testing with Cyeco B200U BWMS with a TRC of 200 m^3/h in accordance with Resolution MEPC.300(72)
- Shipboard testing with Cyeco B800U BWMS with a TRC of 800 m^3/h in accordance with Resolution MEPC.300(72)
- Function tests of the control and automation system witnessed by DNV
- Environmental testing in accordance with DNV class guidelines for environmental test specification for electrical, electronic and programmable equipment and systems (DNV-CG-0339, August 2021) and IACS UR E10 (Rev.8)
- Additional tests for validation of CFD model

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 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.

Revision history of this certificate

Rev.	Date of issuance	Description
-	2023-04-20	First issue See also more details on the certification in IMO INF Report MEPC 81/INF.XX

ANNEX 1 SUMMARY OF TESTING

Summary of land-based testing for the Cyeco BWMS

Table 1 Test water conditions and operational parameters in land-based testing of the Cyeco B200U BWMS with a TRC of 200 m³/h at SHOU-BWDL, during the period 8 October 2021 to 10 January 2022

Test cycle	Water temp. [°C]	Salinity [PSU]	DOC [mg/L]	POC [mg/L]	TSS [mg/L]	UVT [%]	Average UVI at uptake [W/m²]	Average flow rate (1) at uptake [m³/h]	Holding time [hours]
Marine water									
MW01	26.9	29.1	6.5	5.5	68.6	62.2	451	205	0 (2)
MW02	26.9	29.3	6.5	5.3	53.5	72.5	646	203	0 (2)
MW03	25.9	29.8	6.5	5.2	59.8	72.3	576	204	120 (3)
MW04	19.9	30.2	6.6	5.2	52.3	71.6	502	202	0 (2)
MW05	18.6	29.6	6.8	5.3	53.1	70.1	701	203	120 (3)
MW06	20.1	29.3	6.5	5.2	50.3	70.0	574	203	24
MW07	10.2	29.1	6.5	5.7	51.7	70.2	545	203	2
MW08	9.6	29.5	6.3	5.6	59.1	70.2	551	203	2
Brackish water									
BW01	12.3	17.9	6.8	5.8	53.6	71.0	580	203	0 (2)
BW02	13.8	18.7	6.4	5.8	50.8	70.3	696	203	24
BW03	14.2	18.7	6.3	5.8	52.7	70.7	646	204	120 (3)
BW04	13.7	18.8	6.4	5.7	51.7	70.1	563	203	0 (2)
BW05	13.3	18.6	6.5	5.8	53.7	70.5	670	203	120 (3)
BW06	8.2	18.5	6.4	5.8	51.6	70.7	565	203	2
BW07	10.1	19.0	6.3	5.7	52.0	71.6	558	204	2
Fresh water									
FW01	17.1	0.5	7.6	5.3	51.0	55.1	486	203	24
FW02	17.0	0.5	7.5	5.3	51.0	55.7	509	203	120 (3)
FW03	15.5	0.5	7.5	5.3	50.9	55.3	485	203	120 (3)
FW04	14.1	0.5	7.5	5.3	51.0	55.4	484	203	24
FW05	13.9	0.6	7.5	5.4	50.9	55.9	477	203	24

(1) Flow rate after filter and UV unit.
(2) Special test setup to validate zero (0) hours hold time for the USCG. Test cycle not included as one of the five valid and successful test cycles in each salinity, required in Resolution MEPC.300(72).
(3) Test cycle also to verify regrowth in the tank.

Table 2 Average numbers of live organisms in uptake and treated discharge water during land-based testing of the Cyeco BWMS. Live organisms in the ≥10 and <50 µm size group were quantified by microscopy counting after staining with FDA/CMFDA. All counts of pathogenic bacteria (*E. coli*, *Enterococci* and *Vibrio cholerae*) in the test cycles were below the ballast water performance standard.

Test cycle	Organism densities in uptake water (1)		Organism densities in discharge water			
	Organisms ≥50 µm [org/m³]	Organisms ≥10-<50 µm [org/mL]	Organisms ≥50 µm [org/m³]		Organisms ≥10-<50 µm [org/mL]	
			Treated	Control (1)	Treated	Control (1)
Marine water						
MW01 (2)	135,000	1300	2.3	119,000	15.0 (3)	1,210
MW02 (2)	129,000	1,200	5.7	123,000	5.3	1,030
MW03	124,000	1,230	0.0	15,400	1.2	279
MW04 (2)	117,000	1,190	2.7	109,000	8.0	1,090
MW05	120,000	1,220	0.0	15,100	6.8	338
MW06	119,000	1,240	3.3	93,000	2.0	1,020
MW07	110,000	1,190	1.0	96,600	0.8	1,090
MW08	109,000	1,220	0.0	91,300	0.5	1,120
Brackish water						
BW01 (2)	116,000	1,150	5.3	111,000	1.8	1,050
BW02	112,000	1,190	2.7	89,400	0.3	985
BW03	115,000	1,180	0.0	28,100	1.3	437
BW04 (2)	103,000	1,140	3.7	100,000	4.7	1,040
BW05	108,000	1,180	0.0	31,700	4.5	419
BW06	116,000	1,140	5.3	101,000	1.7	1,040
BW07	117,000	1,160	4.7	93,200	1.2	1,060
Fresh water						
FW01	189,000	1,400	7.3	169,000	7.0	1,130
FW02	186,000	1,460	0.3	123,000	2.2	394
FW03	176,000	1,450	0.0	131,000	3.5	384
FW04	177,000	1,450	6.3	159,000	1.2	1,150
FW05	180,000	1,430	7.0	155,000	3.5	1,160

(1) Values rounded to three digits, for exact value see SHOU-BWDL test report.
(2) Special test setup to validate zero (0) hours hold time for the USCG. Test cycle not included as one of the five valid and successful test cycles in each salinity, required in Resolution MEPC.300(72).
(3) Unsuccessful test cycle.

Summary of shipboard testing for the Cyeco BWMS

Table 3 Test water conditions and operational parameters in shipboard testing of the Cyeco B800U BWMS with a TRC of 800 m³/h, during the period 7 November 2021 to 23 July 2022, on board the bulk carrier *DONG JIANG LI* (IMO number 9169110).

Test cycle	Water temp. [°C]	Salinity [PSU]	DOC [mg/L]	POC [mg/L]	TSS [mg/L]	UVT [%]	Average UVI at uptake [W/m²]	Average flow rate (1) at uptake [m³/h]	Holding time [hours]
SB01	19.4	31	4.4	0.5	45.1	96.5	998	802	1.6
SB02	22.6	32	5.2	0.6	44.7	98.2	998	803	2.7
SB03	18.8	0.4	3.4	1.6	8.3	81.5	843	802	29.6
SB04	15.6	11	3.0	1.3	30.9	76.6	953	803	2.2
SB05	26.5	30	6.8	0.8	46.5	90.1	971	801	0.6

(1) Flow rate after filter and UV unit.

Table 4 Average numbers of live organisms in uptake and treated discharge water during shipboard testing of the Cyeco B800U BWMS. Live organisms in the ≥10 and <50 µm size group were quantified by microscopy counting after staining with FDA/CMFDA. All counts of pathogenic bacteria (*E. coli*, *Enterococci* and *Vibrio cholerae*) in the test cycles were below the ballast water performance standard.

Test cycle	Organisms ≥50 µm [org/m³]		Organisms ≥10-<50 µm [org/mL]	
	Uptake (1)	Discharge	Uptake (1)	Discharge
SB01 (Weihai, Yellow Sea)	10,600	0.0	283	0.3
SB02 (Taizhou, East China Sea)	11,600	0.0	310	0.8
SB03 (Dongguan, Pearl River)	13,400	1.3	176	0.3
SB04 (Guangzhou, Pearl River Estuary)	11,100	2.0	238	0.8
SB05 (Tangshan, Bohai Sea)	9,300	0.3	188	0.6

(1) Values rounded to three digits, for exact value see SHOU-BWDL test report.