Certificate No:
TAP00002N7

TYPE APPROVAL CERTIFICATE

This is to certify:

That the Ballast Water Management System

with type designation(s)
Senza BWMS TG2

Issued to
TeamTec BWMS AS
Tvedestrand, **Norway**

is found to comply with
IMO Resolution MEPC.300(72) - Code for Approval of Ballast Water Management Systems (BWMS Code)
Resolution MEPC.169(57)
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 Transport Canada, Marine Safety and Security.

The Certificate is issued based on the Type Approval Certificate No. TAP000028G, Rev.3, issued by DNV 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 **2022-12-23**
This Certificate is valid until **2026-01-18**.
DNV local unit: **Kristiansand S**

Approval Engineer: **Martin Olofsson**

for **DNV**

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.

LEGAL DISCLAIMER: Unless otherwise stated in the applicable contract with the holder of this document, or following from mandatory law, the liability of DNV AS, its parent companies and their subsidiaries as well as their officers, directors and employees ("DNV") arising from or in connection with the services rendered for the purpose of the issuance of this document or reliance thereon, whether in contract or in tort (including negligence), shall be limited to direct losses and under any circumstance be limited to 300,000 USD.

Name of ballast water management system (BWMS)

Senza BWMS

Ballast water management system manufactured by

TeamTec BWMS AS

Place of production

Tvedestrand, Norway

Type and model designations

Senza BWMS TG2

The models available are Senza S and Senza L.

The same models are also available in explosion proof configuration, depicted with Ex in brackets, i.e. Senza S(Ex) and Senza L(Ex).

Equipment/Assembly drawings

The Senza 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 of Senza BWMS	25446	Rev. 18 / 2022-11-14
Piping and instrumentation diagram (P&ID)	P&ID Senza BWMS - safe zone	504290	Rev. C / 2022-01-31
	P&ID Senza BWMS - hazardous zone	505674	Rev. 00 / 2021-11-11
Bill of materials (BOM)	BOM list Senza TG2	24950	Rev. F / 2022-06-07
General arrangement drawings (GA)	GA drawing Chemical Injection Pump Skid - small	505038	Rev. C / 2022-09-05
	GA drawing Chemical Injection Pump Skid - large	504880	Rev. C / 2022-09-05
	GA drawing Biocide Tank 1000 L	505166	Rev. 00 / 2021-10-28
	GA drawing Biocide Tank 3000 L	505140	Rev. 00 / 2021-09-22
	GA drawing Biocide Tank 5000 L	505167	Rev. 00 / 2021-10-24
	GA drawing Chiller Unit	505678	Rev. A / 2022-06-08
	GA drawing Neutralization Dissolving Tank	505174	Rev. A / 2022-02-01
	GA drawing Neutralization Dissolving Tank w/ transfer pump	504957	Rev. A / 2022-02-01
	GA drawing Neutralization Holding Tank	505046	Rev. A / 2022-02-01
	GA drawing TRO Monitor Skid	505496	Rev. A / 2022-01-28
	GA drawing TRO Monitor Skid - hazardous zone	505840	Rev. A /2022-01-27
	TRO monitor In-line assembly kit, Hot tap, Display	24699	Rev. - / 2022-01-19
	TRO monitor In-line assembly kit, Hot tap, Display, Ex	24170	Rev. - / 2022-01-20
Electrical wiring diagrams	Electric Wiring Diagram EL100	25135	Rev. C / 2022-02-01
	Electric Wiring Diagram EL100 - hazardous zone	24917	Rev. C / 2022-02-01

Other equipment manufactured by

None

Treatment Rated Capacity

375 – 3,750 m^3/h

Product description

Treatment sequence:

- Ballast water uptake: Injection of biocide solution (active component: sodium hypochlorite – NaOCl)
- Ballast water discharge: Neutralization

System design limitations / Water quality parameters

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

System design limitations / Operational parameters

Holding time
The Senza BWMS has demonstrated performance to the ballast water performance standard in land-based testing with a minimum holding time between uptake and discharge of 4 hours in marine and brackish water, and 24 hours in fresh water.
A minimum holding time of 4 hours is required for brackish and marine water, and a minimum holding time of 24 hours is required for fresh water (salinity ≤1 PSU). The system includes a reading of the ballast water salinity and notifies the operator if fresh water is detected.

Dosing
The target TRO of the Senza BWMS is 15 mg/L (as Cl_2) within the range of ± 1.5 mg/L. The TRO concentration at discharge shall be ≤0.1 mg/L. The source of active substance is sodium hypochlorite (NaOCl) stored as a 12% (w/w) bulk chemical solution.
When using alternate component Halogen TRO sensor, the target TRO of the Senza BWMS control system shall be set to 16 mg/L (as Cl_2). This is evaluated by DNV as necessary to obtain equivalent dosing of active substance compared to the original TRO analyzer used during type approval testing. The Halogen TRO sensor is analyzing directly in the ballast water flow (in-line) without any delay.

Treatment Rated Capacity
The flow capacity of the BWMS is mainly depending on the chemical's injection pump (Senza S for 225-1500 m^3/h and Senza L for 1500-3750 m^3/h). Indirectly also by the diameter of ballast water main line which decides the dimensions of the mixing disc for each diameter. The treatment rated capacities (TRC) of Senza BWMS related to nominal diameter (ND) of main line are listed below, together with a lower design flow. The minimum flow is 10% of the design flow.

Size	Injection pump	Lower design flow [m^3/h]	TRC [m^3/h]
ND 200	Senza S	225	375
ND 250	Senza S	375	450
ND 300	Senza S	450	600
ND 350	Senza S	600	1,125
ND 400	Senza S	1,125	1,500
ND 450	Senza L	1,500	2,250
ND 500	Senza L	2,250	3,750

The system has no flow control measures installed. Therefore, the flow shall be regulated by the ballast pump(s) or the vessel identified valve(s). The BWMS shall be installed with a flow meter located before the chemical injection point. The system gives an alarm if the ballast water flow rate exceeds the TRC specified for a particular Senza BWMS installation.

Control and monitoring equipment

Software version
The Senza BWMS is type approved with the system control software, version 25427.02.0. 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 25440 *Software Change and Revision Control Procedure* 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 Senza BWMS is type approved with the following arrangements for monitoring the safe operation of the treatment system:

- Drip trays are designed for each of the biocide tank, the neutralizer dissolving tank, the neutralizer tank and under the injection pump skid.
- Leak detectors in the drip trays for the biocide tank (LS131) and the injection pump skid (LS121)
- High level sensor (LT131) for the biocide tank
- Rubber lining inside the biocide tank
- Ventilation pipe from the biocide tank to above deck
- Flow monitoring (FT111) in the main ballast line before the injection point

Electrical and electronic components
The Senza BWMS is type approved with the electrical and electronic components indicated on the P&ID 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 (Rev.7 or later).

For the following electrical and electronic components, the models specified in the Bill of Materials shall be used (for TRO analysis, either a TeamTec TRO analyzer or the Halogen TRO sensor option is to be used, not both):

Tag No.	Component name	Manufacturer	Model(s)
W171	TRO analyzer	TeamTec BWMS AS	S.sensing WS-W S.sensing WS-W Ex
IA111 IA112	In-line TRO sensor (upstream) In-line TRO sensor (downstream)	Halogen Systems Inc.	SWN-P-HT2 EX-P-HT4 (for Ex installations)
EL100	Control panel	TeamTec BWMS AS	EL-100 EL-100 Ex

Hazardous area / Ex-proof

The TRO analyzer (S.sensing WS-W Ex), the TRO sensor Halogen EX-P-HT4 and the ballast water flow meter (OPTIFLUX 2300C Ex) of Senza BWMS have been evaluated and found to be in compliance with DNV rules Pt.4 Ch.8 Sec.11 and meet the requirements for installation and use in hazardous area Zone 1.
All other units of the Senza BWMS must be installed in non-hazardous areas.

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.

Document approval

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

- Power supply arrangement
- Interface description towards the ship's existing systems including alarms for failure
- List of Ex equipment according to DNV rules Pt.4 Ch.8 Sec.11 if the system is to be installed in hazardous area Zone 1. Valid Ex-certificates of relevant components are to be included.
- Piping and Instrumentation Diagram (P&ID)
- Bill of Materials
- Commissioning procedure

Type approval documentation

Approval for use of active substances

- IMO: Report of the twenty-seventh meeting of the GESAMP-Ballast Water Working Group, Annex 4, MEPC 66/2/10 dated 2014-01-24
- IMO: Basic Approval (proposed by Japan in document MEPC 66/2/4), Report of the Marine Environmental Protection Committee, MEPC 66/21 dated 2014-04-25
- IMO: Report of the twenty-eighth meeting of the GESAMP-Ballast Water Working Group, Annex 6, MEPC 67/2/4 dated 2014-06-25
- IMO: Final Approval (proposed by Japan in document MEPC 67/2/2), Report of the Marine Environmental Protection Committee, MEPC 67/20 dated 2014-10-31

System documentation

- TeamTec BWMS AS: Operation, Maintenance and Safety Manual of Senza BWMS, Document No: 25446, Rev.18, 2022-11-14
- TeamTec BWMS AS: Bill of Materials of Senza BWMS, Document No: 24950, Rev.F, 2022-06-07
- Kurita Water Industries Ltd.: Functional Design Specification of KURITA BWMS, Document No: FDS-01-05, Rev.05.02, 2021-03-09
- TeamTec BWMS AS: Risk Assessment Senza TG2, Document No: 25442, Rev.1, 2022-03-17
- Kurita Water Industries Ltd.: Scaling Report of Line Mixing for KURITA BWMS, Document No: STR-01-04, Rev.04, 2020-12-24
- TeamTec BWMS AS: Installation and Design Guideline Senza BWMS, Document No: 25441, Rev.A, 2022-04-20
- TeamTec BWMS AS: Software Change and Revision Control Procedure, Document No: 25440, Rev.00, 2022-02-04

Commissioning procedure

- TeamTec BWMS AS: System Acceptance Test of Senza BWMS version TG2, Document No: 25439, Rev.01, 2022-05-23

Test reports

- Golden Bear Research Center: Final land-based ballast water management report according to USCG final rule – KURITA BWMS, Rev.-, 2020-04-17
- Golden Bear Research Center: Final shipboard ballast water management report according to USCG final rule – KURITA BWMS, Rev.-, 2020-02-05
- SGS Korea Co., Ltd.: Summary for Type Approval – Component Testing of KURITA BWMS (42 sub-reports), Document No: STA-R20-0001, Rev.3, 2020-11-13
- Applica Test & Certification AS: Type testing of BWMS components, Report 30903, Rev.0, 2022-09-05
- DNV AS: Evaluation report – O&M testing of TRO sensor, Report No.: 262.1-029782-J-242, Rev.0, 2022-10-31

Tests carried out

- Land-based testing with KURITA KA-103 BWMS with a TRC of 375 m^3/h in accordance with Resolution MEPC.300(72)
- Shipboard testing with KURITA KA-103 BWMS with a TRC of 375 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)

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
-	2022-12-23	The certificate is issued based on the type approval certificate No. TAP000028G, Rev.3, issued by DNV, 2022-12-21, on behalf of the Norwegian Maritime Authority.

ANNEX 1 SUMMARY OF TESTING

Summary of land-based testing for the Senza BWMS

Table 1 Test water conditions and operational parameters in land-based testing of the Senza KA-103 BWMS with a TRC of 375 m³/h in 2019-2020 at the Golden Bear Research Center.

Test cycle	Flow rate [m³/h]	Treated volume [m³/h]	Water temp. [°C]	Salinity [PSU]	POC [mg/L]	DOC [mg/L]	TSS [mg/L]	Holding time [hours]	Average TRO at uptake [mg/L]
Marine water									
PLB6	370	287	20.4	26.1 (2)	9.4	6.9	60.1	27	14.9
PLB7	372	207	20.4	26.1 (2)	10.3	7.4	64.9	28 (1)	14.8
PLB8	369	206	20.3	28.0	10.9	6.6	83.4	24	14.6
PLB9	371	215	20.2	28.3	10.8	7.7	83.0	25	14.0
PLB12	375	220	17.4	28.1	9.4	7.4	58.3	24 (1)	14.6
PLB16	370	205	12.1	28.3	9.9	6.8	74.1	4	14.9
PLB17	374	208	12.1	28.1	10.6	7.0	75.8	4	14.8
Brackish water									
PLB1	356	205	13.4	10.0	10.5	7.3	153.3	24 (1)	N.D.(3)
PLB2	364	203	13.3	10.0	9.4	7.2	141.1	24 (1)	N.D.(3)
PLB3	346	202	13.6	10.3	10.6	7.5	90.1	24	10.3
PLB4	362	202	13.6	10.2	10.6	7.6	90.8	24	14.6
PLB5	352	210	14.5	10.4	9.4	7.6	83.4	24	N.D.(3)
PLB18	375	221	11.1	19.0	11.9	8.1	102.0	4	14.6
PLB19	372	220	11.0	19.3	8.3	8.0	81.8	4	14.0
Fresh water									
PLB10	377	215	18.7	0.6	9.4	8.2	51.7	24	15.1
PLB11	376	216	18.7	0.6	11.2	9.6	59.7	24	14.6
PLB13	372	216	14.8	0.9	9.4	8.5	52.1	24 (1)	14.8
PLB14	376	219	15.3	0.9	11.0	9.0	60.0	24 (1)	15.0
PLB15	367	206	15.9	0.7	11.1	8.1	61.1	24	15.4

(1) To evaluate regrowth as per paragraph 2.50 of part 2 of the annex to the resolution MEPC.300(72) 2 m³ of treated water were collected during discharge before neutralization and kept dark for additional 96 hours. Analysis was made after neutralization and showed compliance with the ballast water performance standard, see Table 3.

(2) The salinity of the marine water test cycles PLB6 and PLB7 were below the marine water salinity rage of 28-36 PSU stated in MEPC.300(72). Deviations from the salinity requirements were evaluated as per paragraph 2.29 in Part 2 of the annex to MEPC.300(72). Test water for marine and brackish water test cycles is sourced during the high tidal cycle and low tidal cycle, respectively, from the Carquinez Straits of North San Francisco Bay. Validation studies performed by GBRC show that the high and low tide test cycles are clearly different in terms of organism composition and representative for marine and brackish communities, respectively. The resulting tests were therefore evaluated to be representative and not less challenging for the BWMS than under the circumstance if the deviations had not occurred.

(3) No data reported. Logged data was lost due to momentary power failure. PLB1, PLB2 and PLB5 were completed without any major alarm for high/low TRO, meaning average TRO has been between 13.5 - 16.5 mg/L.

Table 2 Average numbers of live organisms in uptake and treated discharge water during land-based testing of the Senza 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		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	Treated	Control
Marine water						
PLB6	500,000	6,900	0.15	160,000	1.5	2,200
PLB7	430,000	6,100	0.31	160,000	1	2,200
PLB8	240,000	1,100	0.32	150,000	2.8	170
PLB9	240,000	1,100	0.21	150,000	4.2	170
PLB12	240,000	6,400	0.20	250,000	0.17	2,700
PLB16	100,000	1,800	0.23	100,000	0.17	1,700
PLB17	120,000	1,600	0.22	100,000	0.17	1,700
Brackish water						
PLB1	320,000	1,900	1.3	200,000	0.67	620
PLB2	280,000	1,100	7.2	200,000	1.33	620
PLB3	590,000	1,200	0.21	430,000	0.17	570
PLB4	770,000	1,600	0.21	430,000	0.17	570
PLB5	460,000	2,300	2.8	220,000	3.3	870
PLB18	120,000	4,400	0.22	130,000	0.67	3,400
PLB19	170,000	3,700	0.21	130,000	0.33	3,400
Fresh water						
PLB10	250,000	1,800	0.16	280,000	0.5	1,400
PLB11	350,000	1,300	0.21	280,000	0.5	1,400
PLB13	350,000	2,900	0.42	250,000	0.17	1,000
PLB14	390,000	5,400	0.20	250,000	0.17	1,000
PLB15	180,000	3,500	0.42	180,000	0.17	1,200

Table 3 Results from evaluation of regrowth for the Senza BWMS as per paragraph 2.50 of part 2 of the annex to the resolution MEPC.300(72). 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 after 5 days holding time		Salinity [PSU]
	Organisms ≥50 µm [org/m³]	Organisms ≥10-<50 µm [org/mL]	
PLB7	2.4	5.7	26.1 (1)
PLB12	0.47	0.3	28.1
PLB1	0.49	2	10.0
PLB2	0.47	0.7	10.0
PLB13	0.45	0.17	0.9
PLB14	0.45	0.17	0.9

(1) See note in Table 1.

Summary of shipboard testing for the Senza BWMS

Table 4 Test water conditions and operational parameters in shipboard testing of the Senza KA-103 BWMS with a TRC of 375 m³/h in 2019 on board the *USTS Golden Bear*.

Test cycle	Flow Rate [m³/h]	Treated volume [m³]	Water temp. [°C]	Salinity [PSU]	POC [mg/L]	DOC [mg/L]	TSS [mg/L]	Holding time [hours]	Average TRO at uptake [mg/L]
PSB1	364	414	11.8	0.6	9.7	7.3	96.1	24	15.1
PSB2	375	376	15.9	32.8	3.4	1.9	27.3	24	14.8
PSB3	372	366	20.0	33.0	7.2	2.3	82.5	24	14.1
PSB4	375	299	29.1	21.0	2.5	3.7	20.1	24	14.5
PSB5 (1)	270	370	14.7	30.3	3.8	2.0	26.5	24	8.8
PSB6	375	373	17.5	18.4	1.2	2.2	16.9	24	15.1

(1) Concluded invalid by DNV due to technical challenges.

Table 5 Average numbers of live organisms in uptake and treated discharge water during shipboard testing of the Senza 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	Discharge	Uptake	Discharge
PSB1 (Vallejo, CA)	49,000	0.20	640	1.67
PSB2 (Long Beach, CA)	130,000	0.23	520	0.17
PSB3 (Lisbon, Portugal)	120,000	3.14	130	0.17
PSB4 (Galveston, TX)	58,000	0.20	140	0.17
PSB5 (1) (San Francisco Bay, CA)	87,000	0.23	360	0.17
PSB6 (Vallejo, CA)	150,000	0.21	170	0.17

(1) Concluded invalid by DNV due to technical challenges.