

## Membrane BioReactor

Grey and Black Water Treatment

# Leaders in environmental solutions for ships



Picture courtesy of P&O Princess Cruises

The increased size and number of cruise ships has led to concerns on the impact of their waste discharges on the natural environment.

Hamworthy has met the challenge of protecting the environment head-on. The Membrane BioReactor (MBR), is based on biological degradation and membrane separation. This process produces the highest quality discharge without requiring any addition or generation of chemicals that are hazardous to the environment or ship operation.

Effluent quality tests conducted by the US National Sanitary Foundation on Hamworthy's MBR produced results exceeding the most stringent future legislative pollutant standards envisaged (page 4).

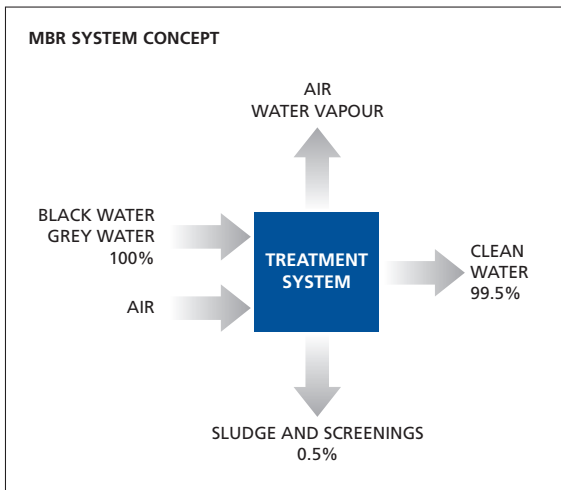
With over 30 years experience in wastewater treatment, Hamworthy is ready to serve the needs of the marine industry and the environment.



Typical MBR installation

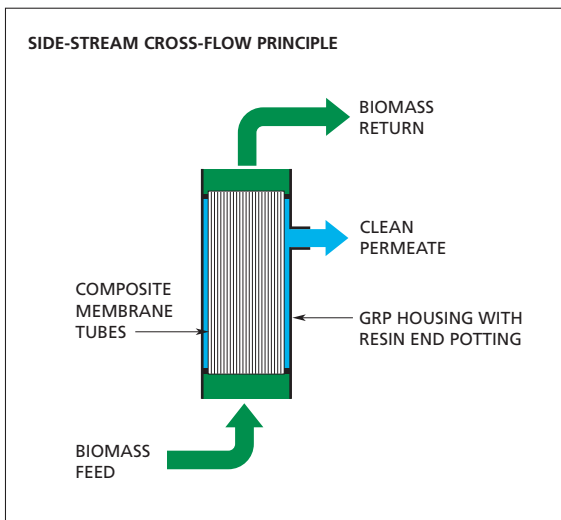
## Proven technology

Hamworthy has over 7000 conventional sewage plants in operation around the world, more than any other supplier. The innovative MBR system is an evolution of the proven sewage treatment plant technology, which allows for the treatment of grey and black water to satisfy the most stringent standards.



## MBR system benefits

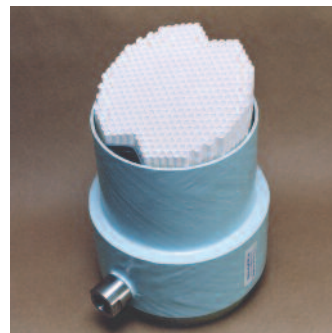
- IMO and USCG certified.
- Simple design comparing to physical chemical systems and hybrid systems.
- Simple operation requiring low skill levels.
- Safe, reliable operation with no coagulation, flocculation, chemical oxidants, or pH neutralisation.
- Compact design saving space and weight.
- Robust construction for long life and low maintenance.
- Membrane integrity is visible and secured.
- No odour emissions due to biological process.
- Complete flexibility with newbuild, conversion and retrofit options.
- One supplier, one complete system.



## Ultrafiltration membrane modules

The MBR systems utilise side-stream cross-flow membrane configuration. The membrane module has robust GRP housing perfectly suited for ship board environment.

The module contains large numbers of ultrafiltration membrane tubes designed to achieve very high permeate production under the cross-flow scouring velocity with minimum risks of any blockage.



Sectional membrane module

# Market drivers



## Regulatory

- IMO Regulations for the quality of black water discharges.
- USCG/EPA indications that grey water discharges will be regulated and monitored.
- NATO navy strategy for environmentally sound warships.
- Indication that discharge consents for offshore platforms will be aligned with marine standards.
- Other national and regional regulatory requirements.

## Customer requirements

- Meet and exceed the likely regulatory requirements for both new and existing installations.
- Maintain a more proactive public image.
- Minimisation of size and weight.
- Lowest possible cost of ownership.

## Effluent discharge quality comparisons

Independent test results recorded by the US National Sanitary Foundation show that effluent quality standards are far in excess of those required by International standards.

Item	Units	USCG 33CFR 159 PT1-300	IMO MEPC.2 (vi)	USCG/Alaska 33CFR 159.309	Hamworthy Test Results
Test Duration	-	10 days	10 days	30 days	31
Suspended Solids	mg/l	150	50 (100 at sea)	30	3.1
BOD <sub>5</sub>	mg/l	Not required	50	30	2.6
Faecal Coliform	Count/100ml	200	250	20	10.6
pH	-	Not required	Not required	6.0 - 9.0	Within limits
Chlorine	µg/l	Not required	As low as practicable	10.0	0

Hamworthy continues to optimise the MBR system design. By building on our successful experiences and working closely with customers, we have successfully rolled out the MBR Mk II and Mk III systems across wider marine and offshore sectors, with reduced energy consumption, costs and importantly, operational man-hours.

## Features of MBR performance

Hamworthy MBR technology achieved outstanding performance in Alaska under the scrutiny of the local authority, USCG and USEPA studies over the past seasons. The membrane permeate quality exceeds the most stringent coliform standards even without additional UV or chemical disinfection. According to the independent USEPA Cruise Survey in 2004, this simple system readily removed over 70% of total Nitrogen and Phosphorus. The latest system optimisation have achieved over 25% savings on energy consumption and consumables, and over 50% reduction in operational man-hours. Satellite communication allows the MBR systems to be remotely monitored by specialists as part of our fleet support program.

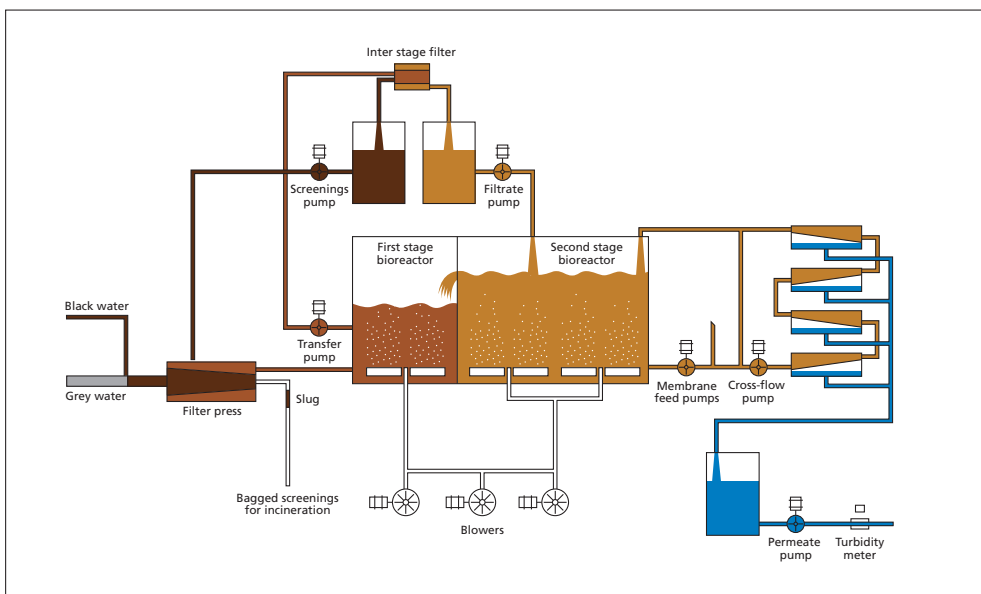
## Principles of operation

Black and grey water passes through the automatic screen press into the first stage bioreactor where the active biomass degrades organic material. The active biomass is pumped through an interstage filter fitted with fine mesh.

The filtered biomass, free of any fibrous materials, is returned into the second stage bioreactor. Biomass is circulated through membrane modules to produce a trans-membrane pressure and scouring velocity. Clean permeate is taken from the membrane modules. The concentrated biomass is returned to the second stage bioreactor for discharge. The system is automated.



MBR control panel



# Complete flexibility

Following the successful introduction of our advanced wastewater treatment technology Hamworthy has established a rapidly growing installation base all supported by our team of wastewater treatment specialists who are there to help you design your bespoke system.



P&O Princess Cruises' *'Sun Princess'*



*'Safe Astoria'*



MoD Type 45 Destroyer

## Cruise Newbuilding and Conversion

A total of thirteen vessels in the *'Carnival Cruise Lines'* fleet have been converted to utilise MBR technology for black and grey water treatment.

In addition two vessels in the *'Regent Seven Seas'* fleet and one vessel in the *'Royal Caribbean International'* fleet have been retrofitted with MBR units.

The Cunard *'Queen Victoria'* and the Holland America *'Signature'* newbuilds at Fincantieri Shipyard, Italy plus the *'Aida'* newbuilds at Meyer Werft Shipyard, Germany have been fitted with Hamworthy MBR technology.

Two newbuilds for *'Seabourn Cruises'* at Mariotti Shipyard, Italy are to be fitted with Hamworthy MBR technology.

Independent testing of the effluent has enabled certification to be issued to allow overboard discharge in Alaskan waters.

## Ferries

The *'British Columbia Ferries'* newbuild at Vancouver Shipyard are to be fitted with MBR technology.

## Offshore

The semi-submersible drilling rig *'Dada Gorgud'* operated by Caspian Drilling Company and owned by SOCAR has been retrofitted with MBR technology.

## Military Newbuild

Hamworthy has been contracted to supply advanced MBR wastewater treatment systems to the MoD for the Type 45 Destroyers being constructed at BAE Marine at Scotstoun and Vosper Thornycroft at Portsmouth. Hamworthy is among the first Tier 1 companies to be awarded contracts on all six vessels.

We have just completed final plant design and received design approval for Hamworthy MBR technology for the Royal Navy's aircraft carrier project. Should the Ministry of Defence award the contract then Hamworthy will receive these orders.

Hamworthy MBR wastewater treatment systems, which will handle both black and grey water, are being fitted in anticipation of more stringent environmental legislation during the vessels lifetime.

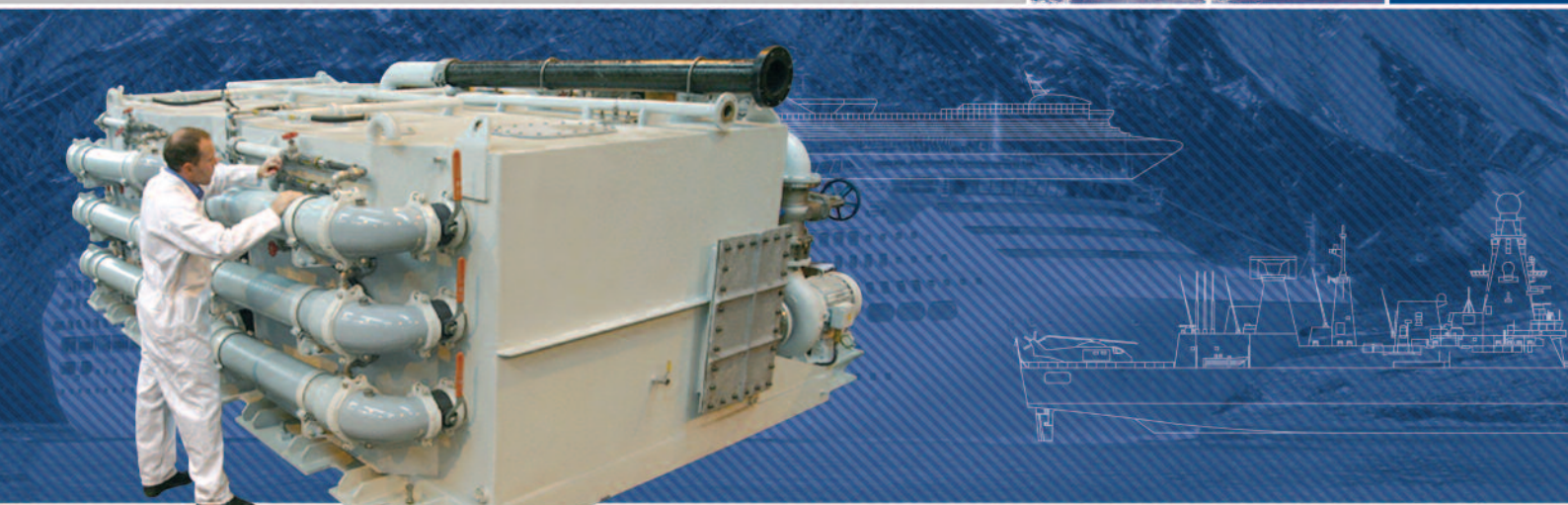
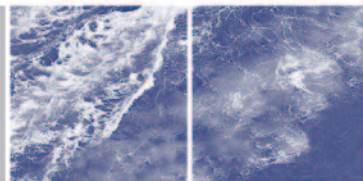
# Project management

Assistance will be given to ensure complete project control from conception through to operation and service support.



## MBR Reference List

	Ships Name/Hull No.	Installation Type	MBR Model	Mk No.	Complement	Capacity (m <sup>3</sup> /Day)
Military	HMS Daring	Newbuild	MBR50N	1	235	100
	HMS Dauntless	Newbuild	MBR50N	1	235	100
	HMS Diamond	Newbuild	MBR50N	1	235	100
	HMS Dragon	Newbuild	MBR50N	1	235	100
	HMS Defender	Newbuild	MBR50N	1	235	100
	HMS Duncan	Newbuild	MBR50N	1	235	100
	HMS Queen Elizabeth	Newbuild	MBR200N	3	1450	324
HMS Prince of Wales	Newbuild	MBR200N	3	1450	324	
Offshore	Dada Gorgud	Replacement	MBR40	2	120	40
	Dada Istiglal	Replacement	MBR2	2	120	9
	Safe Astoria	Replacement	MBR4	3	250	82
	Keppel Fels B302	Newbuild	MBR4	3	500	100
Cruise and Ferry	Seven Seas Mariner	Replacement	MBR240R	1	1200	480
	Star Princess	Conversion	MBR320C	1	4400	960
	Diamond Princess	Conversion	MBR320C	1	4400	960
	Sapphire Princess	Conversion	MBR320C	1	4400	960
	Coral Princess	Conversion	MBR320C	1	3500	640
	Island Princess	Conversion	MBR320C	1	3500	640
	Dawn Princess	Conversion	MBR240C	1	2920	720
	Sun Princess	Conversion	MBR240C	1	2920	720
	Pacific Princess	Replacement	MBR160R	1	1150	320
	Regal Princess	Conversion	MBR160R/240R	1	2419	400
	Grand Princess	Conversion	MBR320C	1	4160	640
	Golden Princess	Conversion	MBR320C	3	4160	960
	Sea Princess	Conversion	MBR12	2	3150	454
	Royal Princess	Conversion	MBR6	2	1150	201
	Pacific Sun	Replacement	MBR12	2	2653	200
	Pacific Sky	Replacement	MBR240R	1	2200	480
	Ocean Village	Replacement	MBR240	2	2000	240
	Pacific Jewel	Replacement	MBR12	2	3010	225
	Queen Victoria	Newbuild	MBR320N	3	2200	620
	Queen Elizabeth	Newbuild	MBR320N	3	3472	640
	Hull 681 Mega Yacht	Newbuild	ST10(V) / MPU	2	120	17
	Aida 1	Newbuild	MBR600N	3	3134	1200
	Aida 2	Newbuild	MBR600N	3	3134	1200
	Aida 3	Newbuild	MBR600N	3	3134	1200
	Aida 4	Newbuild	MBR600N	3	3134	1200
	Aida 5	Newbuild	MBR600N	3	3134	1200
	Aida 6	Newbuild	MBR600N	3	3134	1200
	Century	Replacement	MBR480R	3	2600	960
	Eurodam H6149	Newbuild	MBR360N	3	2800	720
	BC Ferry	Newbuild	MBR40	2	600	15
	Seabourn Odyssey	Newbuild	MBR140	2	800	280
	Seabourn Sojourn	Newbuild	MBR140	2	800	280
MAR 064	Newbuild	MBR140	2	800	280	
Nieuw Amsterdam H6181	Newbuild	MBR360N	3	2800	720	
Marghera H5989	Conversion	MBR24	3	3700	1200	
Marghera H5990	Conversion	MBR24	3	3700	1200	
Meyerwerft H687	Newbuild	MBR32	3	5600	1729	
Meyerwerft H688	Newbuild	MBR32	3	5600	1729	



Hamworthy Water Systems Limited  
Fleets Corner Poole  
Dorset BH17 0JT  
England

tel: +44(0)1202 662600  
fax: +44(0)1202 668793  
e-mail: [mbr@hamworthy.com](mailto:mbr@hamworthy.com)  
web: [www.hamworthy.com/wastesystems](http://www.hamworthy.com/wastesystems)

A subsidiary of Hamworthy plc



The manufacturers reserve the right to alter the specification and data to incorporate improvements in design. Certified drawings will be issued on request.

© All details copyright Hamworthy plc.