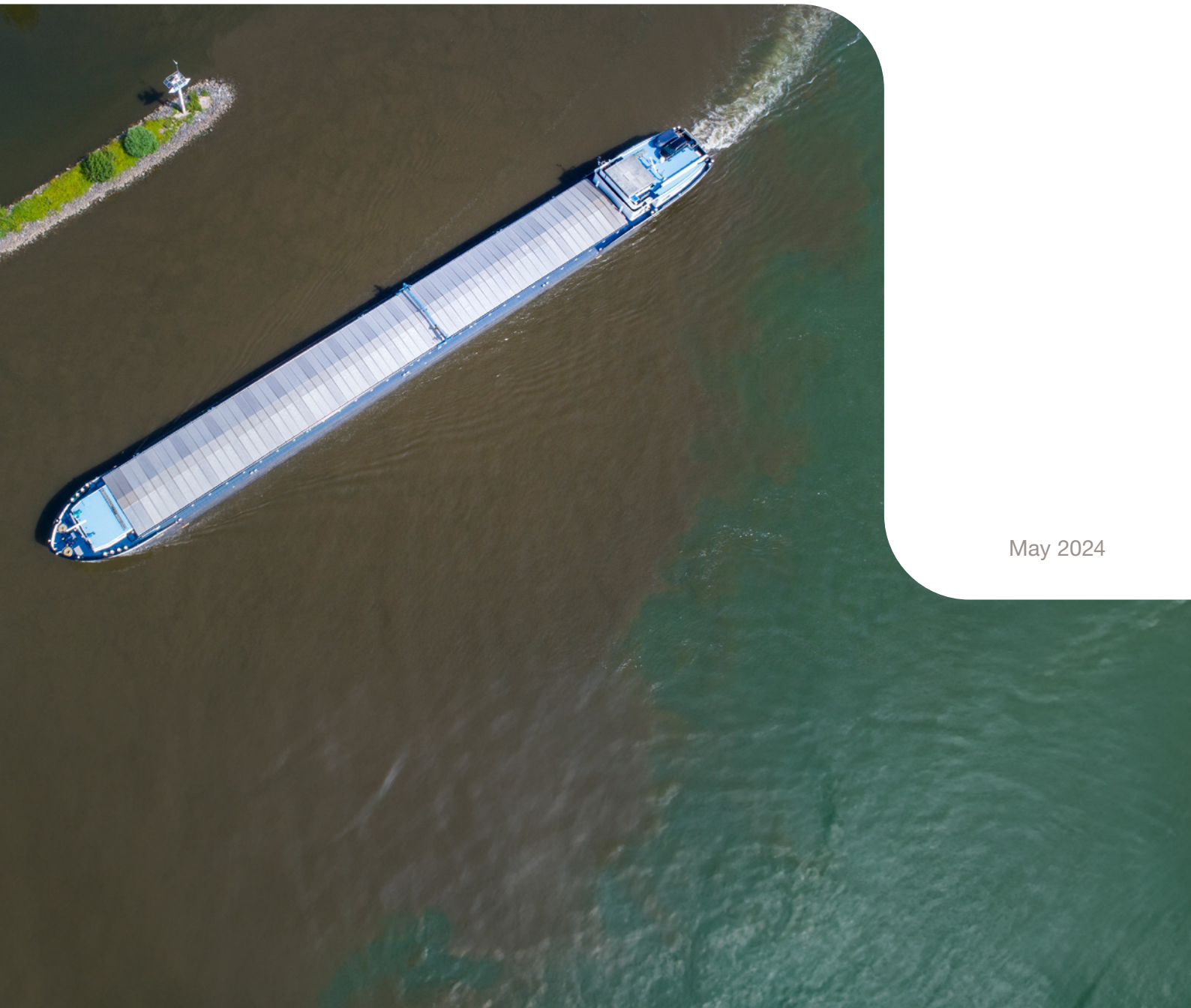
WHITE PAPER

Ballast water management and challenging water quality (CWQ)

Understanding the interim guidance and bypass of ballast water management systems (BWMS)



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1. Introduction

At MEPC 81 in March 2024, the Marine Environment Protection Committee adopted interim guidance on the procedures and responsibilities involved when ballast water management systems (BWMS) encounter challenging water quality (CWQ). Besides defining concepts and CWQ triggers, the guidance lays out steps for pre-planning, troubleshooting and other actions to mitigate BWMS issues, along with conditional procedures for bypass and decontamination. It will apply at least through the experience-building phase of the Ballast Water Management (BWM) Convention, which is scheduled to conclude in the fall of 2026.

The need for guidance has been apparent. Concerned administrations have called for it repeatedly, supported by actors in key marine segments.

Some tanker operators, for example, have had difficulties with cargo operations when BWMS flow is reduced in certain ports. In such cases, bypassing the BWMS has been an unclear and complicated process, requiring advance permission from authorities.

Apart from bringing clarity, the interim guidance allows a reactive bypass of the BWMS (based on triggers from the system itself) under very limited circumstances. However, it does not grant permission to disregard the system's type approval. The guidance makes clear that shipowners have significant responsibilities, not only before and after bypassing but also when selecting a BWMS in the first place.

2. Interim guidance for handling challenging water quality

The concept of challenging water quality with regard to BWMS was first introduced at MEPC 71 in 2017. In the years since, it has discussed at many MEPC meetings. Likewise, it has been a topic of the BWM Convention review process during the experience-building phase, which is set to end with the convention review in 2026. Resolution MEPC.387(81), *Interim guidance on the application of the BWM Convention to ships operating in challenging water quality conditions,* was adopted at MEPC 81.

Briefly summarized, the primary purpose of the guidance is to assist ships in planning for compliance with the BWM Convention, which includes making provisions for bypassing a BWMS under certain circumstances.

When a BWMS reaches an **operational limitation** or is unable to meet **operational demand** during ballasting, a **reactive bypass** may be performed without consulting the vessel's flag administration or the next port state. However, the guidance emphasizes that bypassing should be a last resort, and it does not remove the obligation to comply with the D-2 discharge standard. Measures to prevent a bypass and to decontaminate the ballast tanks after a bypass must always be taken.

To understand the interim guidance, one must understand not only the aforementioned concepts but also the definition of challenging water quality.

3. What challenging water quality is – and is not

Water that causes issues for a BWMS is not necessarily challenging according to the interim guidance. In fact, the guidance provides a specific definition of challenging water quality:

> *Challenging water quality (CWQ) refers to ambient uptake water having quality parameters (including but not limited to high total suspended solids, or turbidity) that cause a properly installed, maintained and operated type-approved BWMS to be temporarily inoperable due to an operational limitation or an inability to meet operational demand. However, temperature and salinity are not parameters that define CWQ.*

The definition is interesting in three key ways:

1. The mention of total suspended solids puts emphasis on sediments and filtration issues.
2. Temperature and salinity are specifically excluded as CWQ parameters – but the range of parameters is otherwise left open.
3. The water is only considered challenging if the type-approved BWMS treating it is properly installed, maintained and operated. Simply encountering a problem does not make the water challenging.

Sediments and filter performance

Total suspended solids (TSS), which are specified in the CWQ definition, are solids in water that can be trapped by a filter. Since sediments are the main example, challenging water quality has often been referred to as "muddy water", even in MEPC discussions.

Under a high sediment load, a BWMS filter may be unable to self-clean sufficiently. This will increase the differential pressure across the filter, eventually leading to clogging.

However, filter performance varies greatly, and the mesh size cannot be seen as an indicator for how well a filter will perform. Moreover, it is a misconception that the amount of TSS corresponds to the level of challenge.

During type approval testing, BWMS are evaluated with a TSS concentration of 50 mg/L. While some administrations have called for an increased concentration, this alone will be insufficient to secure improved filtration. Even at high TSS concentrations, small particles may pass through a filter mesh without issue. To accurately reflect real-world performance, the tests must use a realistic distribution of particle sizes – ideally based on waters that are known to cause issue.[1]

CWQ parameters vs System Design Limitations

Sediments are not the only challenge for BWMS. A large amount of dissolved organic matter can also result in challenging water quality, as it increases the consumption of total residual oxidants (TRO) and decreases the water's UV transmittance. If the uptake water contains concentrated organic matter, both electrochlorination (EC) and UV systems may run into difficulty. In UV systems, the UV transmittance is directly related to the System Design Limitations (SDL), because it impacts the light's intensity at the UV sensor.

However, despite a relationship between challenging water quality and certain SDL, not all SDL are relevant to the interim guidance. Temperature and salinity, which are key SDL parameters for EC systems, are specifically excluded from the CWQ definition. If a vessel operates in cold or low-salinity waters, the installed BWMS must be able perform there. Neither insufficient heating nor a lack of supplemental salt on board will qualify as CWQ conditions.

Where SDL parameters are also CWQ parameters, it is the SDL that set the boundaries. The SDL of the installed BWMS define its performance range and are clear from the time of purchase. The interim guidance neither changes that range nor allows the crew to ignore it.

1. As an example, Alfa Laval engaged the DHI Maritime Technology Evaluation Facility for supplemental testing of filter performance in Alfa Laval PureBallast 3 systems (see page 11). DHI has conducted independent BWMS type approval testing since 2010. In this case, the aim was not type approval but rather to compare the relative performance of two different filter configurations. To ensure a realistic evaluation, DHI used challenge water that was designed to replicate the naturally occurring particle size distribution found in Bremerhaven.

4. Operational limitation and operational demand

The definition of challenging water quality contains two other important concepts: operational limitation and operational demand. These define when a BWMS fails, relating to system-specific triggers that should be included in the Ballast Water Management Plan (BWMP).

Operational limitation refers to an absolute failure. This may be an automatic BWMS shutdown, a critical alarm that demands a manual shutdown according to the manual, or a shutdown required for safety reasons.

Operational demand is more complicated, as it puts failure in relation to cargo operations. It is the minimum sustained flow rate that will allow continued cargo operations without sacrificing vessel stability or safety. Defined in the vessel's BWMP, the operational demand should not exceed 50% of the treatment-rated capacity (TRC) of the installed BWMS.

For tankers and other vessels whose cargo operations require high ballast water flow, operational demand is a critical factor. Reducing flow to 50% or less (if the operational demand is defined as less in the BWMP) means poor business efficiency, plus significant added costs for long harbour stays. In addition, it has consequences for energy efficiency. The same amount of ballast water will be needed, but it will take twice the time and energy to pump it aboard.

Operational demand vs System Design Limitations

The operational demand is a percentage of the TRC in the BWMS type approval. This flow rate must be defined in the BWMP, which means it must be approved by the flag state administration or by a classification society appointed by the flag state. Although the maximum allowable value is 50% of the TRC, the actual value may be less, depending on the SDL of the installed BWMS.

As noted earlier, the SDL for an installed BWMS are unchanged by the interim guidance. The vessel must reduce the BWMS flow rate as required by the SDL. If the installed BWMS is designed to reduce flow to 25% under certain conditions, the vessel cannot claim that 50% is the minimum flow rate for cargo operations (i.e. the operational demand) when those conditions arise.

Secondary to system responsibility

As emphasized earlier, the definition of challenging water quality is only fulfilled when the BWMS is properly installed, maintained and operated. If these criteria are not met, an operational limitation or failure to meet operational demand will not justify CWQ procedures or a BWMS bypass.

5. CWQ procedures and reactive bypass of the BWMS

When a properly installed, maintained and operated BWMS encounters challenging water quality, meaning that it experiences an operational limitation or is unable to meet operational demand, the interim guidance makes allowance for bypassing it. The vessel may perform a reactive bypass without consulting its flag administration or the next port state – so long as all other possibilities have been ruled out.

A reactive bypass is one triggered by the self-monitoring functions and the performance of the BWMS during operation. In other words, the BWMS must shut down on its own or signal its inability to meet operational demand before CWQ procedures can be initiated. A reactive bypass is a final option, to be implemented only when failure is apparent and bypassing cannot be avoided.

Why not pre-emptive bypass?

The interim guidance does not give permission for a pre-emptive bypass, which is a bypass made without indication from the BWMS. A vessel cannot bypass the BWMS in anticipation of an operational limitation or failure to meet operational demand – even if issues have occurred previously in the same location. A pre-emptive bypass must always be agreed in advance between the vessel's flag administration and the port state receiving the ballast water.

The reason for this is that water quality is not constant. In a given port, it can change with the seasons, tides or weather, or even as a result of port operations. Sediment levels and organic content can fluctuate significantly, which necessitates voyage-by-voyage assessment. The self-monitoring functions of the BWMS are the best instrument to determine water quality at any given point in time.

Similarly, it is not possible to say that certain ports have challenging water quality for all vessels, because operational limitations differ between BWMS and operational demand is vessel specific. Universal permission to bypass in certain ports would defeat the intent of the BWM Convention, and it would also remove an incentive for BWMS manufacturers to improve their systems.

Bypassing is a last resort only

Even a reactive bypass must be seen as the last option. The guidance makes clear that many steps must be taken first, including verifying that the BWMS has been properly maintained.

If the BWMS is not performing at capacity, the vessel must troubleshoot and perform any assistive measures possible to ensure that the problem does not originate with the BWMS. In addition, it must utilize any available alternative to bypassing, such as restricting flow or loading less ballast.

Besides containing a vessel-specific definition of operational demand, the vessel's BWMP should include practical and realistic pre-planning measures related to CWQ conditions. A reactive bypass is only allowed when the other possibilities are exhausted.

Bypassing does not remove compliance obligations

Above all, the provisions for a reactive bypass are not permission for non-compliance with the D-2 discharge standard. If a vessel performs a bypass, its scope should be minimized and subsequent decontamination is needed. Likewise, the actions must be reported to subsequent affected ports.

When bypassing the BWMS, the vessel should load as little untreated water as possible. Ideally, the untreated water should be restricted to specific pipes and tanks, which will limit the contamination. If possible, the crew should consider a partial bypass, which avoids the inoperative part of the BWMS but utilizes its remaining functions. Planning for such steps should be included in the BWMP.

Following a bypass, decontamination is needed to restore D-2 compliance. Otherwise, organisms taken up may thrive and reproduce in the ballast tanks, thereby appearing in the discharge water. In general, decontamination means performing ballast water exchange plus ballast water treatment (BWE + BWT) in an approved location. The affected tanks and pipes must be flushed, usually in open sea, then refilled with water that has been treated by the BWMS. These steps should also be included in the BWMP.

All CWQ actions taken must be documented and reported to ports where potentially affected water will be discharged. This reporting must be done in advance, prior to the vessel's arrival.

6. It all comes down to the BWMS

In every respect, the interim guidance presents bypassing the BWMS as the exception rather than the rule. Compared to normal ballast water management, performing a reactive bypass and subsequent decontamination is both less effective from an environmental perspective and less convenient from an operational perspective. It is also detrimental from an energy-efficiency perspective, because the ballast pumps will be run an extra time (as will the lamps of a UV system if partial treatment is employed).

Neither the BWM Convention nor the interests of individual vessels would be well served by bypassing the BWMS regularly. This is why, throughout the interim guidance, the selection and care of the BWMS are highlighted repeatedly.

The importance of BWMS of selection

As explained earlier, the guidance does not overwrite the SDL of the BWMS installed. The BWMS must be operated within its SDL, even if that means limiting operations to ensure compliance. Temperature and salinity, which are key SDL parameter for EC systems, are completely ruled out as reasons for a reactive bypass. If UV systems are designed to reduce flow rate at a given UV transmittance, their owners cannot use the reduction to motivate a bypass when it occurs.

Simply put, shipowners must approach BWMS selection carefully, using the SDL as key indicators. They should avoid choosing a BWMS whose SDL might lead to complications where the vessel sails. The interim guidance urges the choice of “the most suitable BWMS, as known and available, for the circumstances of the ship”, meaning the actual water conditions in which the vessel will operate.

The importance of BWMS installation and upkeep

No matter which BWMS is selected, the guidance points out that proper installation and maintenance are vital. A reactive bypass cannot be justified by installation deficiencies, malfunction or lack of care. Before a bypass is performed, all such factors should be ruled out.

The BWMS must always be maintained and operated according to the manufacturer’s instructions in the system manual. If issues like filter clogging are a persistent issue, despite proper maintenance, the BWMS manufacturer should be contacted. In some cases, such issues can be rectified by correcting a piping arrangement, installing a backflush pump to enhance filter performance or adjusting the system settings. It may also be possible to upgrade the filter or other equipment.

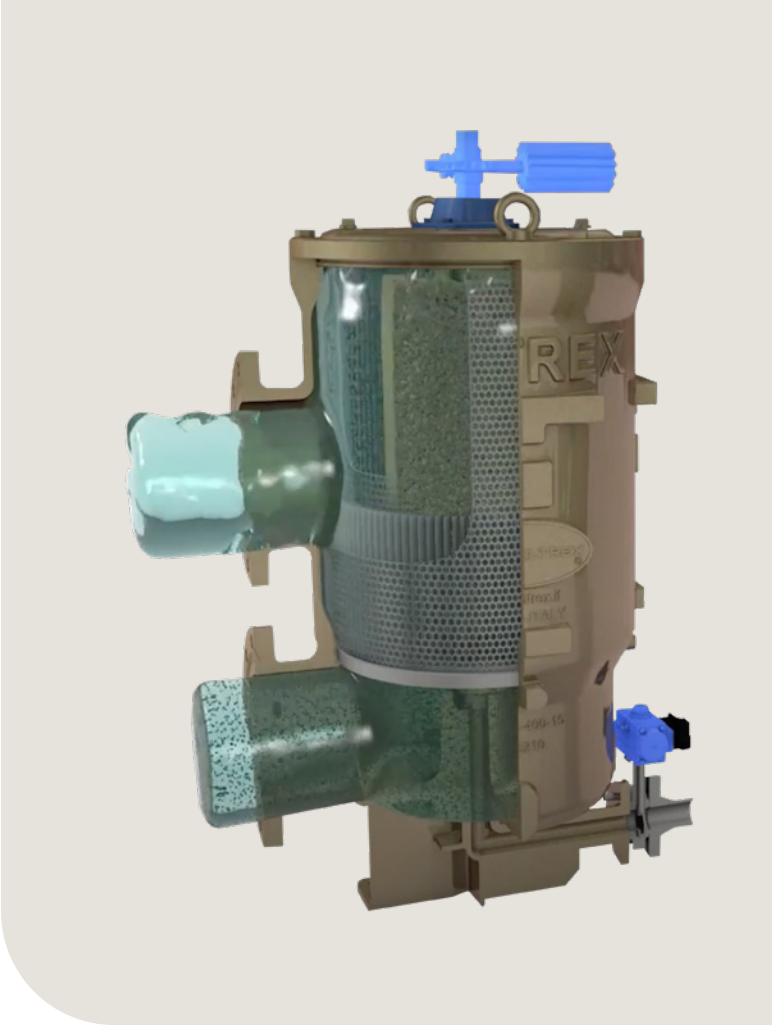
Because a reactive bypass is a last resort with environmental and operational consequences, everything possible should be done to prevent it.

7. Alfa Laval PureBallast and challenging water quality

Alfa Laval's own ballast water management solution, Alfa Laval PureBallast, employs filtration and UV treatment. For all UV systems, there are two situations in which CWQ conditions could arise. The first is water with low UV transmittance, which could result in UV intensity below the SDL. The second is high sediment load, which could lead to increased differential pressure and cause filter clogging.

Today's generation of Alfa Laval technology, PureBallast 3, handles even very low UV transmittance values. When operating in IMO-regulated waters with brackish or marine water, PureBallast 3 systems maintain full flow where the UV transmittance is as low as 42%. Moreover, PureBallast 3 systems have a high-quality filter with excellent performance and enhanced cleaning.

No BWMS is completely immune to CWQ conditions, however. For PureBallast 3 owners who regularly encounter CWQ conditions on their trade routes, Alfa Laval has additional offerings that can reduce the risk of an inconvenient bypass.



PureBallast 3 filter performance upgrade

The BWMS filter removes larger organisms and reduces sediment accumulation in the ballast tanks. Having worked continuously to improve filter performance, Alfa Laval has developed a performance upgrade that enhances the already high self-cleaning efficiency of the Filtrex filter in PureBallast 3 systems.[2]

The upgrade package improves filtration, reduces the risk of clogging and extends filter lifetime. It comprises three options can be selected together or individually:

- An additional backflush pump to provide more pressure during backflushing, which ensures the correct flow for effective cleaning of the filter mesh
- A faster gear motor to increase the rotation speed of the filter backflush shaft, which results in more frequent and thorough cleaning of the filter mesh
- An electric actuator to replace the pneumatic actuator of the control valve, which ensures smoother operation and sufficient system pressure that benefits filtration

The upgrade package helps to maintain BWMS flow rate during operation in challenging waters. The faster gear motor, for example, was tested at the DHI Maritime Technology Evaluation Facility using water with a particle size distribution reflecting challenging water collected in Bremerhaven.[3] It allowed the filter to sustain full flow at almost double the sediment load compared to the standard gear motor, still removing an equal amount of sediments. The faster gear motor is therefore recommended for all PureBallast 3 systems that struggle in challenging waters despite having sufficient backflush flow (e.g. after installing a backflush pump).

CWQ guidance for PureBallast

For all PureBallast owners, Alfa Laval has prepared documentation that explains how the BWMS should be operated in CWQ conditions. The documentation focuses on PureBallst 3 systems, but it is broadly applicable to all PureBallast generations. It takes the interim guidance into account, explaining the specific CWQ triggers for PureBallast and actions that should or should not be taken in a CWQ situation.

PureBallast Compliance Service Package

The interim guidance emphasizes the importance of correct BWMS installation and maintenance with relation to challenging water quality. In addition to troubleshooting potential installation issues, Alfa Laval Marine Service experts can take regular steps to secure BWMS health and compliance. The PureBallast Compliance Service Package provides the annual system inspections, function checks, calibrations and crew training required for compliance.

2. Early PureBallast 3 systems may have other filters installed, and the upgrade is not applicable for these filters. Nor is it needed for PureBallast 3 Ultra systems, where the upgrade features are already incorporated.
3. DHI has conducted independent BWMS type approval testing since 2010. The water for these tests was based on ambient water collected by a vessel while encountering filter challenges in Bremerhaven harbour. The designed water comprised ambient brackish water augmented with a mixture of quartz and kaolin. A full test report is available from Alfa Laval upon request.

To learn more about Alfa Laval PureBallast and the offerings presented here, please visit www.alfalaval.com/pureballast

This is Alfa Laval

Alfa Laval is active in the areas of Energy, Marine, and Food & Water, offering its expertise, products, and service to a wide range of industries in some 100 countries. The company is committed to optimizing processes, creating responsible growth, and driving progress – always going the extra mile to support customers in achieving their business goals and sustainability targets.

Alfa Laval's innovative technologies are dedicated to purifying, refining, and reusing materials, promoting more responsible use of natural resources. They contribute to improved energy efficiency and heat recovery, better water treatment, and reduced emissions. Thereby, Alfa Laval is not only accelerating success for its customers, but also for people and the planet. Making the world better, every day. It's all about *Advancing better*™.

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