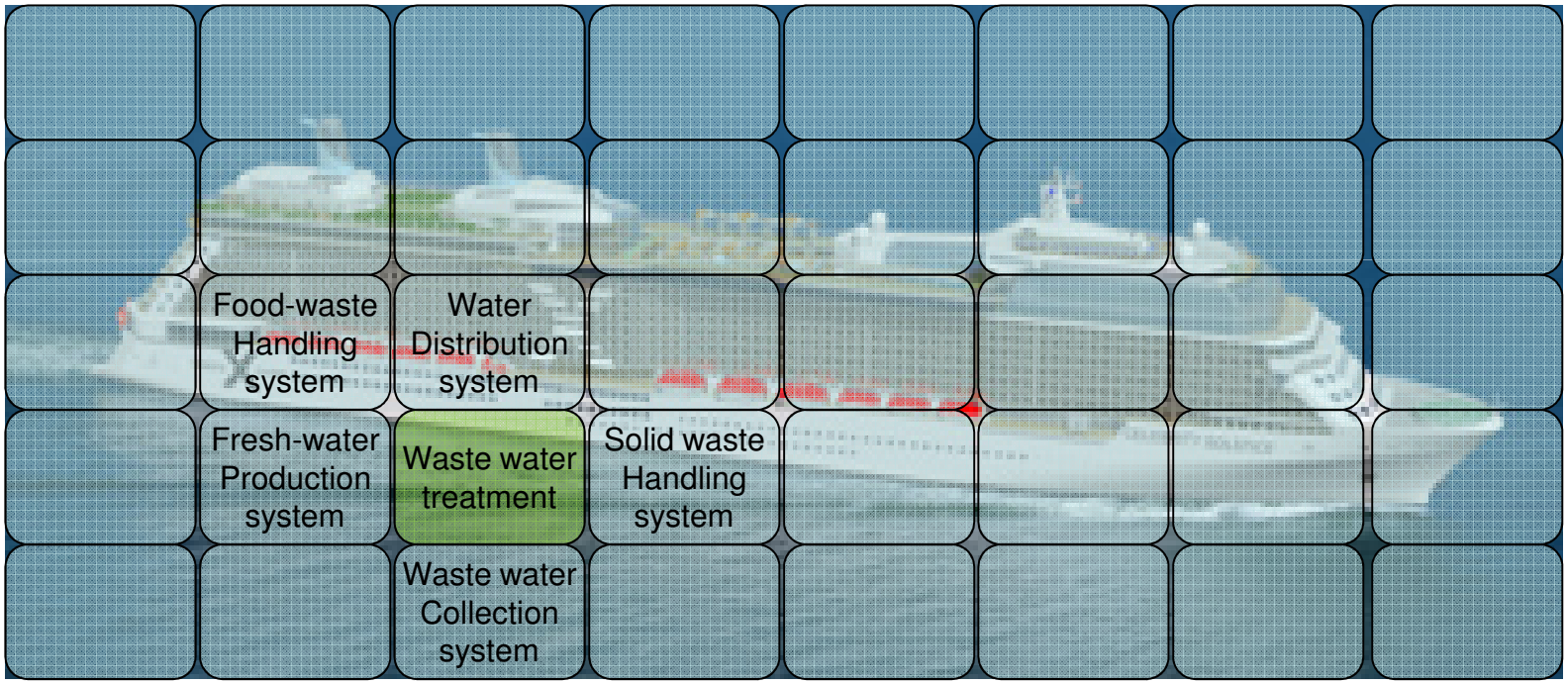
Cruise ship wastewater
Science Advisory Panel (SAP)
22th September 2011

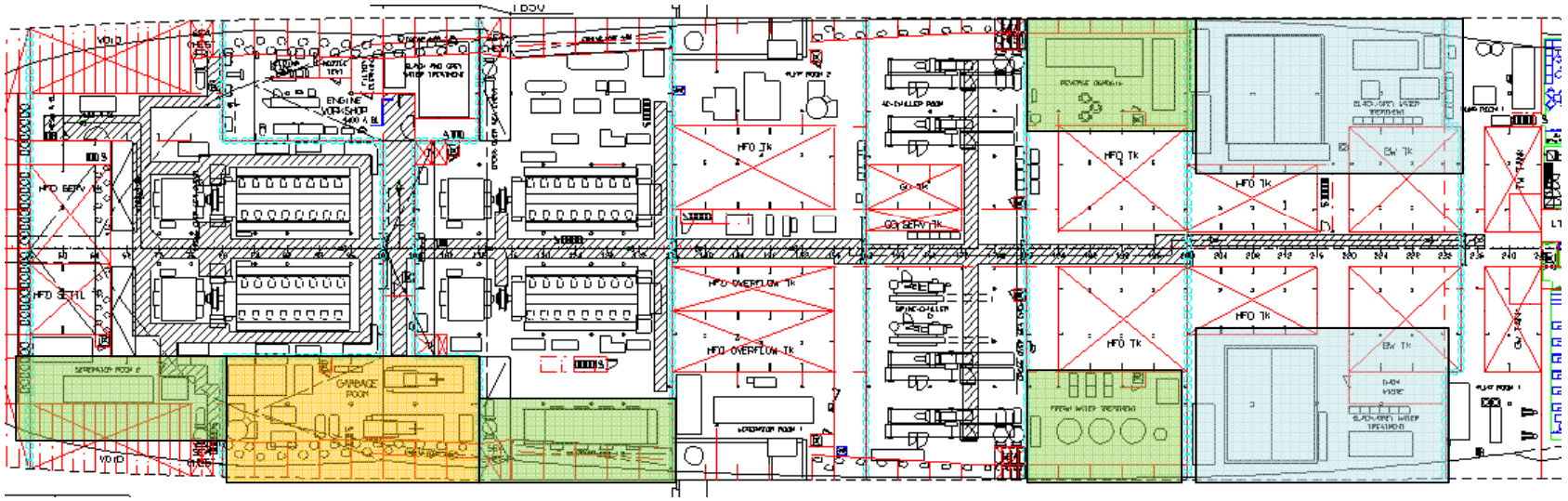
Basic information on system integration waste water treatment in ship building and data collection for the report

MEYER WERFT
PAPENBURG 1795

Space consumption equipment for waste water treatment for Cruise ship new building



Space consumption equipment for waste water treatment for Cruise ship new building



Waste water treatment system

Waste water treatment system

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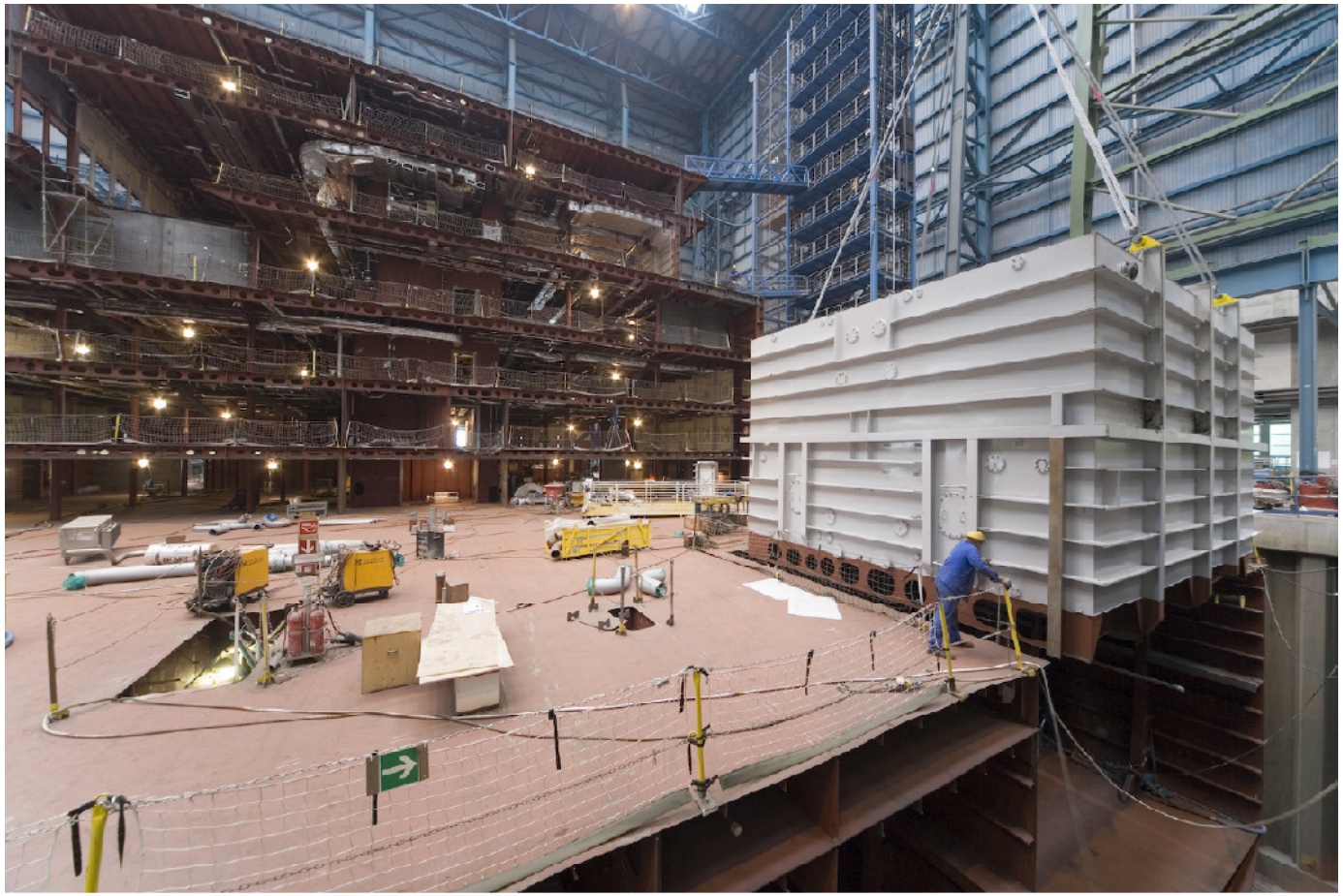
Waste water treatment systems

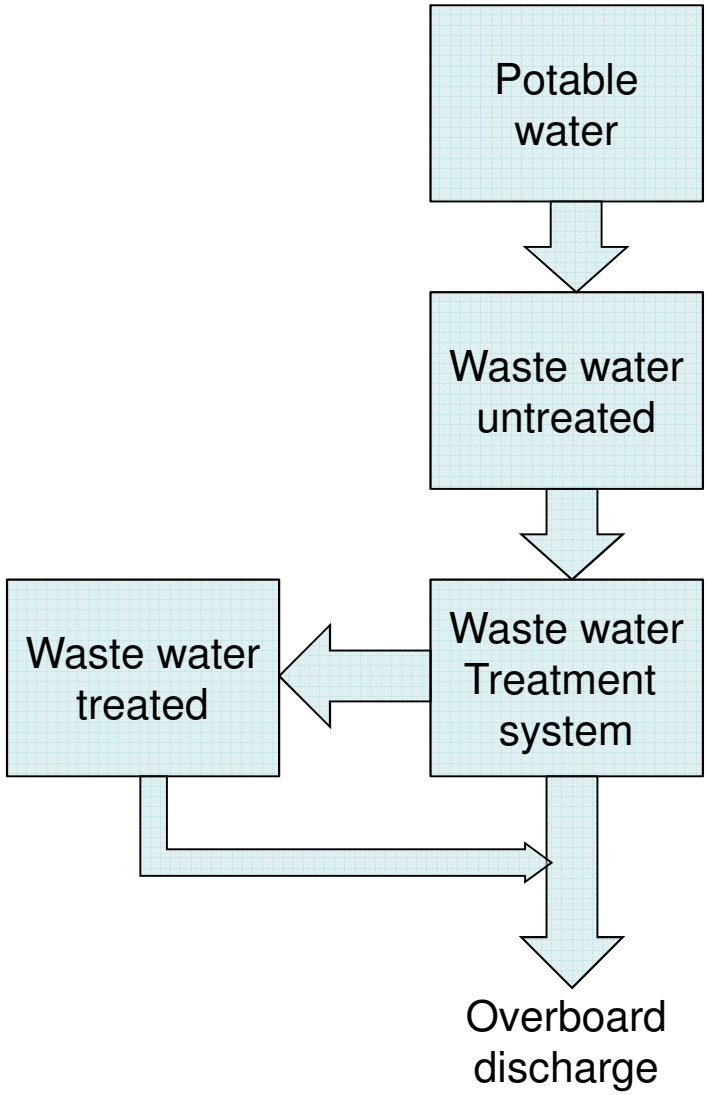
Challenges in Installation, commissioning and operation



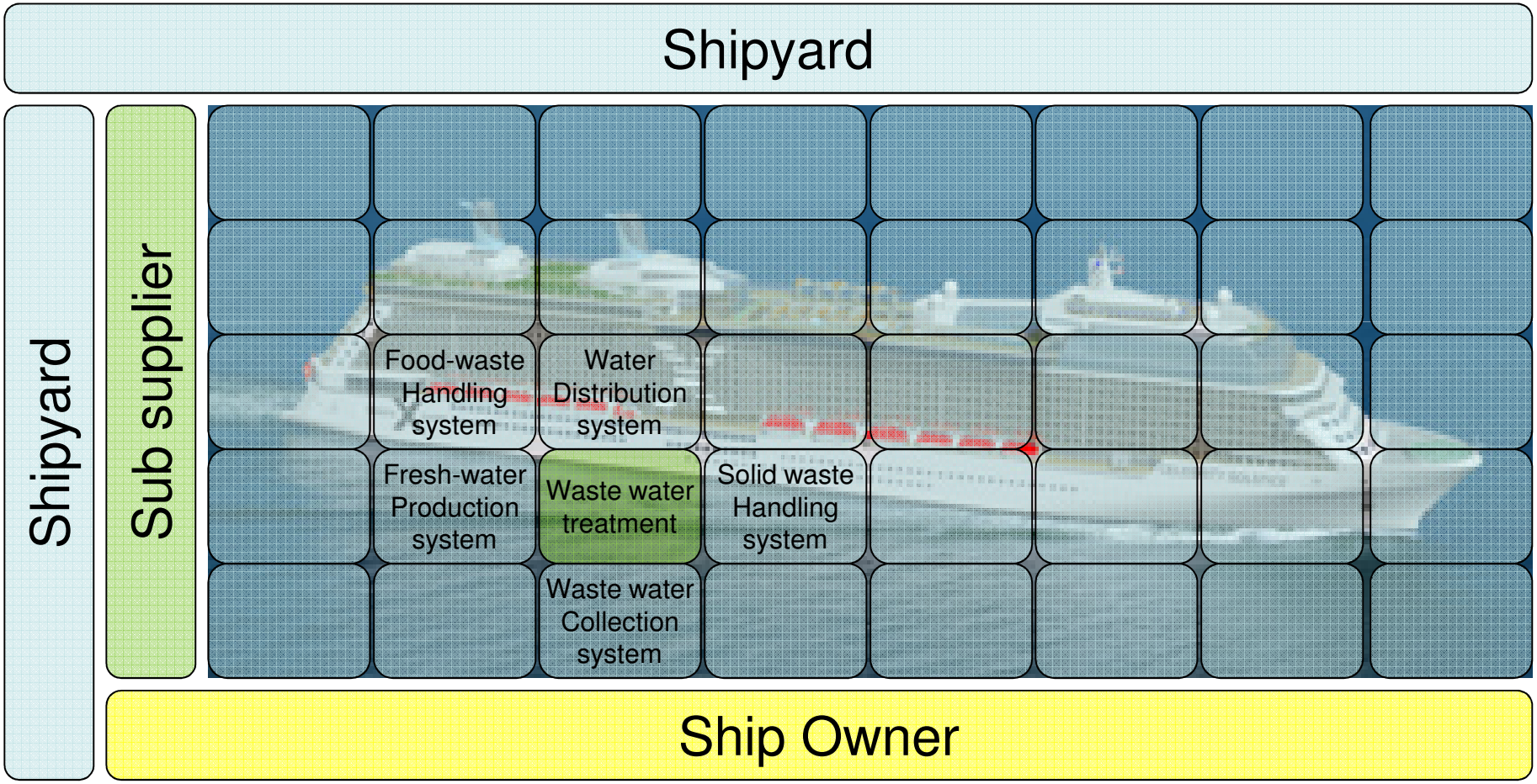
Installation of bioreactor

Space consumption for waste water tanks for Cruise ship new building

	Volume in %
Fuel oil / Lubrication oil	27
Potable water	28
Waste water treated / untreated	21
Ballast water	17
Other tanks	7



Contractual responsibilities for Cruise ship new building



Contractual responsibilities for Cruise ship new building

Shipyard	Integration of the system in the ship Cross connection to other relevant systems Responsible for the whole functions and performance of the ship against the Owner
System supplier	Technical development of the system Performance guarantee for the system itself Responsible for the function and performance against the shipyard
Ship Owner	Operation of the system according system supplier requirements. Providing of adequate crew for operation. Using consumables according to system supplier.

Contractual responsibilities for cruise vessel retrofit

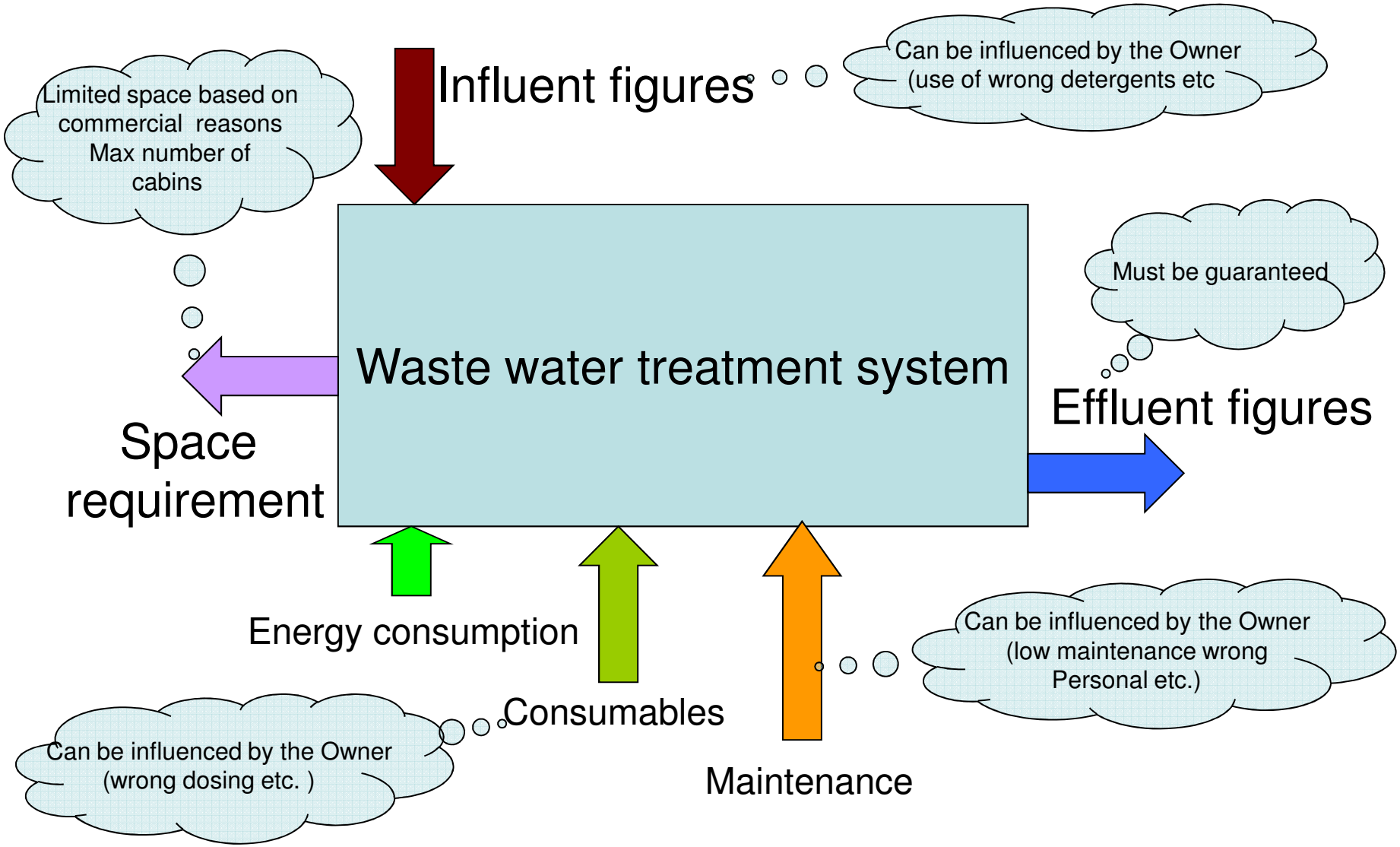
System supplier

Technical development of the system
Performance guarantee for the system itself
Responsible for the function and performance against the Owner

Ship Owner

Operation of the system according system supplier requirements.
Providing of adequate crew for operation.
Using consumables according to system supplier.
Integration of the system in the ship.
Cross connection to all other relevant systems

Waste water treatment design parameter



Waste water treatment design parameter

The waste water treatment system will be designed according to the following design parameter

- Influent figures for waste water.
- Required Effluent figures by rules.
- Number of person on board.
- Space requirement
- Operation cost

Waste water treatment design parameter

Influent figures

- The system design for the waste water treatment is based on estimated average influent figures based on the experience of the industry.
- This figures are not standardized, different manufacturer and different owner will use partly different figures for the system design.
- The real figures can have big deviations from the estimated design figures based on the operation behavior of the passenger and the crew

Waste water treatment design parameter

Influent figures

	Vol(%)	COD (mg/l)	BOD5(mg/l)	TSS (mg/l)
Hotel	67%	500	200	100
Galley	16%	5,000	2,500	2,500
Laundry	9%	300	100	300
Black water	7%	7,000	2,500	1,500
De-watering waste water	1%	30,000	20,000	10,000
TOTAL	**100%**	**1,900**	**900**	**700**

Table 1 Summary of average influent figures used by the industry

Waste water treatment design parameter

Effluent figures

- The system is designed to fulfill at least international rule requirements IMO MEPC.
- For Cruise vessels mostly the design will be in accordance with local requirements (Alaska etc.).
- In addition some of the Owner require reductions of the required figures to keep redundancy in the system.

Waste water treatment design parameter

Effluent figures

	MEPC.2(VI)	33 USCA § 1901 Note (Alaska)	MEPC 159(55)
BOD_5	< 50 mg/l	< 30 mg/l	< 25 mg/l
TSS	< 50 mg/l	< 30 mg/l	< 35 mg/l
Total coliforms	< 250 cfu/100 ml	< 20 cfu/100 ml	< 100 cfu/100 ml
ph	n.a	6.0 - 9.0	6.0 - 8.5
Residual chlorine	n.a	< 10 micrograms/l	n.a

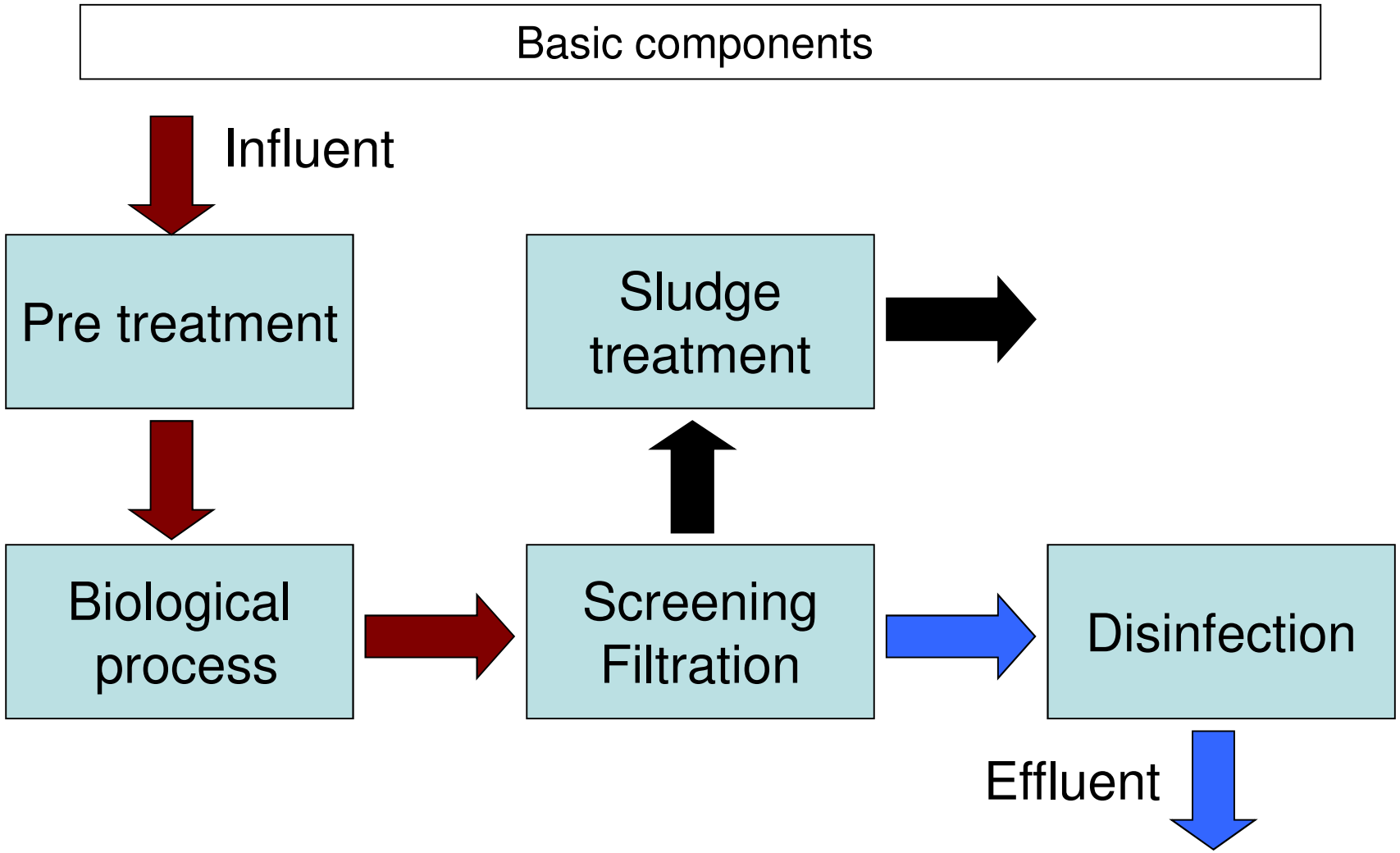
Table 2. Comparison effluent figures between IMO MEPC and Alaska

Waste water treatment systems

Meyer Werft experience waste water treatment systems

	Flocculation System Scanship	4 systems 2005 -2007
	Membrane system external Membrane Hamworthy	5 systems 2007 -2010 2 systems 2012- 2013
	Membrane system Internal Membrane RWO Violia	5 systems 2008 -2010 1 systems 2012
	Membrane system external Membrane Hamworthy	1 systems 2011 1 systems 2012
	Flocculation System Scanship	2 systems 2013 -2014

Waste water treatment systems



Collection of information for the Report

- The information required for the report must come from the system supplier and technique provider.
- This was the reason that the Meyer Werft has ask the system supplier to provide the information which can be incorporated into the report.
- To collect comparable data for the reports the companies was ask to structure the input according to the structure in the draft report.

❖ Primary (solid separation) pre-treatment
❖ Secondary (Organic Digestion) biological process
❖ Tertiary (clarification) screening, filtration, etc.
❖ Disinfection
❖ After treatment (sludge treatment)

Collection of information for the Report

- Meyer Werft ask their system supplier by e-mail if they a willing to give this information (19th August 2011). The deadline for the delivery of the information was the 9th September 2011.
- A reminder was send by E-Mail at the 9th of September to the companies which have not submitted the information.

Collection of information for the Report

Final status of information 16.09.2011

Company	Confirmation to give a feed back	Feedback on Reminder	Delivery of information
Hamworthy	23.08.2011	-	6.09.2011
Headworks	23.08.2011	13.09.2011	18.09.2011
Evac	19.08.2011	15.09.2011	No
Scanship	22.08.2011	No	No
RWO Violia	19.08.2011 Information is contained in the quotation given to DEC	13.09.2011	No Quotation to DEC is submitted to Meyer Werft

First results from supplier

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First results from supplier

Hamworthy Water Systems Ltd Fleetsbridge, Poole, Dorset BH17 0JT, England	MBR Process Descriptions	Rev 1	Sht 1 of 63
	Hamworthy MBR Process Descriptions		

The Hamworthy Membrane BioReactor (MBR) plant provides biological treatment to Black water and all Grey Water streams which include galley, laundry, sanitary, waste food water produced from the ship. The treatment plant also provides treatment to dryer condensate, and decanter return liquor where applicable.

The overall process comprises:

1. Primary (solid separation) pretreatment
2. Secondary (Organic Digestion) biological process
3. Tertiary (clarification) screening, filtration, etc.
4. Disinfection
5. After treatment (sludge treatment)

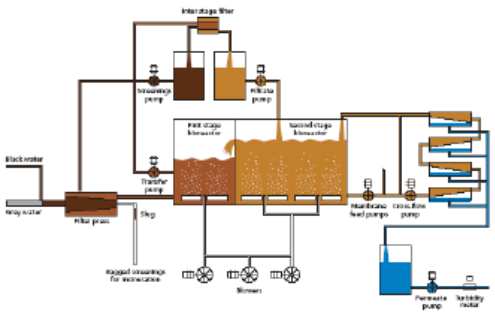

Figure 1: MBR Process Diagram

1. Primary treatment - pre-treatment

Black water from the vacuum system is pumped to the First Stage Reactor via a Screen Press. Black water feed is given precedence over grey water feed. Flow from various collection tanks is pumped to a grey water-Mixing Tank. Mixed grey water flow is then pumped to the First Stage BioReactor directly, or alternatively, via Screen Press. The Mixing Tank can receive black water if so required by the client. In such cases, the Mixing Tank content is managed as black water in accordance with the IMO rules. Dyer condensate and decanter liquor can be directly transferred to the First Stage BioReactor.

Hamworthy Water Systems Ltd Fleetsbridge, Poole, Dorset BH17 0JT, England	MBR Process Descriptions	Rev 1	Sht 2 of 63
	Hamworthy MBR Process Descriptions		

Within the Screen Press, solids of particle size greater than 2 mm are removed from the flow and dewatered for subsequent disposal in ship's incinerator. Screened flow passes on to First Stage Bioreactor. The operation of the Screen Press is fully automatic.

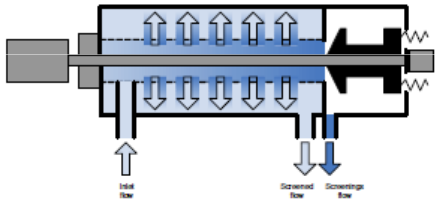

Figure 2: Screen Press Operation

For applications where manual handling of dewatered screenings is not desirable, Vibration Filters mounted with 150 um st. st. mesh are used instead. The Vibration Filters will produce a screenings slurry which can be pumped for disposal or further treatment.

2. Secondary treatment - biological process

The screened wastewater passes to the First Stage BioReactor. From the First Stage BioReactor the biomass is transferred to the Second Stage via the Inter-Stage Filtration (ISF) units. Excess flow is returned to the First Stage from the Second Stage via a weir between the Second and First stages, providing a constant flow of aerated biomass to the First Stage. The First and Second Stage BioReactor are aerated using Blowers. The air provides oxygen for the biomass to break down the organic matter, and also provides mixing energy to keep the biomass in suspension. BOD and ammonia are removed from the raw sewage in these two stages and converted to carbon dioxide water and new cell mass.

ISF remove fines and fibrous materials from the mixed liquor in the First Stage BioReactor. Screenings are retuned to upstream of the Screen Press. Fibrous material separated by ISF is then further removed from the system by the Screenpress. The machine is fully automatic, and its performance can be conditioned using viable speed adjustment.

ISF is not required if Vibration Filters are used in the place of Screen Press.

First results from supplier

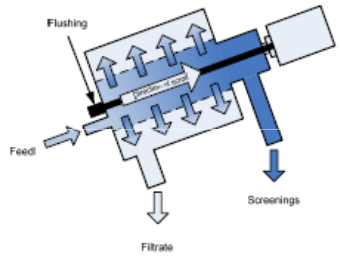

Figure 3: Operation of the Inter Stage Filter (ISF) Unit

1.1. Tertiary - membrane filtration

The membrane modules incorporate 8mm diameter ultra-filtration tubes protected by GRP housing. The ultra-filtration membrane material have a pore size of 0.040 micron, comparing to a typical bacteria of 1 micron. Thus the Membrane is a physical barrier to all bacteria and most viruses. The material is hydrophilic (water loving), which minimises organic fouling, and it is also robust against chemical attack.

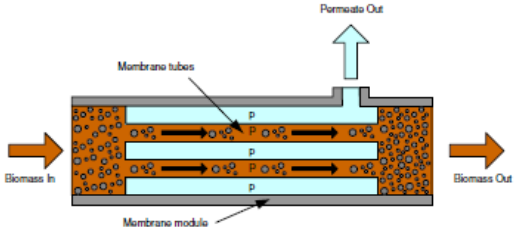

Figure 4: Membrane module

The Cross Flow Pumps are used to generate a Cross Flow Velocity across the membrane surface. This provides a scouring effect, keeping membrane surface clean. The pumps also generate a Trans-Membrane Pressure which forces the permeate from inside the membrane tubes.

The treated effluent and mixed liquors are pumped from the Second Stage BioReactor to the Membrane Crossflow Loop by Membrane Feed Pump(s). Crossflow Pumps then circulate the liquor through the Crossflow Loops containing banks of Membrane modules. The now concentrated mixed liquid in the Crossflow Loop are returned back to the Second Stage BioReactor.

Permeate, i.e. the treated wastewater, is taken from the membrane modules through flow control valves and flow meters, and passes to the Permeate Tank. It is then pumped to overboard, or port reception facilities, or to ship's holding tank.

A sample point is provided on the Permeate Pump discharge to allow real-time monitoring of the effluent quality (turbidity).

A membrane Cleaning Tank is provided to facilitate a set semi-automatic cleaning-in-place (CIP) procedures, which will keep the membrane modules free of biological fouling or blockage.

3. Disinfection

During treatment, Hamworthy's MBR can guarnatee the most stringent Alaska Faecal coliform limits without any disinfection process. This is due to robust membrane integrity which can be easily inspected and maintained.

UV units can be provided if so required by the client.

4. After treatment - sludge treatment

Sludge from the Bioreactors is pumped to the BioSludge Tank, Where the content is aerated to prevent odour or anaerobic conditions. From the BioSludge Tank, the sludge can be 1) held onboard for discharge to port reception facilities, or 2) held onboard for disposal to deep seas, or 3) for further treatment onboard including sludge dewatering, drying and incineration. Hamworthy do not provide sludge treatment systems as in option 3).

It is our understanding that the latest studies carried out by the industry did not conclude which of the above three options are more sustainable or with the least environmental impacts, especially when considering the on-going spread of ECA, increasing restrictions to incinerator operation, and carbon reduction targets.

Next steps

- How can we get the outstanding information's ?
- Confidentiality
- Who will summarize the collected information and prepare a neutral description according to the structure of the Report ?