The Application on Regulation for Ballast Water Treatment

General

- It is estimated that shipping transfers abt.10 billion tones of ballast water each year around the world

- The invasion of foreign species through ship's ballast water is a world-wide economical and ecological threat

The IMO Convention

- The International Maritime Organization (IMO) and other international bodies to take action to address the transfer of harmful organisms by ship's ballast water.

- On February 13, 2004, IMO adopted a new convention (Control and Management of Ship's Ballast Water and Sediment) in which ballast water exchange and/or ballast water treatment will be required on all vessels

Ballast Water Management procedures

1. Ballast Water Exchange Standard

(Regulation **D-1**)

-- Tentative Measures until comply with D-2

2. Ballast Water Performance (treatment) Standard

(Regulation **D-2**)--- Ballast Water should be treated

-- Not come into force yet

At the moment most new ships are still following D-1 standard, but the space for installing B.W. treatment should be considered

Ballast Water Exchange (D-1 Standard)

1. Sequential method

--- 95% of Ballast water from ballast tank discharge to overboard then filling clean deep sea water to the tank one by one.

---Limited by ship's stability

---For some kinds of ship, this method can't be used, such as container vessel, multi-purpose vessel, RoRo vessel and PCTC vessel etc.

Ballast Water Exchange (D-1 Standard)

2. Flow through (Over flow) Method

---Pumping through at least 3 times clean deep sea water to replace ballast water in ballast tanks

---This technique is not effective in removing organisms from ballast water.

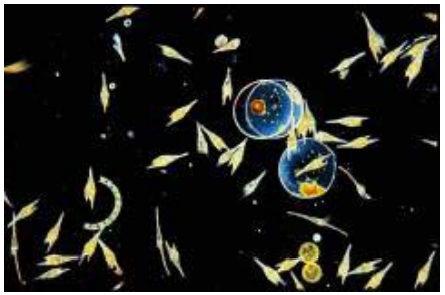
- **There are some limitation in both methods**
- It is therefore **extremely important** to develop the effective ballast water treatment systems as soon as possible, in order to replace Ballast Water Exchange (D-1)

Ballast Water Treatment (D-2 standard)

Ballast Water Performance Requirement

•Less than 10 viable organisms per cbm >50µm

•Less than 10 viable organisms per ml >10µm - <50µm



•Bacteria - Similar to existing bathing water

---Vibrio cholerae	1 cfu/100ml
---Escherichia coli	250 cfu/100ml
---Intestinal Enterococci	100 cfu/100ml

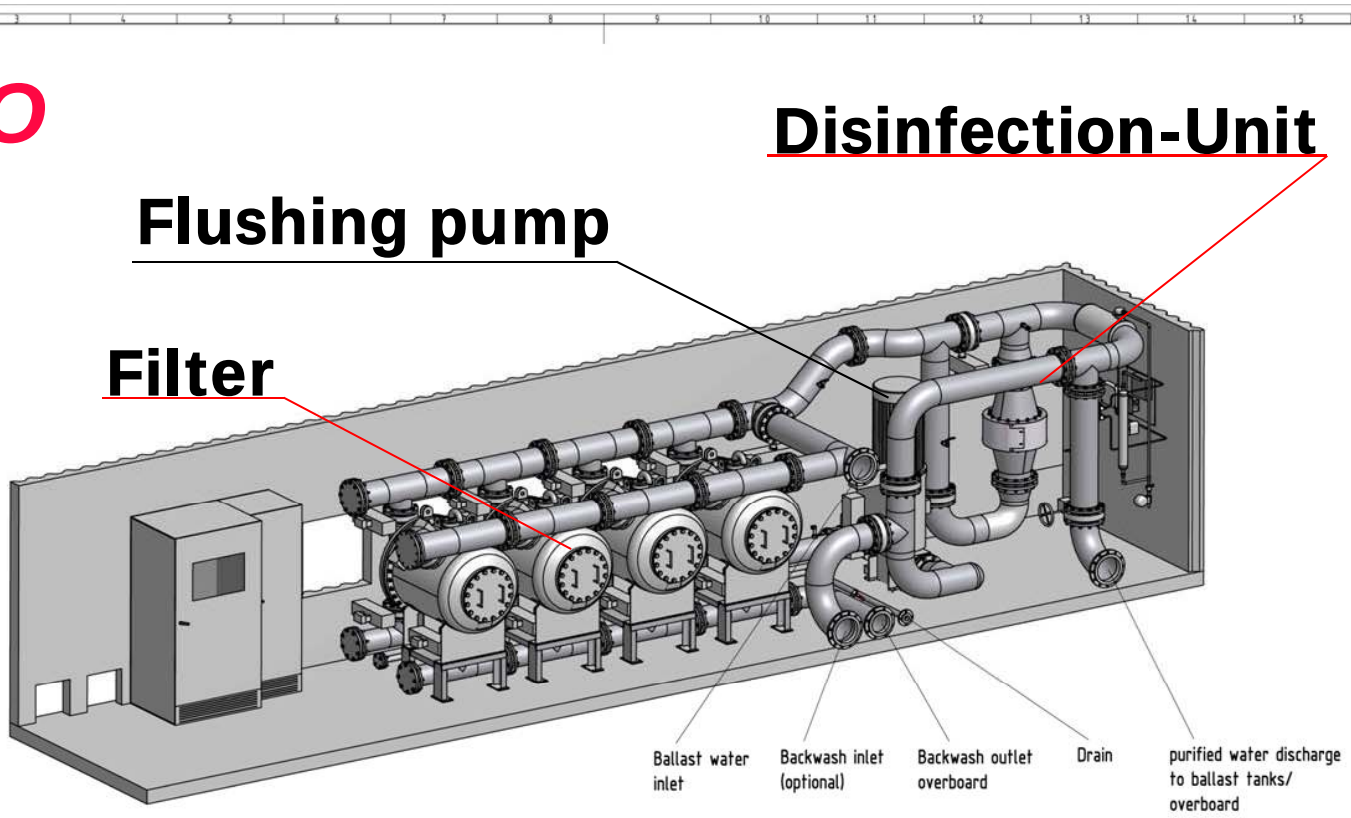
Ballast Water Treatment (D-2 standard)

- **The technology for ballast water treatment**

1. Mechanical treatment methods
   such as filtration and separation
2. Physical treatment methods
   such as sterilization by ozone, inert gases, oxidation, ultra-violet light, electric currents and heat treatment
3. Chemical treatment methods
   such as adding biocides to ballast water to kill organisms
4. Various combinations of the above

Ballast Water Treatment system

RWO

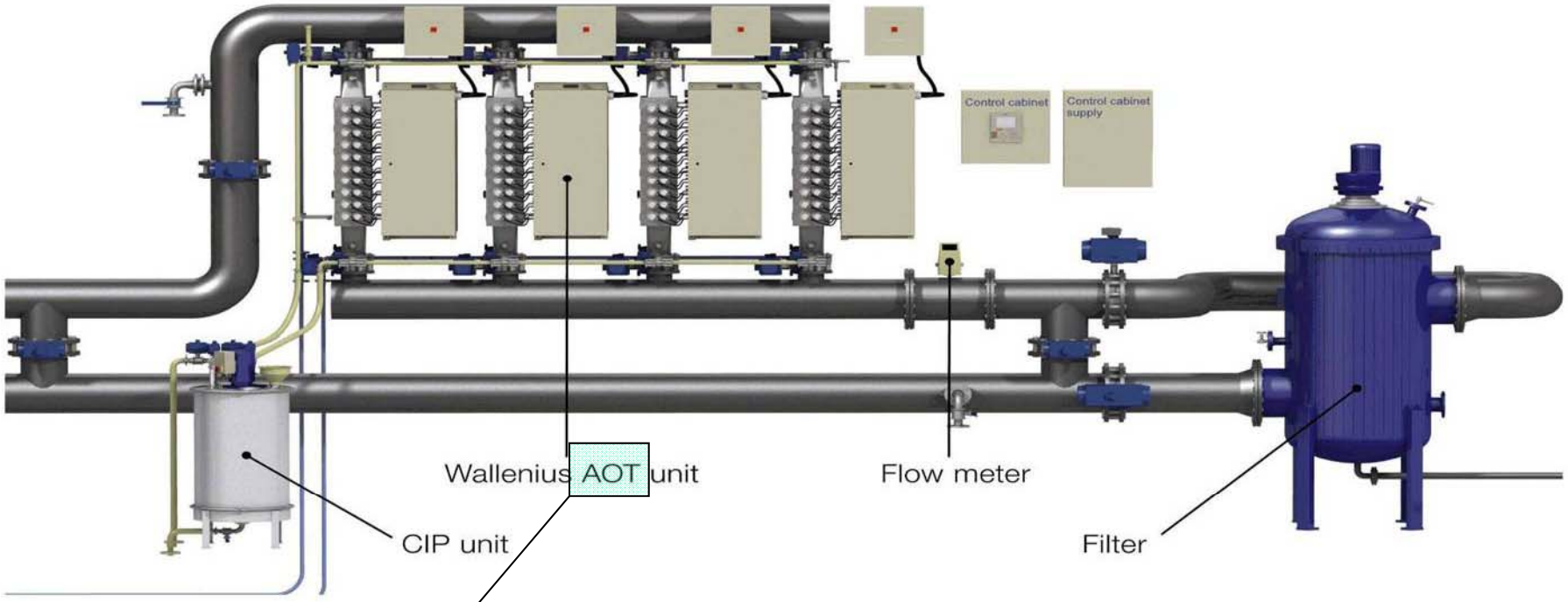


CleanBallast! SYSTEMS

RWO
CleanBallast !
Container plant 500 m3/h

Ballast Water Treatment system

PureBallast System



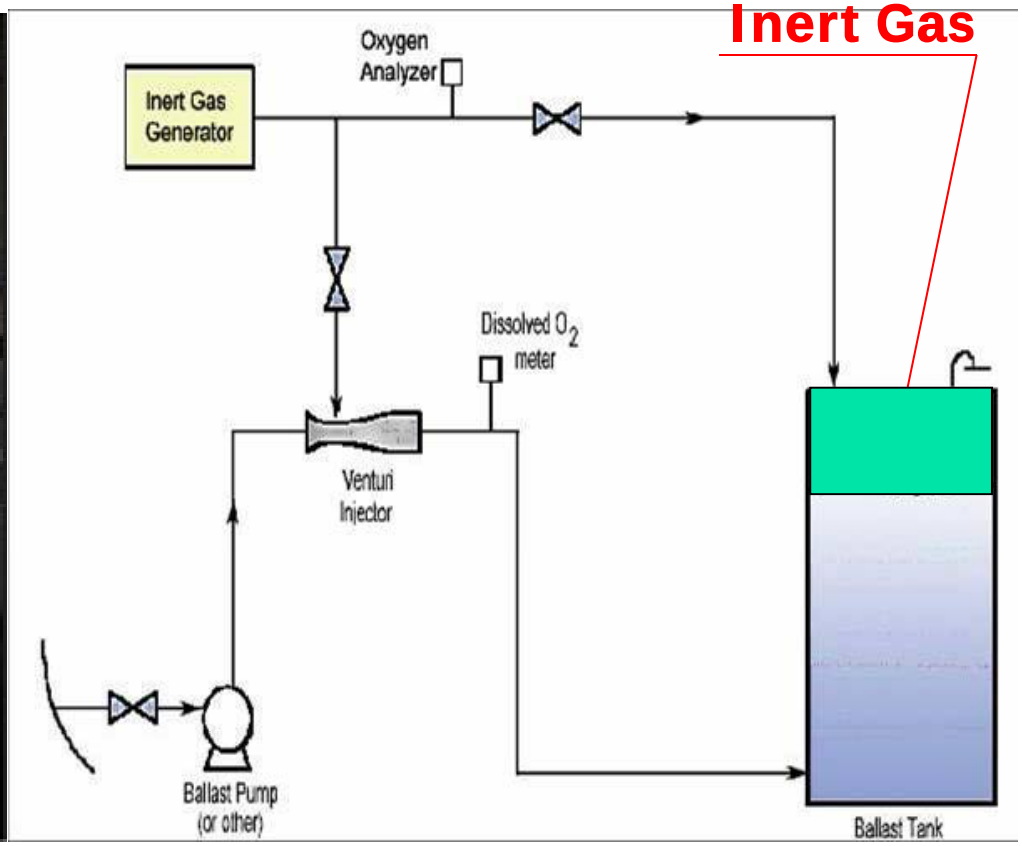
Draft installation of a PureBallast system for 1000 m³/h

Advanced Oxidation Technology

www.alfalaval.com/pureballast

Ballast Water Treatment system

NEI



Gas Super-saturation

Ballast Water Treatment system

BOLLFILTER

Ballast Water Treatment system

Electrolysis / electrochlorination

Korea

Ballast Water Treatment system

Container with test system installed at Texel, Netherlands

Filtration + Ultraviolet irradiation

Ballast Water Treatment system

EcochlorTM System

Chlorination

Ballast Water Performance (D-2)

Application date of D-2

: BW exchange or Treatment (D-1 or D-2)

: BW Treatment D-2

Year of ship construct	Ballast Cap. (m3)	Ship Type/Approx. DWT	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
Before 2009	＜1500	Tanker / DWT < 3400 Bulker / DWT < 4200 Gen Cargo/DWT < 4100										
	≤1500 ≤5000	Tanker / 3400<DWT<15000 Bulker/4200<DWT<14200 Gen Cargo/4100 <DWT<14000										
	＞5000	Tanker / DWT < 3400 Bulker / DWT < 4200 Gen Cargo/DWT < 4100										
In 2009	＜ 5000	Tanker / DWT < 3400 Bulker / DWT < 4200 Gen Cargo/DWT < 4100										
After 2009 Before 2012	＜ 5000	Tanker / DWT < 3400 Bulker / DWT < 4200 Gen Cargo/DWT < 4100										
	≥ 5000	Tanker / DWT < 3400 Bulker / DWT < 4200 Gen Cargo/DWT < 4100										
In or after 2012	All	All										

Ballast Water Performance (D-2)

Acc. to International Conventions, the application of D-2 come into force:

- **12 months after** ratification by **30 States** and Whose fleets not less than **35%** of world merchant shipping tonnage.
- Now It is ratified by **18 States** which occupies **15.27%** world shipping tonnage. So the application date **will be delay** about 2-3 years.
- Some **Ship Owners have required** to install the B.W. treatment system on the new ships

How to *install*

the B.W. treatment system

The problems of ballast water treatment for ship design

1. **Up to now, more than 30 systems are developed or under development**
   ---But only 6 systems have been Type approved by Administration/Class
2. **Too many different kinds and different operation types of ballast water treatment systems and the less experience for using these equipments**
   ---We don't know which one is the best

TYPE APPROVED TREATMENT SYSTEM

No	Maker	Country	Approval	Approved at	Approved date
1	NEI Treatment Systems LLC	USA	Type-approved	By Liberia thro'G8	17-10-2007
2	Alfa Laval Tumba AB	Norway	Type-approved	By DNV	27-06-2008
3	PERACLEAN Ocean	Germany	Type-approved	By Germany	10-06-2008
4	Techcross	Korea	Type-approved	By Republic of Korea	31-10-2008
5	Oceansaver AS	Norway	Type-approved	By DNV	17-04-2009
6	Hyde Marine Inc - Hyde Guardian	USA	Type-approved	By LR for UK-MCA thro'G8	29-04-2009

THE MAKER OF TREATMENT SYSTEM

No	Name	Operation Type
1	Alfa Laval Tumba AB ---Norway	Filtration + Ultraviolet irradiation + TiO_2
2	ATG Willand ---United Kingdom	Filtration + Ultraviolet irradiation
3	Ecochlor Inc ---USA	Chlorination (Chlorine dioxide)
4	Electrichlor Inc ---USA	Filtration + Electrolysis/electrochlorination
5	Environmental Technologies Inc ---USA	Filtration + Ozonation + Ultrasound
6	Gauss ---Germany	Filtration + Ultraviolet irradiation
7	Greenship ---Netherlands	Hydrocyclone + electrolysis/electrochlorination
8	Hamann AG ---Germany	Hydrocyclone + Filtration +Peracetic acid
9	Hitachi ---Japan	Filtration + Coagulant (with magnetic particles)
10	Hi Tech Marine Pty Ltd ---Australia	Heat
11a	Hyde Marine Inc -Hyde Guardian ---USA	Filtration + Ultraviolet irradiation
11b	Hyde Marine Inc -Seakleen™ ---USA	Seakleen
12	JFE Engineering Corporation ---Japan	Filtration + Chlorination + Residual Cl neutralisation + Cavitation
13	Marenco Technology Group Inc ---USA	Filtration + Ultraviolet irradiation
14	Mahle NFV GmbH ---Germany	Filtration + Ultraviolet irradiation
15	MH Systems Inc ---USA	Deoxygenation
16	Mitsui Engineering & Shipbuilding ---Japan	Ozonation + Cavitation

THE MAKER OF TREATMENT SYSTEM

No	Name	Operation Type
17	NEI Treatment Systems LLC ---USA	Deoxygenation + Cavitation
18	Nutech 03 ---USA/Korea	Ozonation
19	Oceansaver AS ---Norway	Deoxygenation + Cavitation
20	Optimarin ---Norway	Filtration +Ultraviolet irradiation
21	Panasia ---Korea	Filtration +Ultraviolet irradiation +OH
22	Qwater ---USA	Filtration +Ultrasound
23	Resource Ballast Technology ---South Africa	Filtration +Ozonation + Cavitation + Electrolysis/electrochlorination
24	RWO Marine ---Germany	Filtration +Electrolysis/electrochlorination
25	Severn Trent De Nora ---USA	Electrolysis/electrochlorination +Residual Cl neutralisation
26	Siemens ---USA, UK, Germany	Filtration + Electrolysis/electrochlorination
27	Techcross ---Korea/China	Electrolysis/electrochlorination
28	Toagosei Group ---Japan	Filtration + Chlorination +Residual Cl neutralisation
29	Ferrate Treatment Technologies	Advanced oxidation (Fe^{6+})
30	Sincerus	Electrolysis/electrochlorination
31	Blue Ocean Shield ---China	Electrolysis/electrochlorination
32	Dalian University ---China	Advanced Oxidation
33	SUNRUI ---China	Electrolysis/electrochlorination

The problems of ballast water treatment for ship design

3. Consideration of the treatment capacity and the size of equipment

--- Generally the engine room space is limited, the size of equipment is very important, especially for small vessel

4. More electric power consumption

--- Because of additional equipment such as back flushing pump, Disinfection-Unit, AOT Unit and other equipments etc.

5. High price

--- The price of the new equipment is very high, because it takes huge money and time in research and development.

--- After more and more BW treatment systems used in the ship building, the price will be reduced.

Application of Ballast Water Treatment in Ship Design

Example 1

19100DWT MULTI-PURPOSE VESSEL

19100DWT MULTI-PURPOSE VESSEL

PRINCIPAL PARTICULARS

Length overall	abt. 166.00 m
Breadth	22.90 m
Depth	13.90 m
draught (Scantling)	9.50 m
Capacity of water ballast tanks	**9650** m3
Application Date for D-2 standard	**2017**

19100DWT MULTI-PURPOSE VESSEL

It is Owner's requirement to install BW treatment system

Reason:

- The new regulation will be come into force in the future for all ships

  ---It is easier to install the B.W. treatment system for new vessel than the existing ones

- The vessel will be navigated in the special area that is very dirty

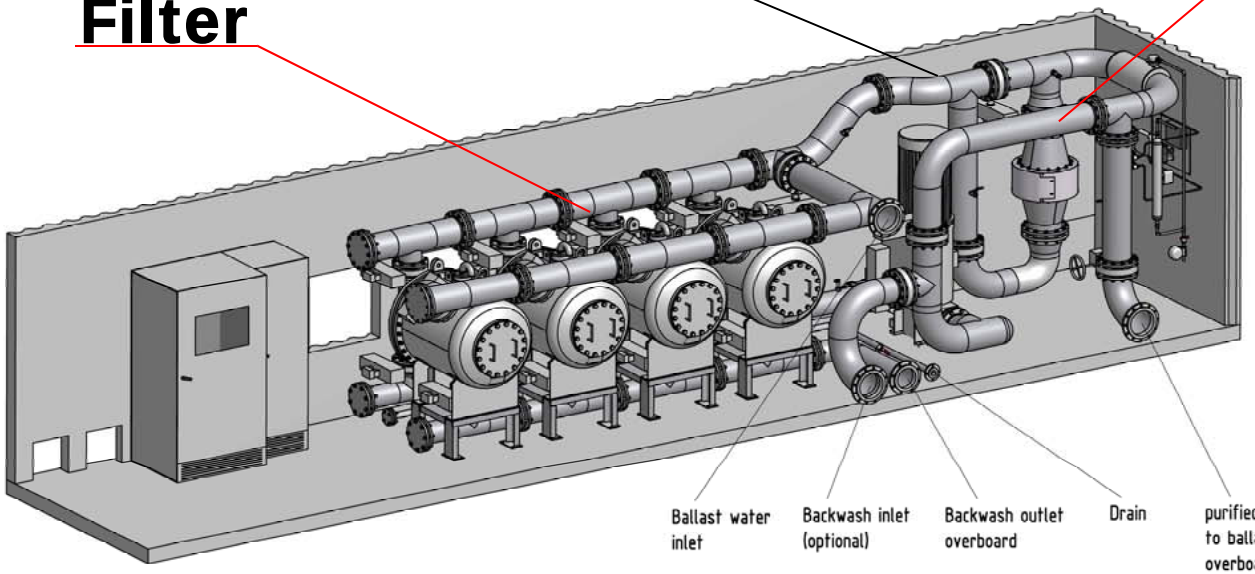
--- Where there are a lot of mud and sand in the ballast water as well as organisms

--- After the vessel navigating in that area for a few years, there are many sediment in the ballast tanks

--- To be cleaning it by owner

Acc. to the special requirements from ship owner we select **RWO CleanBallast! SYSTEMS** in this vessel

RWO CleanBallast! SYSTEMS



Filter:	**5m x 3m x 2m ,**
Disinfection-Unit:	**1.9m x 1.6m x 2.6m**
Control box:	**1.8m x 0.8m x 2.2m**

Container plant 500 m3/h

19100DWT MULTI-PURPOSE VESSEL

PRINCIPAL PARTICULARS ***for RWO*** **CleanBallast! SYSTEMS**

Number:	**2 sets**
Capacity:	350m3/h (each)
Filter	**2 sets**
Flushing pump	**2 sets**
▪ Capacity:	330 m3/h (each)
▪ Delivery pressure:	0.60 MPa
▪ Electric power consumption:	**110 kW** (each)
Disinfection-Unit	**2 sets**
▪ Electric power consumption:	**20kW** (each)
Total electric power consumption:	**abt. 130kW X 2**
Pressure loss:	**0.08** MPa
Total price:	**One million USD**

Advantage:

- **Big filter with Flushing pump**

  Big filter---- means good filtration performance

  Flushing pump----The flushing pump will be automatic started to back washing the filter to keep filter cleaning---It's profit for operation

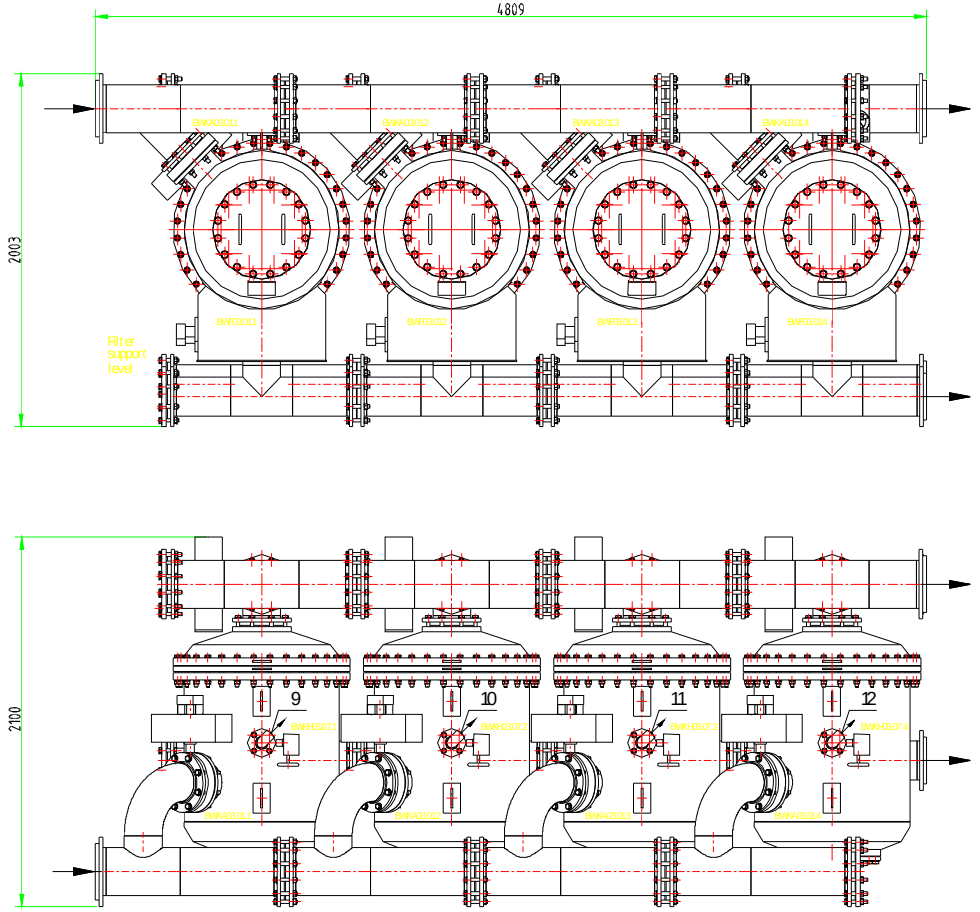
- **It is suitable to use for ship in dirty area**.

Disadvantage:

- **Big size**
- **Big electric consumption**
- **High discharge resistance (Pressure loss)**
- **High price**

19100DWT MULTI-PURPOSE VESSEL

Filter

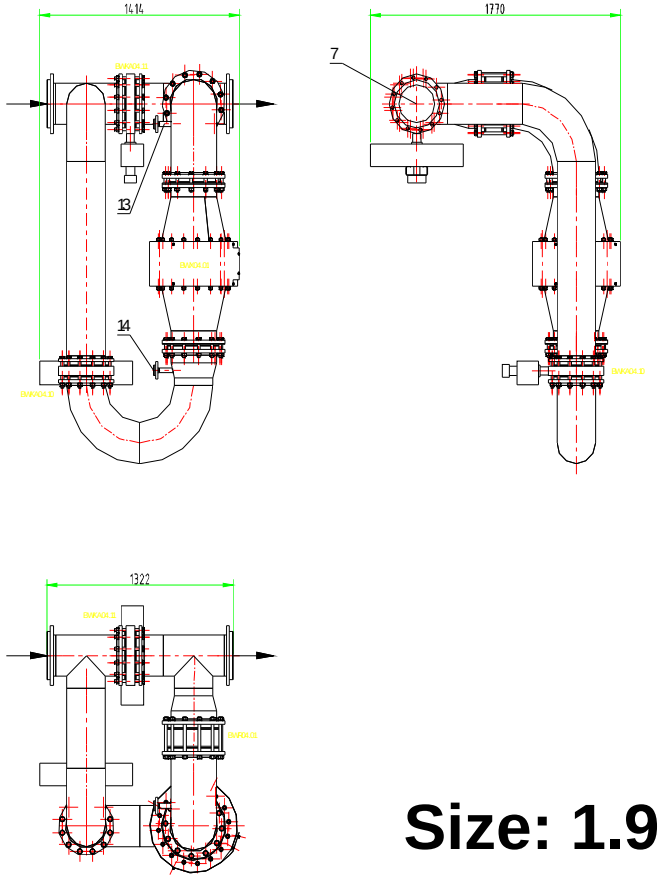


Size: 5m x 3m x 2m

RWO

19100DWT MULTI-PURPOSE VESSEL

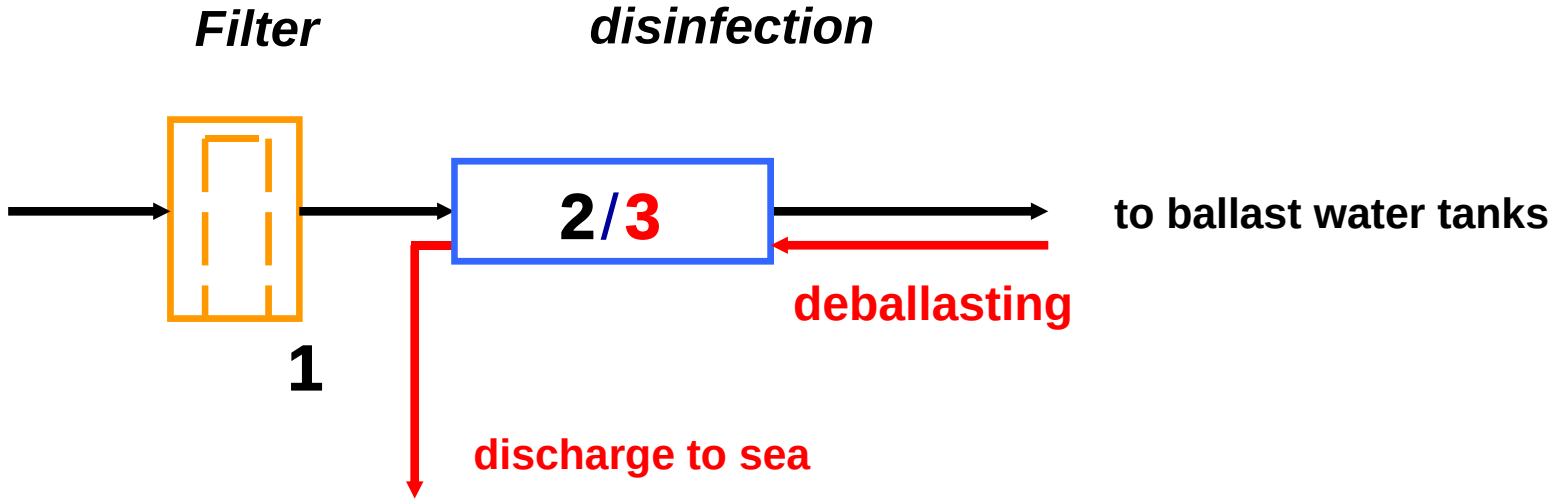
Disinfection-Unit



Size: 1.9m x 1.6m x 2.6m

RWO

Ballast water treatment concept



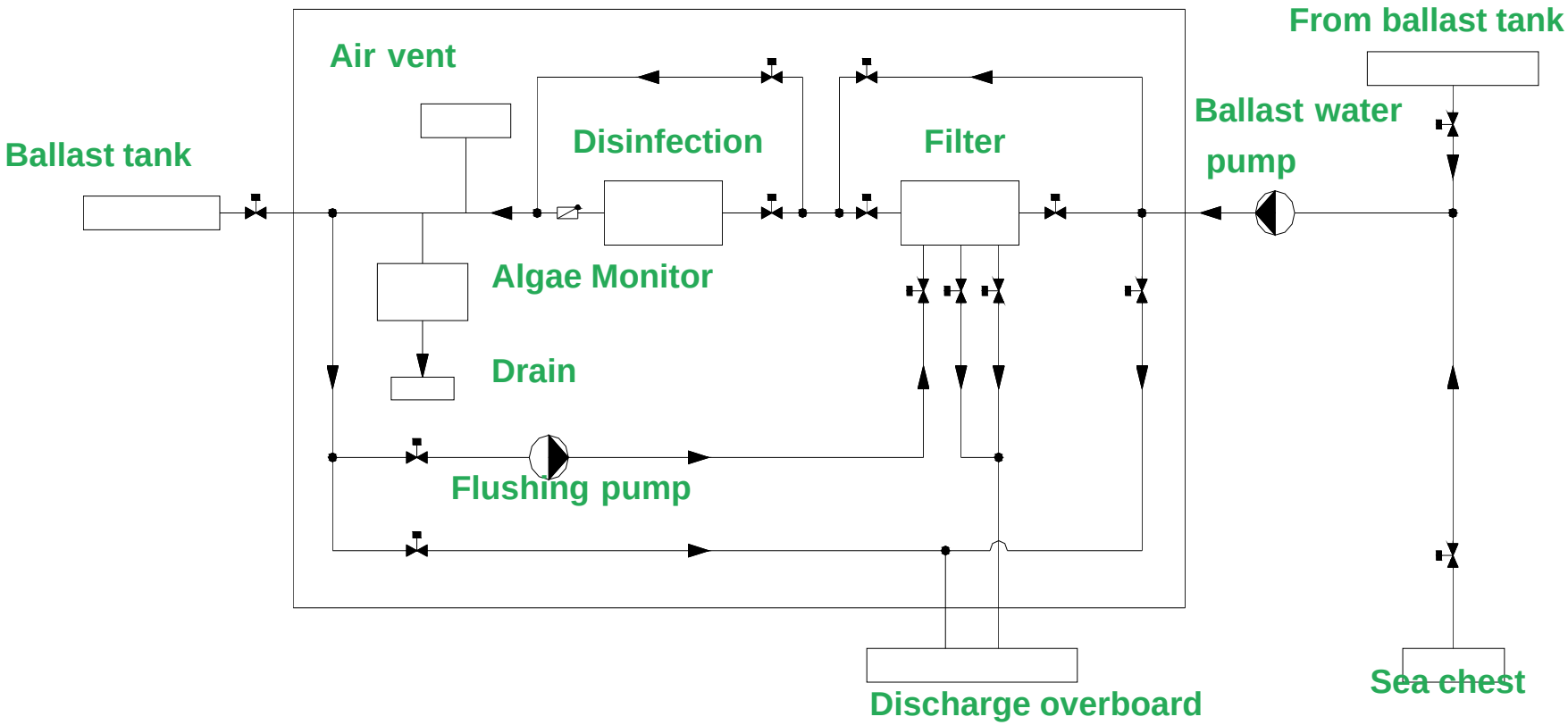
1. Mechanical filtration to remove suspended solids, sediments and certain organisms during ballasting

2. Disinfection to reduce the number of organisms before filling ballast water tanks

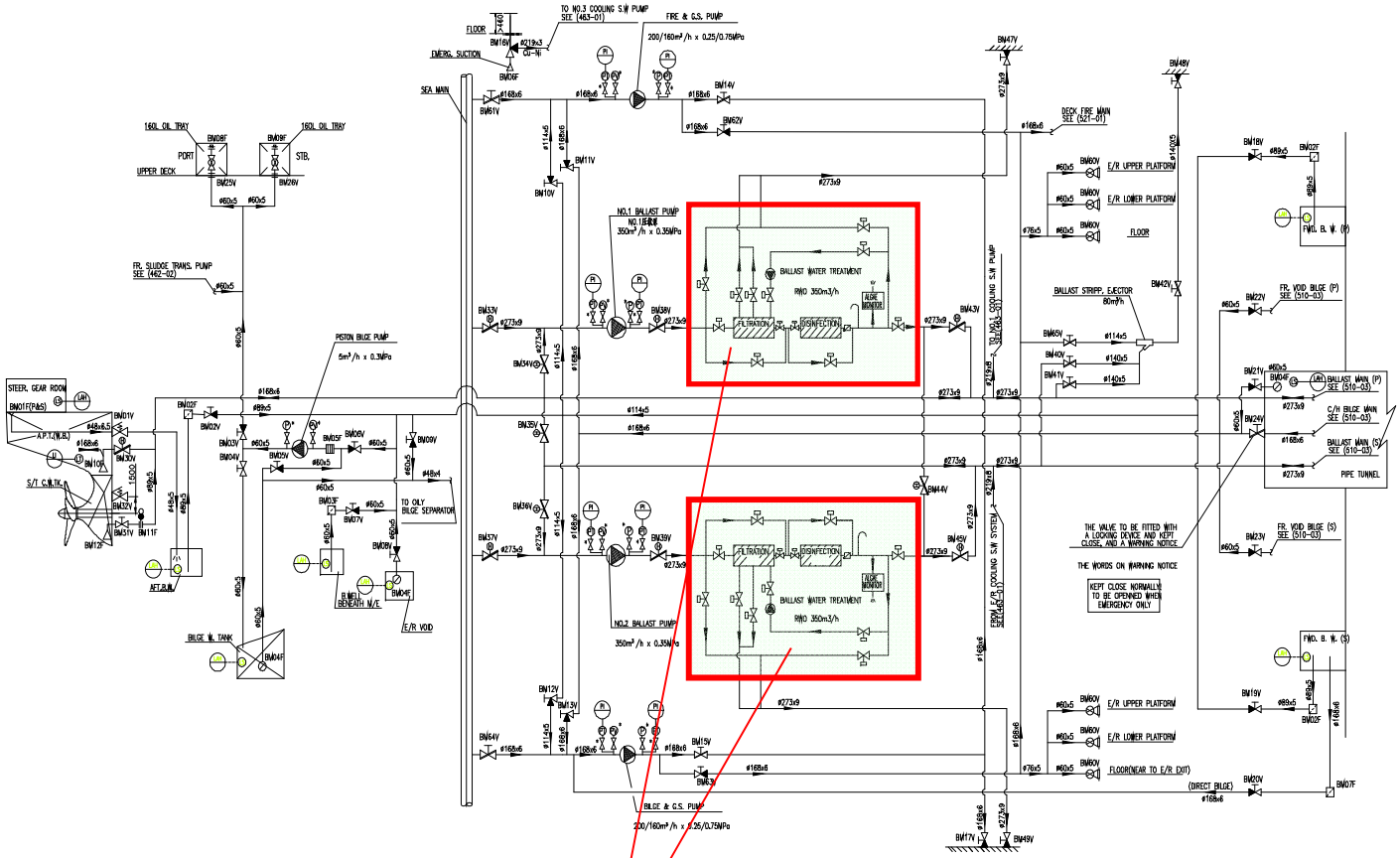
3. Second disinfection to reduce the number of organisms according to the future Performance Standard D2 at ballast water discharge

SYSTEM DRAWING

RWO

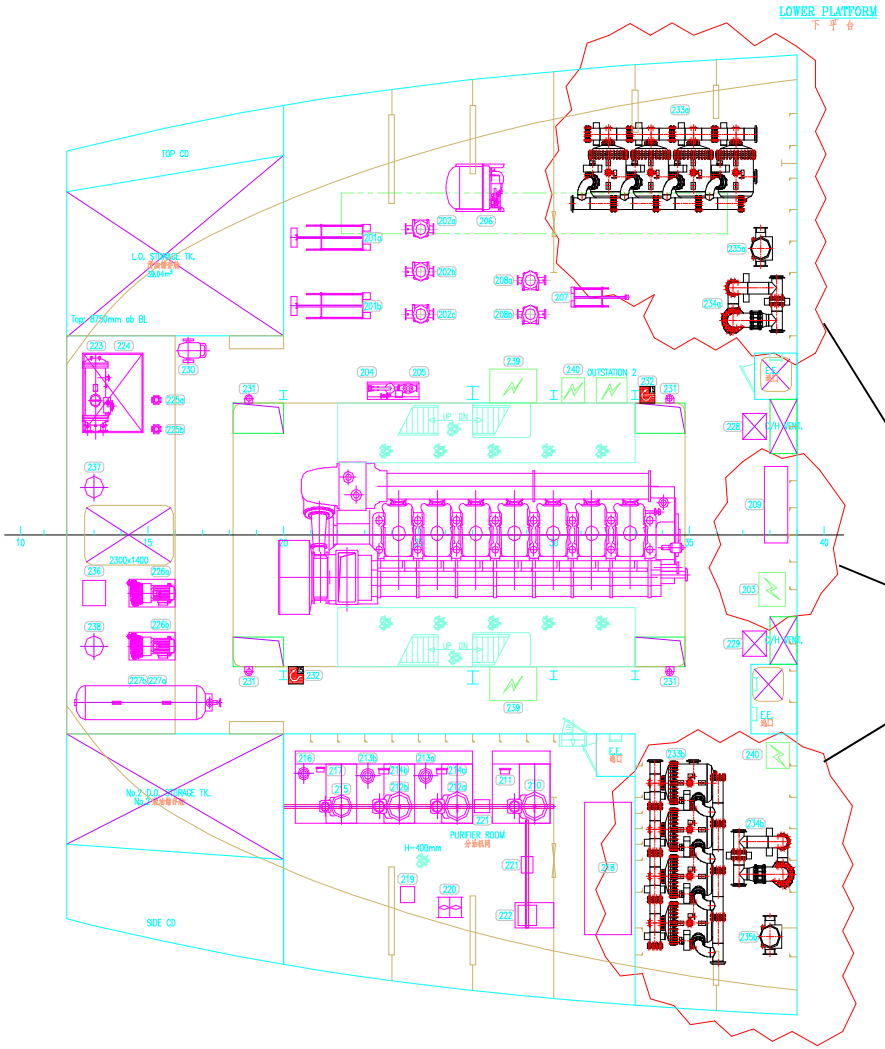


SYSTEM DRAWING



Ballast water treatment

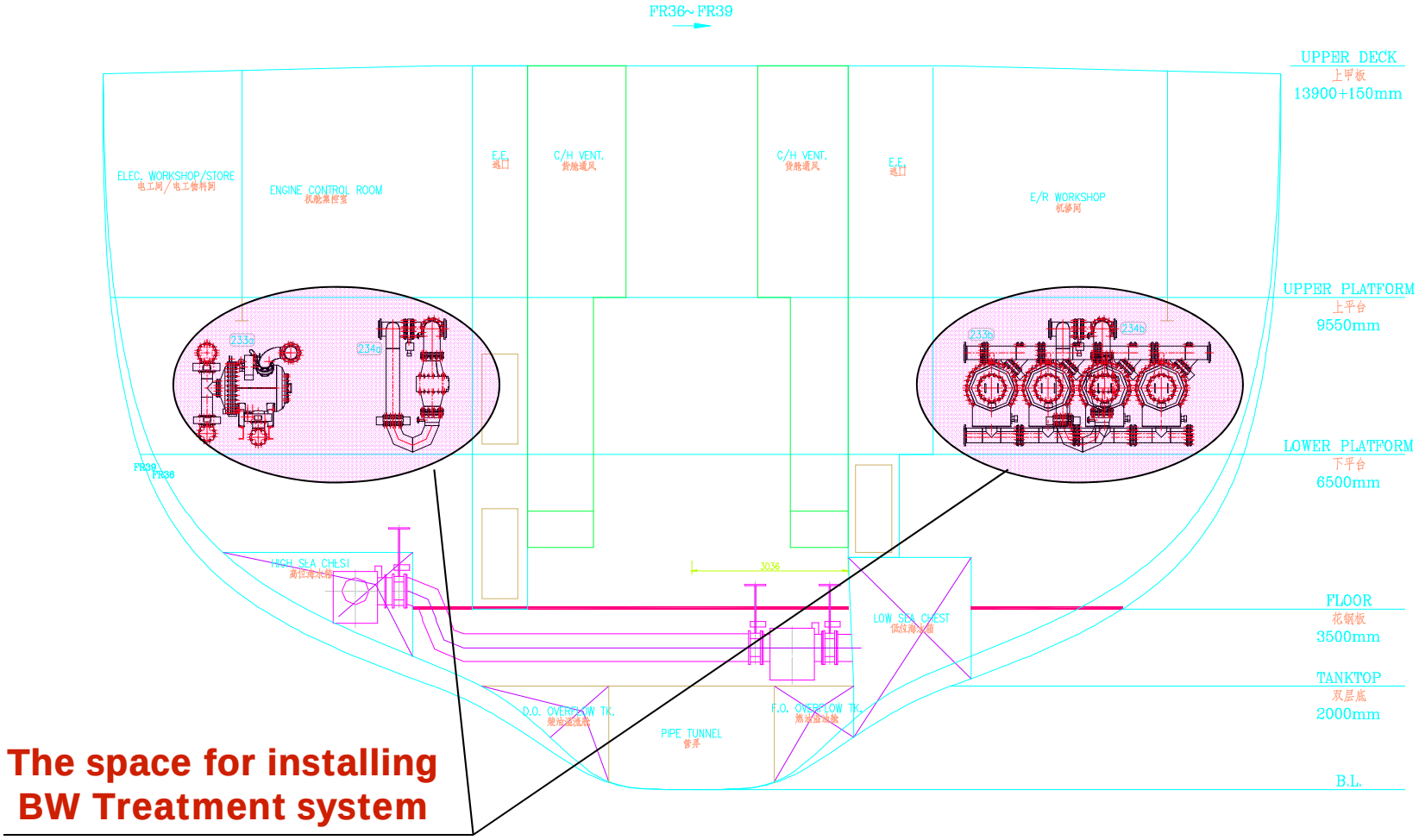
ENGINE ROOM LAYOUT



The space for installing BW Treatment system

19100DWT MPV

ENGINE ROOM LAYOUT



The space for installing BW Treatment system

19100DWT MPV

Application of Ballast Water Treatment in Ship Design

Example 2

400,000 DWT ORE CARRIER

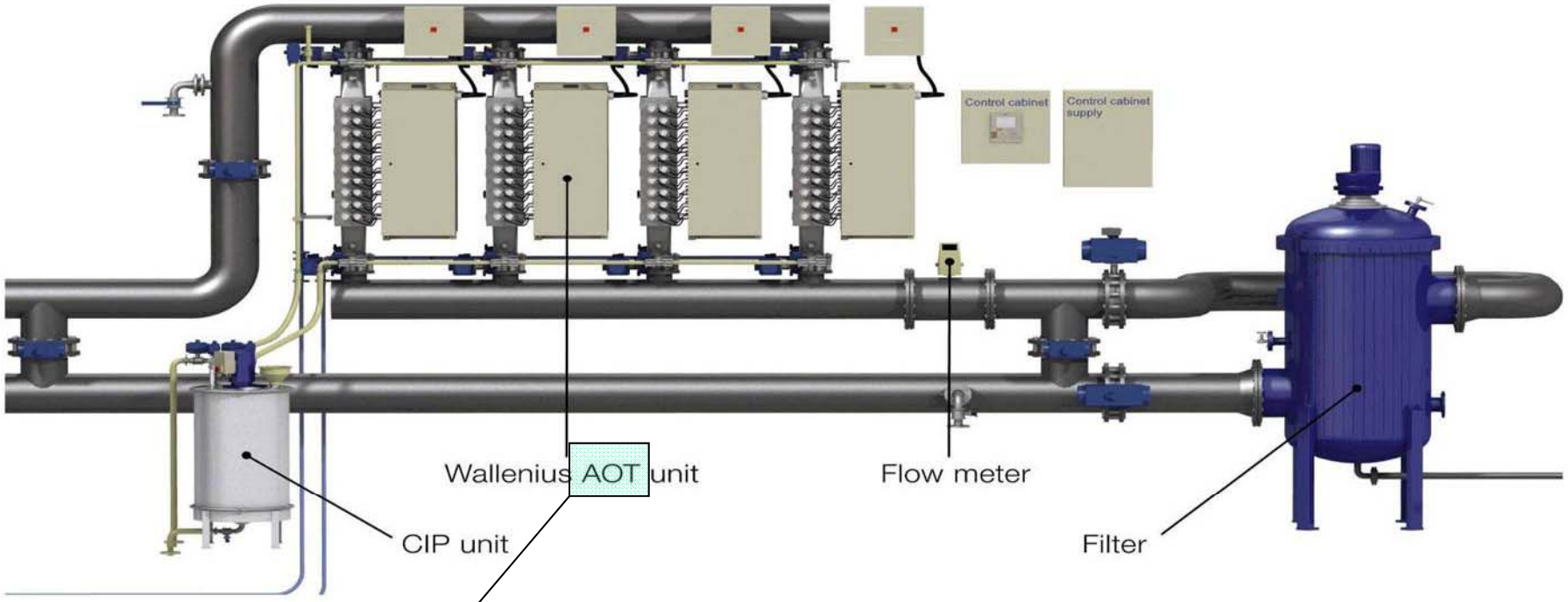
400,000 DWT ORE CARRIER

PRINCIPAL PARTICULARS

- Length overall — abt. 360.00 m
- Breadth — 65.00 m
- Depth — 30.40 m
- draught (Scantling) — 22.00 m
- Capacity of water ballast tanks — 190,700 m^3
- Application Date for D-2 standard — **2017**

Ballast Water Treatment system

PureBallast System



Draft installation of a PureBallast system for 1000 m³/h

Advanced Oxidation Technology

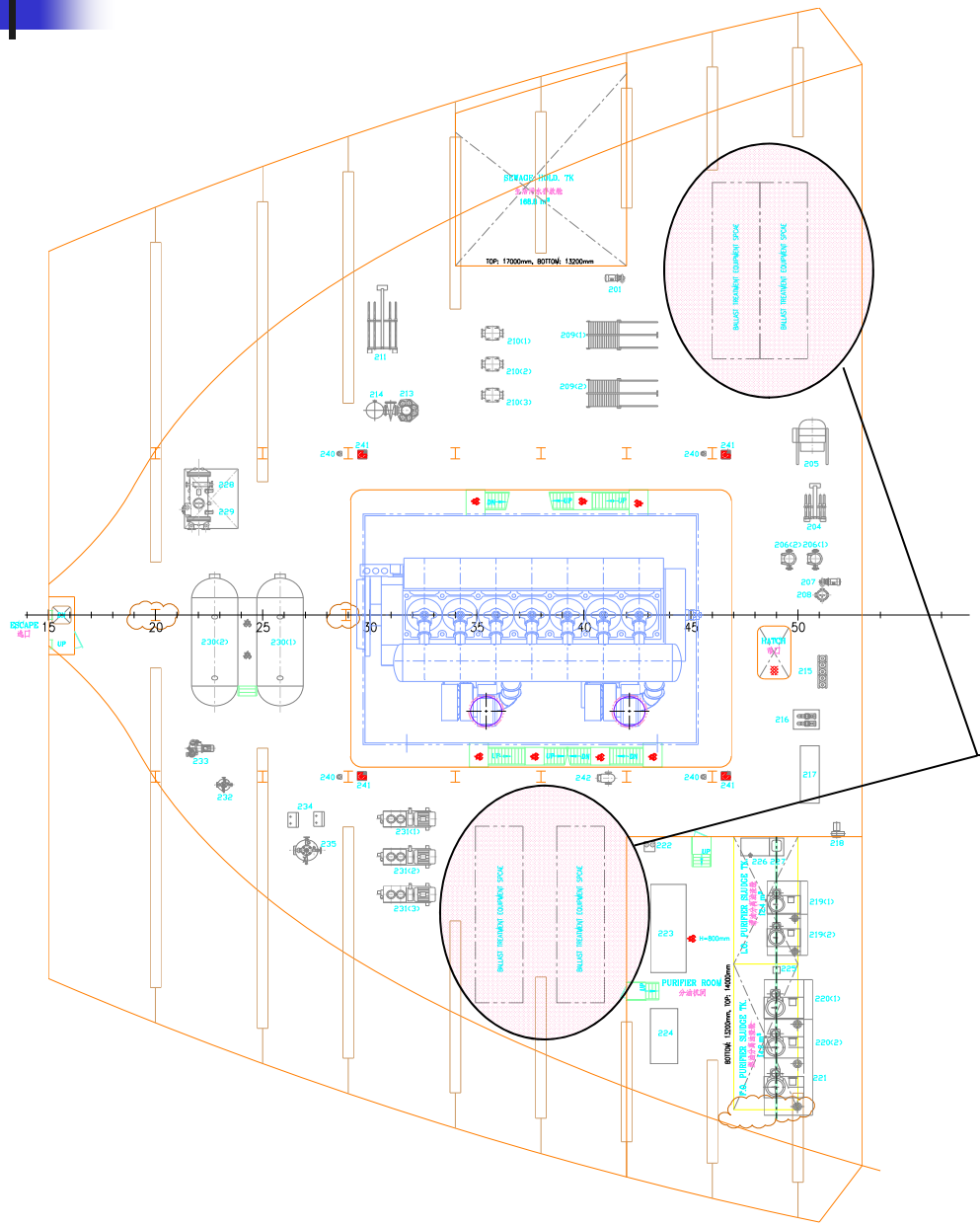
www.alfalaval.com/pureballast

400,000 DWT ORE CARRIER

PRINCIPAL PARTICULARS *for* Alfa Laval PureBallast SYSTEMS

Number:	**2 sets**
■ Capacity:	4000m3/h (each)
Filter	**2 sets**
■ Pressure drop:	0. 005-0.05 MPa
Wallenius AOT Unit	**2 sets**
■ Electric power consumption:	**510 kW** (each)
■ Working pressure:	0.25-0.6 Mpa
■ **Total electric power consumption:**	**abt.(510+6)kW X 2 =1026kW**

ENGINE ROOM LAYOUT



Example 2:

400,000 DWT ORE CARRIER

The preparative space for installing BW Treatment system

The size base on Alfa Laval PureBallast System

The consideration of using ballast water treatment in ship design

- **The suitable capacity of total ballast water in the vessel**

  --- as less as possible

- **Select good performance for the system**

  --- High efficiency

  --- Safety and durable

  --- Big capacity and less electric consumption

  --- Smaller size and simple structure

  --- Easily for installation and maintenance

  --- Lower cost

The consideration of using ballast water treatment in ship design

- **Using permanent ballast for some kind of vessels in order to reduce the quantity of water ballast**

  --- For example, the container vessel, normally part of ballast water to be used at loading condition in order to increase the stability. We can use permanent ballast instead of this part of ballast water.

  --- Otherwise, the specific gravity of permanent ballast (such as steel， iron， stone and concrete etc.) is heavier than sea water. It's better for ship's stability.

The consideration of using ballast water treatment in ship design

- **The suitable capacity for ballast pump and suitable time for Ballasting /de-ballasting**

  --- The capacity of BW treatment system should be minimized because it is related to the engine room space, electric power consumption, and the equipment price etc.

  --- The pump **capacity** is base on Ballasting /de-ballasting time. If the time longer, the pump capacity will be reduced. It should be agreed by Ship Owner

The consideration of using ballast water treatment in ship design

- **The pump delivery pressure will be increased**

  --- Because of additional discharging resistance when BW through the BW treatment system

  --- For new vessel there is no problem, but for existing vessels, the original pump delivery pressure will be not enough for installing some kinds of BW treatment system that has high additional resistance in the system. The original ballast pumps should be replaced.

- **More electric power consumption**

  ---The power of Aux. engine may be increased

  --- It is a big problem for existing vessels.

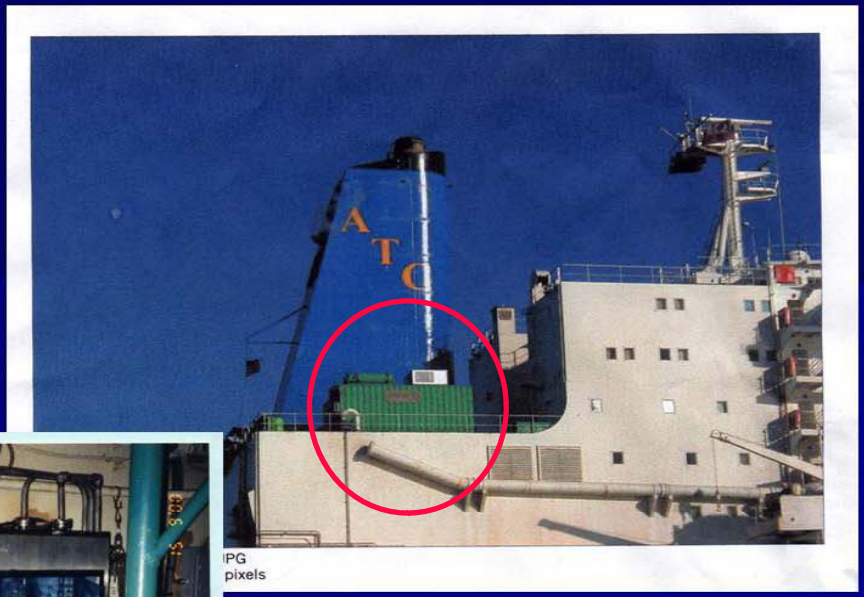
- **Find suitable space for installing B.W. treatment equipment**

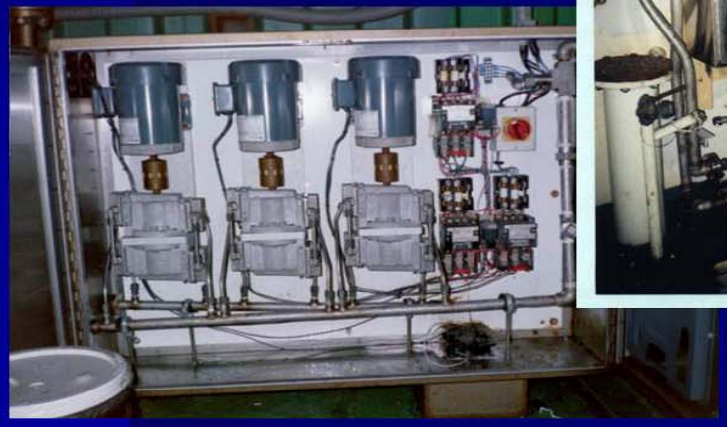
  ---It may be had some problems for small vessel

  ---Specially for existing vessel

Ozone Treatment System

Equipment Installation





On the superstructure

Inert Gas treatment system

- TECO *Pat Cantrell*
- 40,000 DWT Bulker
- Trades US Gulf and East Coast
- 2 x 1,000 m3/hr Pumps
- Double-Bottom and Lower Wing Tanks

NEI

Inert Gas treatment system

- 12” Diameter Venturis in Machinery Space
- 2,500 m3/hr Inert Gas Generator

In the double bottom

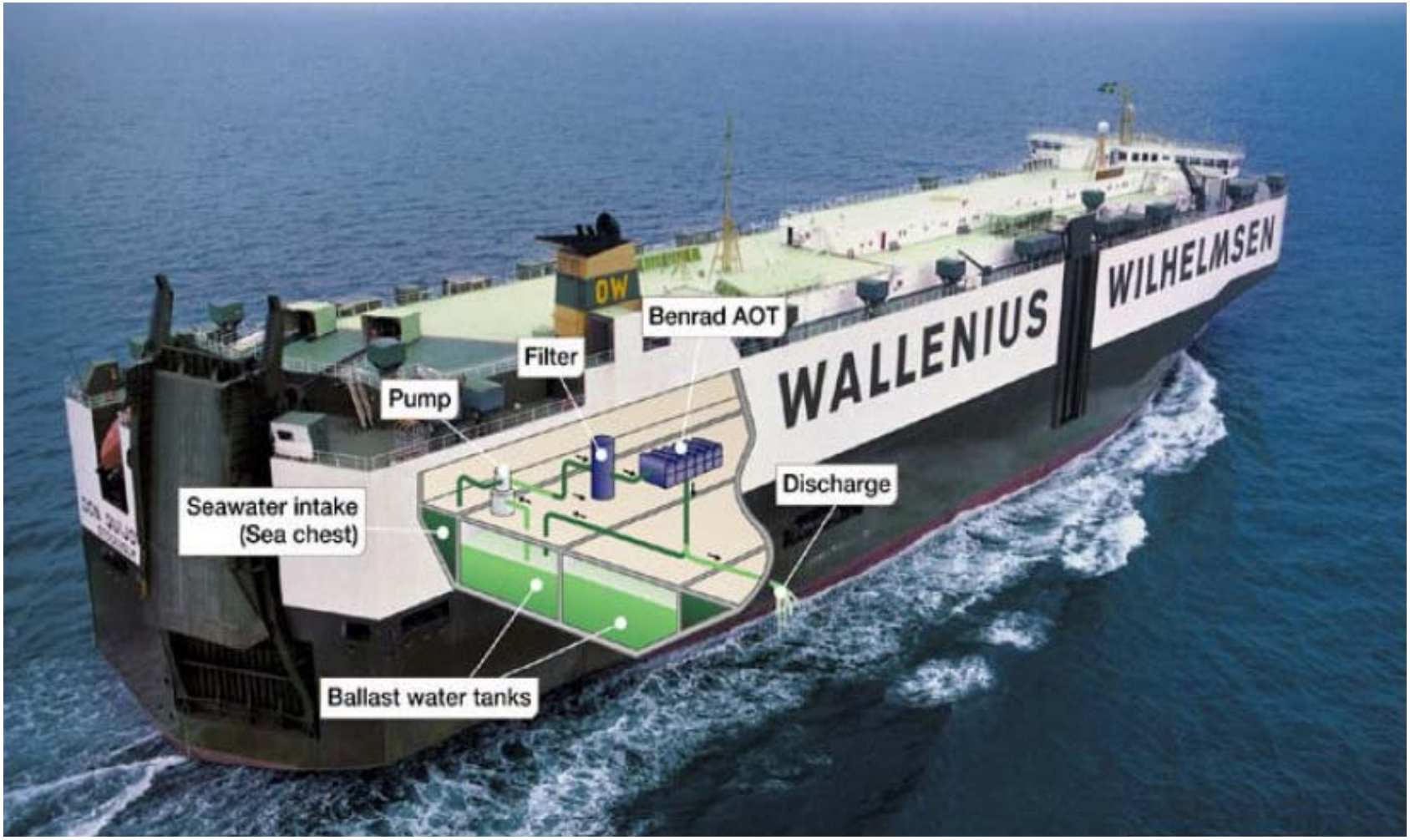
on low wing tank

filtration treatment system

In the engine room

Filtration and Oxidation Treatment system

In a car carrier



Filtration and Oxidation Treatment system

In the engine room

6.18 Ø750 DN400

500 m³/h 50μ

In operation 2003

Filtration and Oxidation Treatment system

The Benrad **AOT** (Advanced Oxidation Technology) unit

In the engine room

CONCLUSION

The above mentioned is only examples

- *There are many other different problems for different kinds of B.W. Treatment system. We need study and develop these systems in the ship design to comply with the new regulation*
- *We hope more and more Ballast Water Treatment system will be approved by Administration or Class and can be used in ship building*
- *We believe that Ballast Water Treatment system will be easier to install on ship as same as other marine equipment In the future*


THANKS