DNV·GL

# TYPE APPROVAL CERTIFICATE

Certificate No:
**TAP000018Z**
Revision No:
**1**

## This is to certify:

**That the Ballast Water Management System**

with type designation(s)
**PureBallast 3.2, PureBallast 3.2 Compact Flex**

Issued to
## Alfa Laval Tumba AB
**Tumba, Sweden**

is found to comply with
**DNV GL rules for classification – Ships**
**DNV GL class programme DNVGL-CP-0209 – Type approval – Ballast water management systems**
**IMO Resolution MEPC.279(70) - 2016 GUIDELINES FOR APPROVAL OF BALLAST WATER MANAGEMENT SYSTEMS (G8)**

## 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 Guidelines contained in Resolution MEPC.279(70) and DNV GL Rules stated above. This Certificate is valid only for the Ballast Water Management System referred to above.**

**For the compliance with the resolution MEPC.279(70), 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 GL, unless otherwise instructed by relevant Maritime Administrations.**
**Type:**
**PureBallast 3.2**
**PureBallast 3.2 Compact Flex**

Issued at **Høvik** on **2018-02-02**
This Certificate is valid until **2023-02-02**.
DNV GL local station: **Stockholm**

for **DNV GL**

Approval Engineer: **Tone Knudsen Fiskeseth**

**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.

## Type and model designation

**PureBallast 3.2**
**PureBallast 3.2 Compact Flex**

The difference between the PureBallast 3.2 and 3.2 Compact Flex models are limited to difference in system configuration and modularity, the biological treatment function is the same.

Place of production: Alfa Laval Aalborg A/S, Aalborg, Denmark.

## Equipment / assembly drawings

| Type | Description | Dwg Nr. | Rev. | System Type desigantion |
|---|---|---|---|---|
| Piping and instrumentation diagram | Flow chart 250,300,500,600,750,1000 & HP 250,300,500 | 9034854 | 0 | PureBallast 3.2 |
| | Flow chart 1200,1500,2000 | 9034855 | 0 | |
| | Flow chart 3000 & HP 1500 | 9034856 | 0 | |
| | Flowchart HP 2000 | 9034857 | 0 | |
| | Flow chart HP 3000 | 9034858 | 0 | |
| Piping and instrumentation diagram | Flow chart 85 – 1000 | 9034867 | 0 | PureBallast 3.2 Compact Flex |

## Product description

Separation by filtration and treatment by ultraviolet radiation (UV)

Treatment sequence:

- Ballast water uptake: Filter and UV disinfection
- Ballast water discharge: UV disinfection

PureBallast 3.2 is approved with;

- Four sizes of UV reactors; 170, 300, 600 and 1000 $m^3/h$.
- Elleven filter sizes in a series; Filtrex ACB Automatic Filter with 20µm wire mesh.
- The PureBallast 3.2 consist of one, or multiple UV reactors, and a corresponding filter.
- The PureBallast 3.2 Compact Flex uses one of the four sizes of UV reactors and a corresponding filter arranged on modules for easy installation.
- A clean-in-place (CIP) function used for cleaning of the UV reactor after ballasting and de-ballasting.

## System design limitations

This equipment has been designed for operation in the following conditions:

**UV Intensity**

| UV-reactor size [$m^3/h$] | UV intensity lower limit in marine and brackish water[1] | UV intensity lower limit in fresh water at full flow (TRC) [2] | UV intensity lower limit in fresh water at half flow[3] |
|---|---|---|---|
| 170 | 210 $W/m^2$ | 480 $W/m^2$ | 410 $W/m^2$ |
| 300 | 210 $W/m^2$ | 480 $W/m^2$ | 410 $W/m^2$ |
| 600 | 210 $W/m^2$ | 480 $W/m^2$ | 410 $W/m^2$ |
| 1000 | 252 $W/m^2$ | 576 $W/m^2$ | 492 $W/m^2$ |

1) UV intensity below lower limit, corrresponding to an UV transmission of approx. 42% for these systems, implies that the ballast water is not treated in accordance with this certificate.
2) UV intensity corrresponding to an UV transmission of approx. 54%.
3) The system includes flow reduction control in fresh water. Flow can be reduced by up to 50%. UV intensity below lower limit, corrresponding to an UV transmission of approx. 49% for these systems, implies that the ballast water is not treated in accordance with this certificate.

The system includes UV-lamp power optimization control. UV-lamp power is reduced in favorable water conditions based on measured UV-intensity. Lamp power can be reduced by up to 50%.

Each UV reactor is available in design pressure rating; 6 or 9 bar for the 600 & 1000 reactors and 6 or 10 bar for 170 & 300 reactors.

**Temperature and Salinity**
Temperature and salinity of the water is not a limiting condition for the ballast water management system.

**Holding time**
The system has been tested successfully with 24 hours between uptake and discharge. Holding time is not found to be a limiting condition for the ballast water management system.

**TRC/Pressure**
UV Reactors can be installed in parallel configuration to achieve higher flow capacities according to the PureBallast design and installation guide and the table below:

| Systems flow Designation | TRC [$m^3/h$][1, 3] | UV – Reactor size[2] | Filter size Filtrex ACB *Design pressure*:10 bar *Differential pressure for Backwash to be initiated:* 0,5 bar |
|---|---|---|---|
| **85** | 32 - 85 | 1 x 170 | ACB-906-100 |
| **85 HP** | 32 - 85 | 1 x 170 | ACB-906-100 |
| **135** | 42 - 135 | 1 x 170 | ACB-910-150 |
| **150 HP** | 65 - 150 | 1 x 300 | ACB-935-200 |
| **170** | 50 - 170 | 1 x 170 | ACB-915-150 |
| **250** | 30 - 250 | 1 x 300 | ACB-935-200 |
| **250 HP** | 60 - 250 | 1 x 600 | ACB-935-200 |
| **300** | 30 - 300 | 1 x 300 | ACB-945-200 |

| | | | |
|---|---|---|---|
| **300 HP** | 60 - 300 | 1 x 600 | ACB-945-200 |
| **500** | 60 - 500 | 1 x 600 | ACB-955-250 |
| **500 HP** | 100 - 500 | 1 x 1000 | ACB-955-250 |
| **600** | 60 - 600 | 1 x 600 | ACB-985-300 |
| **600 HP** | 120 - 600 | 2 x 600 | ACB-985-300 |
| **750** | 100 - 750 | 1 x 1000 | ACB-985-300 |
| **750 HP** | 200 - 750 | 2 x 1000 | ACB-985-300 |
| **1000** | 100 - 1000 | 1 x 1000 | ACB-999-350 |
| **1000 HP** | 200 - 1000 | 2 x 1000 | ACB-999-350 |
| **1200** | 120 - 1200 | 2 x 600 | ACB-9100-400 |
| **1500** | 200 - 1500 | 2 x 1000 | ACB-9100-400 |
| **1500 HP** | 300 - 1500 | 3 x 1000 | ACB-9100-400 |
| **2000** | 200 - 2000 | 2 x 1000 | ACB-9120-500 |
| **2000 HP** | 400 - 2000 | 4 x 1000 | ACB-9120-500 |
| **3000** | 300 - 3000 | 3 x 1000 | ACB-9200-600 |
| **3000 HP** | 600 - 3000 | 6 x 1000 | ACB-9200-600 |

1) TRC is the net flow out of the treatment system, a net flow exceeding the given value implies that the ballast water is not treated in accordance with this certificate.

2) During ballast water discharge, the size and number of UV reactors limits the systems TRC.

3) Stripping operation can be performed with unfiltered drive water, but then the flow rate for the UV treatment shall not exceed 1/3 of TRC during stripping operation and lamp power shall be 100%.

## Operational specifications for the different components

**Cleaning in Place (CIP)**
Cleaning Liquid: ALPACON DESCALANT Offshore

**Monitoring**
The type approved system must be installed with a conductivity sensor (QIT201-51), temperature sensor(TT201-33), pressure sensors (PT201-16; PT201-71 and/or-72), a flow meter (FIT201-1) and a flow control valve (V201-8) according to the flow charts. A temperature switch (TS201-60) inside the UV reactor is arranged with an independent shutdown functionality.
Information regarding the selected components shall be part of the documentation related to the specific installation, either by a reference to valid type approval certificate or technical documentation.

**Control Equipment/sensors**
The type approved system includes the following control units and sensors:

| **Name / (Flow chart legend)** | **Model** |
|---|---|
| UV sensor / (QT201-50) | *For UV reactor model 170, 300 and 600:* UV-Technik, Speziallampen GMBH SUV 20.2 Y2 C40° 1000w/m2 MP |
| | *For UV reactor model 1000:* UV-Technik, Speziallampen GMBH SUV 20.2 Y2 C40° 3000w/m2 MP |
| **3.2** | |
| Control Cabinet (CC) (including control panel) | CC PB 3.2 (Control panel Beijer X2 Marine 15) |
| Lamp Drive Cabinet (LDC) | LDC PB 3.2 |
| Remote Control Panel (optional) | RCP 3.2 (Control panel Beijer X2 Marine 15) |
| PLC program | V3.2.1 |
| Software program | V3.2.1 |
| **3.2 Compact Flex** | |
| Electrical Cabinet (including control panel and Lamp power supply) | EC 3.2 (Control panel Beijer X2 Marine 7) |
| Lamp Drive Cabinet | LDC 1 |
| Lamp Drive Cabinet | LDC 2 |
| Remote Control Panel 3.1 (optional) | RCP (Control panel Beijer X2 Marine 7) |
| PLC program | V3.2.1 Compact Flex |
| Software program | V3.2.1 Compact Flex |

All changes in software are to be recorded as long as the system is in use onboard. The records of all changes are to be forwarded to DNV GL for evaluation and approval.Major changes in the software, defined in the Software Quality Assurance Plan, CAT-SQAP-001, are to be approved before being installed in the computer. Based on the modification, a Certification of Application Functions may be required for the particular vessel.

## Documents approval

The following documentation is to be submitted for approval in each case:

- Piping and Instrumentation Diagram (P&ID) of the ballast system including the treatment system installation
- Power supply arrangement
- Interface description specifying external signals including alarms for failure
- Description confirming the arrangement of alarms for bypass of the BWMS system (as part of Ballast Water Management Plan)

## Tests carried out

- Land-based testing in accordance with Resolution MEPC.174(58) using PureBallast 3.0 with UV reactor size 300 and Hydac filter RF-10 with a 50 µm mesh filter

- Land-based testing in accordance with Resolution MEPC.174(58) using PureBallast 3.1 with UV reactor size 300 and Filtrex filter ACB 945-200 with a 20 µm mesh filter
- Additonal land-based testing in accordance with Resolution MEPC.279(70) using PureBallast 3.2 with UV reactor size 300 and Filtrex filter ACB 945-200 with a 20 µm mesh filter
- Shipboard testing in accordance with Resolution MEPC.174(58) using The PureBallast 3.0 with UV reactor size 1000 and Hydac filter RF-10 with a 50 µm mesh filter
- Type tests of the control and automation system witnessed by DNV GL
- Testing in accordance with environmental test specification for instrumentation and automation equipment, DNV Standard for Certification No. 2.4 (April 2006) and Resolution MEPC.174(58)
- Additional testing of Pureballast 3.1 in accordance with environmental test specification for instrumentation and automation equipment, DNVGL-CG-0339 Environmental test specification for electrical, electronic and programmable equipment and systems (November 2016) and Resolution MEPC.174(58)
- Type test of the control and automation system for flow 170, witnessed by DNV GL
- Type test of the control and automation system for the Compact Flex model, witnessed by DNV GL

A summary of the test results from land-based and shipboard tests are given in an annex to this certificate.

## 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, DNV GL 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 should be carried onboard a vessel fitted with this ballast water management system at all time. The annex containing the summary of the test results of land-based and shipboard tests should also be available for inspection onboard the vessel.

# ANNEX 1 SUMMARY OF TESTING

**Summary of land-based testing for AlfaLaval AB, PureBallast 3.1 using UV reactor size 300 m³/h and Filtrex ACB 945-200 with a 20 µm mesh screen, 2014**

PureBallast 3.1 has a lower UV dose in fresh water than the more conservative PureBallast 3.2 and the testing is therefore considered applicable for PureBallast 3.2.

**Table 1** Test water conditions in fresh, brackish and marine water test cycles.

| Test cycle* | Sample | TSS (mg/L) | POC (mg/L) | DOC (mg/L) | MM (mg/L) | UV-T (%) | Salinity (PSU) | UVI (mW/m²) | Flow rate Treated (m³/h) | Holding time (day) |
|---|---|---|---|---|---|---|---|---|---|---|
| F-1 | Inlet | 56 | 8.3 | 8.0 | 47 | 45 | 0.37 | 362-366 | 304 | 5 |
| F-3 | Inlet | 61 | 6.4 | 8.2 | 54 | 45 | 0.35 | 303-308 | 306 | 5 |
| F-4 | Inlet | 61 | 6.7 | 9.5 | 54 | 42 | 0.36 | 260-262 | 303 | 5 |
| F-5 | Inlet | 54 | 6.2 | 11 | 48 | 42 | 0.37 | 207-210 | 307 | 5 |
| F-6 | Inlet | 54 | 6.2 | 11 | 48 | 42 | 0.37 | 211 | 304 | 5 |
| B-9 | Inlet | 56 | 7.7 | 11 | 48 | 45 | 17 | 238-241 | 302 | 5 |
| B-10 | Inlet | 58 | 8.0 | 10 | 50 | 44 | 18 | 272-273 | 308 | 5 |
| B-11 | Inlet | 58 | 8.0 | 10 | 50 | 44 | 18 | 271-273 | 300 | 5 |
| M-8 | Inlet | 39 | 9.3 | 11 | 30 | 46 | 33 | 236-238 | 308 | 5 |
| M-9 | Inlet | 44 | 9.0 | 11 | 35 | 46 | 33 | 228-231 | 307 | 5 |
| M-10 | Inlet | 44 | 9.0 | 11 | 35 | 46 | 33 | 229-231 | 303 | 5 |
| Requirements | | | | | | | | | | |
| Fresh water and brackish water (inlet) | | >50 | >5 | >5 | - | ** | - | - | - | - |
| Marine water (inlet) | | >1 | >1 | >1 | - | ** | - | - | - | - |

*Only three consecutive valid successful tests were performed for this filter in marine and brackish water salinity as this was identified as an additional filter.

**The tested UVT is lower than the required UVT as validated in accordance with paragraph 2.4.21 of the annex to G8.

**Table 2** Average numbers (three replicates) of live organisms in inlet, treated and control discharge waters. Live organisms ≥10 and <50 µm were quantified by most probable number assay (MPN). All counts of pathogenic bacteria (*E. coli*, enterococci and *Vibrio cholerae*) in the test cycles were below the ballast water discharge standard.

| Test cycle | Organisms ≥50 µm (organisms/m³) | Organisms ≥10 and <50 µm (organisms/mL) | Organisms ≥50 µm (organisms/m³) | | Organisms ≥10 and <50 µm (organisms/mL) | |
|---|---|---|---|---|---|---|
| | | | Treated | Control | Treated discharge | Control discharge |
| | Inlet to BWMS | Inlet to BWMS MPN | discharge | discharge | MPN | MPN |
| F-1 | 279,837 | 3,433 | 2.0 | 99,349 | 0.19 | 1373 |
| F-3 | 288,278 | 2,900 | 1.3 | 97,019 | <0.18 | 1247 |
| F-4 | 288,278 | 2,900 | 1.0 | 97,019 | <0.18 | 1247 |
| F-5 | 348,870 | 1,933 | 0.67 | 175,287 | 1.4 | 440 |
| F-6 | 348,870 | 1,933 | 0.67 | 175,287 | 0.68 | 440 |
| B-9 | 393,511 | 11,467 | 0.33 | 114,512 | 3.4 | 276 |
| B-10 | 625,241 | 11,600 | 2.7 | 55,068 | 0.60 | 667 |
| B-11 | 625,241 | 11,600 | 1.3 | 55,068 | 1.0 | 667 |
| M-8 | 167,650 | >16,000 | 3.0 | 24,208 | 2.4 | 1600 |
| M-9 | 237,994 | >16,000 | 2.3 | 79,520 | 3.5 | 1600 |
| M-10 | 237,994 | >16,000 | 2.0 | 79,520 | 9.5 | >1600 |

**Summary of additional land-based testing for AlfaLaval AB, PureBallast 3.2 using UV reactor size 300 m³/h and Filtrex ACB 945-200 with a 20 µm mesh screen**

**Table 3** Test water conditions in fresh, brackish and marine water test cycles.

| Test cycle | Temp. (˚C) | Salinity (PSU) | UV-T* (%) | DOC (mg/L) | POC (mg/L) | TSS (mg/L) | UV-I (W/m²) | Average flow rate (m³/h) | Holding time (day) |
|---|---|---|---|---|---|---|---|---|---|
| F-5 | 15 | 0.37 | 54 | 5.2 | 6.3 | 70 | 508-511 | 304 | 1 |
| F-6 | 15 | 0.37 | 54 | 5.2 | 6.3 | 70 | 503-508 | 307 | 1 |
| B-1 | 5.8 | 19 | 46 | 11 | 9.5 | 63 | 269-296 | 305 | 1 |
| B-2 | 5.9 | 19 | 46 | 11 | 9.5 | 63 | 233-249 | 313 | 1 |
| M-1 | 6.2 | 29 | 71 | 7.3 | 7.5 | 45 | 597-870 | 306 | 1 |
| M-2 | 6.2 | 29 | 71 | 7.3 | 7.5 | 45 | 597-884 | 302 | 1 |

*****The tested UVT is lower than the required UVT as validated in accordance with paragraph 2.4.21 of the annex to G8.

**Table 4** Average numbers (three replicates) of live organisms in inlet, treated and control discharge waters. Live organisms ≥10 and <50 µm were quantified by most probable number assay (MPN). All counts of pathogenic bacteria (*E. coli*, enterococci and *Vibrio cholerae*) in the test cycles were below the ballast water discharge standard.

| Test cycle | Organisms ≥50 µm (organisms/m3) | Organisms ≥10 and <50 µm (organisms/mL) | Organisms ≥50 µm (organisms/m³) | | Organisms ≥10 and <50 µm (organisms/mL) | |
|---|---|---|---|---|---|---|
| | | | Treated | Control | Treated | Control |
| | Inlet to BWMS | Inlet to BWMS MPN with 95% confidence interval | | | MPN | MPN |
| F-5 | 840,561 | >16,000 * | 5.2 | 261,717 | <0.18 | >1,600 |
| F-6 | 715,203 | 5,400 1,600-18,000 | 3.0 | 261,717 | 0.47 | >1,600 |
| B-1 | 219,283 | 490 160-1,500 | 1.0 | 132,471 | <0.18 | 303 |
| B-2 | 190,272 | 490 160-1,500 | 6.7 | 132,471 | <0.18 | 303 |
| M-1 | 153,236 | 790 260-2,400 | 0 | 80,179 | 0.48 | 377 |
| M-2 | 137,125 | 490 160-1,500 | 0 | 80,179 | 0.30 | 377 |

* The 95% confidence interval is not available when the estimated average is >16,000 org./mL

All land-based test results using the Hydac filter is not included in this annex, but has been evaluated as supportive data for this certificate.

**Summary of shipboard testing for AlfaLaval AB, PureBallast 3.0 using Hydac RF-10 filter with a 50 µm mesh screen**

PureBallast 3.0 has a lower UV dose in fresh water than the more conservative PureBallast 3.2 and the testing is therefore considered applicable for PureBallast 3.2. Fresh water neither included in shipboard testing.
Hydac RF-10 was the first filter for PureBallast 3.0 and 3.1 and Filtrex ACB was the alternative filter forming the basis for the approval of PureBallast 3.2. AlfaLaval has later decided to discontinue the base filter (Hydac).

**Table 5** Flow rate, UVT, UVI, average numbers (three replicates) of live organisms in inlet and treated discharge waters. Live organisms ≥10 and <50 µm were quantified by both most probable number assay (MPN) and microscopy counting after staining with CMFDA/FDA. All counts of pathogenic bacteria (*E. coli*, enterococci and *Vibrio cholerae*) in the test cycles were below the ballast water discharge standard.

| Test cycle | Average flow rate during ballast operation ($m^3/h$) | UVT | UV-I ($W/m^2$) | Organisms ≥50 µm per $m^3$ | | Organisms ≥10 and <50 µm per mL; Algal re-growth + CMFDA/FDA-stained motile organisms | | |
|---|---|---|---|---|---|---|---|---|
| | | | | Inlet | Discharge | Inlet CMFDA/ FDA | Discharge CMFDA/ FDA | Discharge MPN |
| No. 1 | 356 | 96 | 1,815-1,820 | 6,429 | 1.5 | 70 | 0.53 | <0.18 |
| No. 2 | 889 | 96 | 1,710-1,805 | 8,490 | 0 | 1,102 | 2.8 | 0.27 |
| No. 3 | 950 | 96 | 1,280-2,100 | 2,100 | 0 | 787 | 0.75 | <0.18 |
| No. 4 | 950 | 90 | 1,175-1,403 | 23,603 | 1.9 | 103 | 0.67 | <0.18 |
| No. 6 | 998 | 60 | 497-563 | 7,537 | 7.0 | 175 | 6.4 | <0.18 |
| No. 9 | 893 | 99 | 1,168-1,187 | 20,272 | 4.6 | 128 | 0.17 | <0.18 |