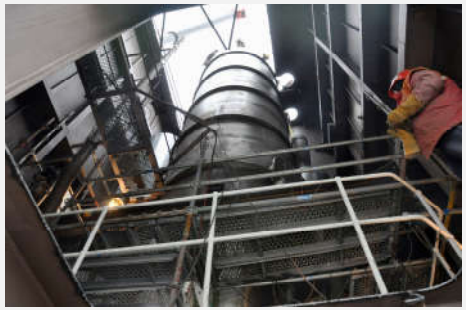



# EXPERIANCE AND CHALLANGES DURING DESIGNING AND INSTALLATION OF SCRUBBER RELATED SYSTEMS

REMONTOWA HOLDING

REMONTOWA SHIPREPAIR YARD

REMONTOWA SHIPBUILDING

REMONTOWA MARINE DESIGN

REMONTOWA HYDRAULIC SYSTEMS

REMONTOWA ELECTRICAL SOLUTIONS

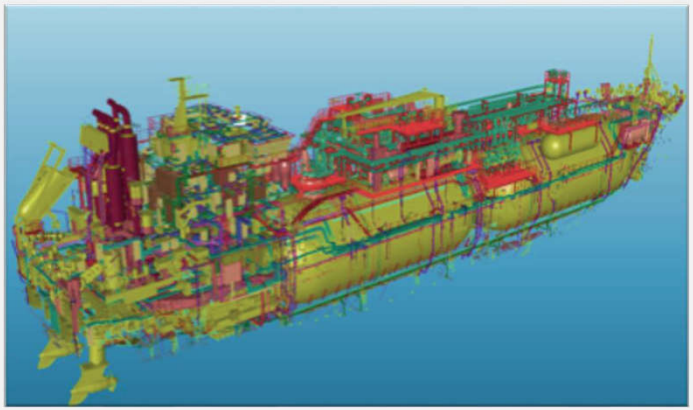
REMONTOWA LNG SYSTEMS

FAMOS® Interior Factory

# REMONTOWA MARINE DESIGN & CONSULTING

## RMDC offers services:

- one of the biggest design companies in Europe is the leading provider of engineering services for the design and supply of all types of vessels and marine constructions.
- comprehensive design from concept design up to workshop design for both yards and ship owners. Wide range of consultancy based on years of experience in ship design and ship building.
- an innovative and reliable design partner for any type of ship from the first sketch on a paper to complete production drawings.
- all types of marine design related engineering services such as conversion design, stability calculation, feasibility studies, project management, shipyard evaluation etc.



# REMONTOWA SHIPREPAIR YARD

In the following 65 years „Remontowa” has become a leader among the European shiprepair yards and a major player on the world market.

## „Remontowa” S.A. offers complex services:

- Counseling  for shipowners in range of technical service of fleet.
- Design, engineering and building of the ships and other sea/maritime objects.
- Shiprepairs of all types of vessels up to 44.4 m in width, 295 m in length.
- Repairs and conversions of drilling rigs and jack-up drilling platforms.
- Offshore vessels conversions, upgrades and repairs.
- Conversions of all types of vessels.

# REMONTOWA SHIPREPAIR YARD

## TECHNICAL FEATURES OF REMONTOWA DOCKS

| Dock No | 1 | 2 | 3 | 4 | 5 | 6 |
|---|---|---|---|---|---|---|
| Lifting capacity (t) | 6 400 | 3 200 | 15 000 | 9 000 | 25 000 | 36 000 |
| Docking capacitay (dwt) | 8 000 | 4 000 | 50 000 | 18 000 | 85 000 | 135 000 |
| Overall length (m) | 131.2 | 87.4 | 189.4 | 164.4 | 225 | 255 |
| Supported length (m) | 125 | 85.2 | 185 | 150 | 210 | 255 |
| Clear breadth (m) | 24 | 21.0 | 36.9 | 25.8 | 37 | 44.4 |
| Trim (m) | 2.5 | 1.3 | 2.8 | 3 | 4.5 | 3.2 |
| Ships draught (m) | 5.0 | 5.0 | 7.5 | 7.4 | 8.4-bow 9.8-stern | 9.5 |
| Cranage (t) | 50 | 50 | 10+10 | 10+10 | 20+20 | 25+25 |

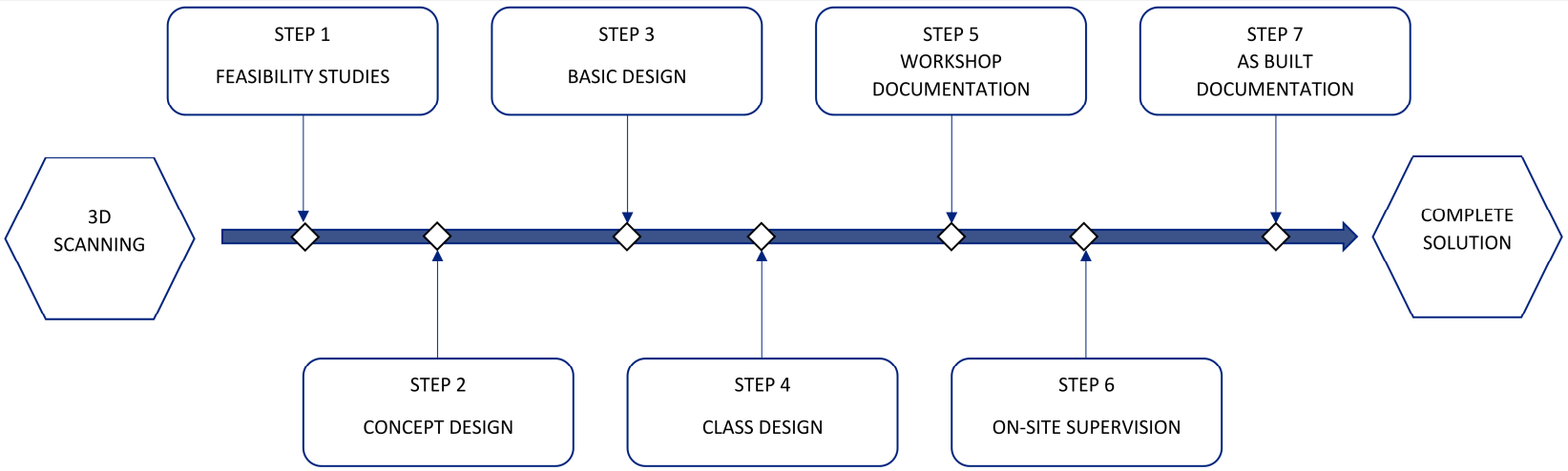
# REMONTOWA MARINE DESIGN & CONSULTING

***MARPOL convention Annex VI on Regulations for the Prevention of Air Pollution from Ships***
introducing global restrictions on sulfur content for fuels to 0,1 % S (from 2020 or 2025 at the latest), together with Regional and Local restrictions from EU Sulfur Directive, and US Code of Federal Regulations provides a need for wide range of ships sailing in SECA and ECA waters to control NOX & SOX emissions to air.

**Here comes the question should we use low sulfur fuel or install Exhaust Gas Scrubbing Systems? What will be the costs of system installation? Will the system fit our vessels ?**

***WHAT WE CAN OFFER IN THIS AREA ?***

Thanks to our extensive experience in conversion designs, our skilled staff can provide high quality all-inclusive service. Our design office will take care of the design in all disciplines: Hull Structure, Strenght Calculations, Stability, Deck Equipment, Machinery & Piping together with Electrical Design & Automation.



# SCRUBBER SYSTEM – FESIBILITY STUDY

| Component | Supplier 1 | Supplier 2 | Supplier 3 | Supplier 4 |
|---|---|---|---|---|
| *Scrubber units* | X | X | X | X |
| *Intruments* | X | X | X | X |
| *Monitoring and analyser system* | X | X | X | X |
| *Control system* | X | X | X | X |
| *Electrical supply, wiring, cabling* | C | C | C | C |
| *Power distribution* | C | C | C | C |
| *Scrubbing/Process pumps* | X | X | X | X |
| *Water treatment unit* | X | X | X | X |
| *Cooling pumps* | X | X | X | X |
| *Heat exchanger* | X | X | X | X |
| *Alkali feed module* | X | X | X | X |
| *Buffer tank* | NA | NA | NA | NA |
| *Sludge tank for closed loop* | C | C | C | C |
| *Alkali tank* | C | C | C | C |
| *Process/circulation tank* | X | C | X | X |
| *Sealing air fans* | NA | NA | X | NA |
| *By-pas damper* | NA | NA | X | NA |
| *Exhaust manifold* | NA | C | NA | NA |
| *System valves* | X | X | X | X |
| *Ship side valves* | C | C | C | C |
| *Hull penetration* | C | C | C | C |
| *Floors, gratings etc.* | C | C | C | C |
| *Piping* | C | C | C | C |
| *Steelworks* | C | C | C | C |
| *Scrubber units gas bellows* | C | C | C | C |
| *Scrubber units water bellows* | C | C | C | C |
| *Insulation* | C | C | C | C |
| *Commisioning* | X | X | X | X |
| *Documentation* | X | X | X | X |
| *Plan approval* | X | X | X | X |

X – Vendor scope
C – Customer/Yard supply
NA - Not applicable

- **DESCRIPTION OF EXISTING EXHAUST SYSTEM AND WORKING CONDITIONS**
- **DESCRIPTION OF OFFERED SCRUBBER SYSTEMS**
- **RANGE AND TERMS OF DELIVERY**
- **COMPARISON STUDY**
- **SUMMARY AND RECOMMENDATION**

| | Supplier 1 | Supplier 2 | Supplier 3 | Supplier 4 | *Factor* |
|---|---|---|---|---|---|
| *Seawater inlet* | | | | | *0,05* |
| *Power consuption* | | | | | *0,05* |
| *Alkaline medium consuption* | | | | | *0,05* |
| *Total mass* | | | | | *0,05* |
| *Required space for scrubber* | | | | | *0,15* |
| *Required space for auxiliary equipment* | | | | | - |
| *Level of interference below main deck* | | | | | *0,15* |
| *Level of interference above main deck* | | | | | *0,15* |
| *Scope of supply* | | | | | *0,05* |
| *Delivery time* | | | | | *0,05* |
| *Delivery terms* | | | | | *0,05* |
| *Price for delivery scope* | | | | | *0,25* |
| **Total (incl. factor)** | | | | | |

# SCRUBBER SYSTEM – FESIBILITY STUDY

## EXHAUST BACKPRESSURE CALCULATIONS

**Measurements**

| | ME1 | ME2 | ME3 | ME4 | |
|---|---|---|---|---|---|
| $T_4$ = | 238 | 245 | 251 | 247 | °C |
| $p_3$ = | -10 | -10 | -10 | -10 | mm WC |
| $T_3$ = | 214 | 250 | 260 | 296 | °C |
| $p_2$ = | 63 | 45 | 37 | 57 | mm WC |
| $T_2$ = | 184 | 165 | 187 | 170 | °C |
| $p_1$ = | 218 | 230 | 218 | 242 | mm WC |
| $T_1$ = | 227 | 237 | 201 | 207 | °C |
| $p_0$ = | 437 | 428 | 409 | 467 | mm WC |
| $T_0$ = | 379 | 376 | 357 | 372 | °C |

| | ME1 | ME2 | ME3 | ME4 | |
|---|---|---|---|---|---|
| $\Delta p_{SIL}$ = | 73 | 55 | 47 | 67 | mm WC |
| $\Delta p_{ECON}$ = | 70 | 111 | 109 | 109 | mm WC |
| $\Delta p_{SCR}$ = | 122 | 96 | 130 | 142 | mm WC |

**Calculations**

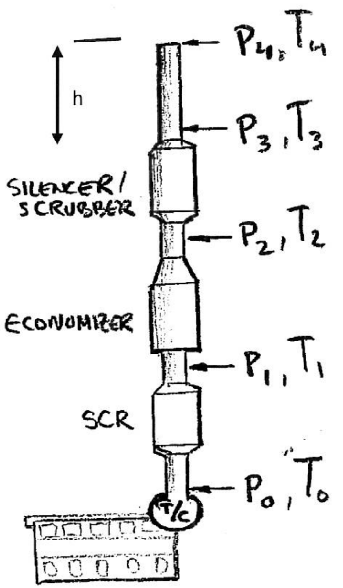
*Pressure*

| | ME1 | ME2 | ME3 | ME4 | |
|---|---|---|---|---|---|
| Engine load | 98 | 98 | 98 | 95 | % of MCR |
| $\Delta p_{MAX}$ = | 500 | 500 | 500 | 500 | mm WC |
| $\Delta p_{TOTAL} = p_0 - p_3$ = | 447 | 438 | 419 | 477 | mm WC |
| $\Delta p_{SIL} = p_2 - p_3$ = | 73 | 55 | 47 | 67 | mm WC |
| $\Delta p_{ECON} = p_1 - p_2$ = | 155 | 185 | 181 | 185 | mm WC |
| $\Delta p_{SCR} = p_0 - p_1$ = | 219 | 198 | 191 | 225 | mm WC |

*Temperature*

| | ME1 | ME2 | ME3 | ME4 | |
|---|---|---|---|---|---|
| $\Delta T_{TOTAL} = T_0 - T_4$ = | 141 | 131 | 106 | 125 | °C |
| $\Delta T_{ECON} = T_1 - T_2$ = | 43 | 72 | 14 | 37 | °C |
| $\Delta T_{SCR} = T_0 - T_1$ = | 152 | 139 | 156 | 165 | °C |

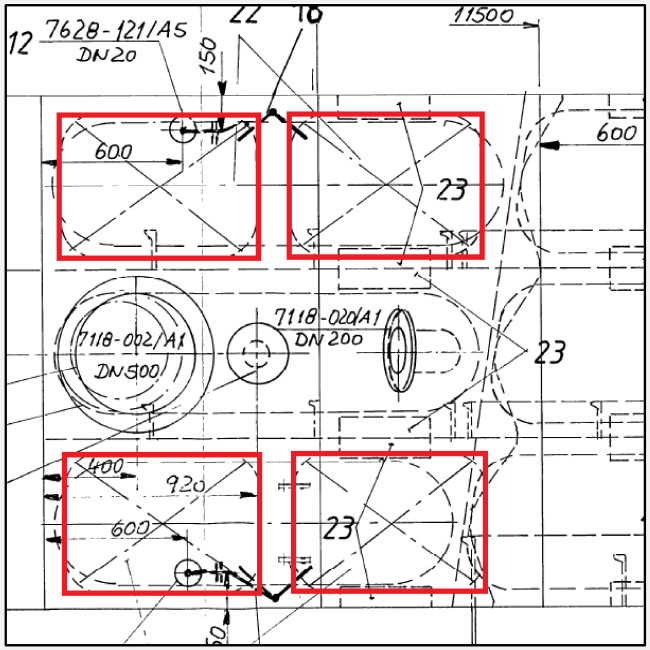
| | | |
|---|---|---|
| Ambient temperature, Engine Room = | 29 | °C |
| Ambient temperature, Outside = | 9 | °C |
| Ambient pressure, Outside = | 1024 | hPa(mbar) |
| Ambient pressure, Outside = | 10240 | mm WC |

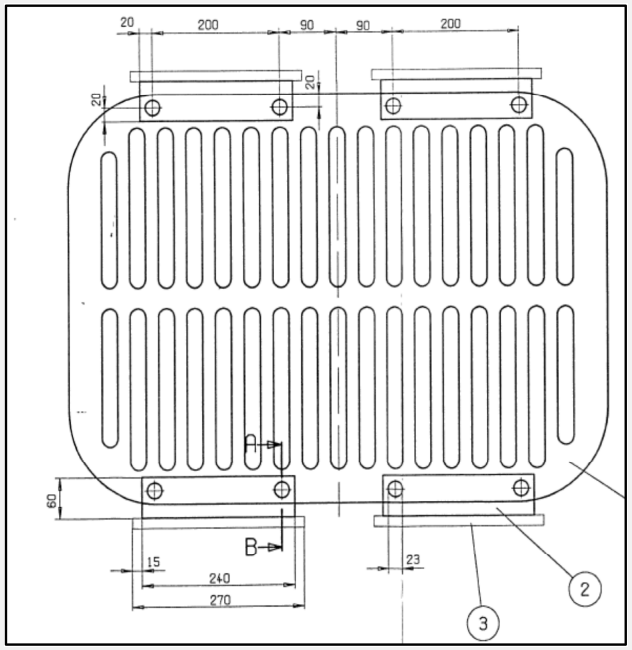



*Ev. kan skorstenseffekten kontrolleras med formeln: med $\Delta p = 0{,}0435 \cdot h \cdot \Delta T$*

# SCRUBBER SYSTEM – FESIBILITY STUDY

## SEACHEST CAPACITY CALCULATION




2. **Maximum water velocity $v_{max}$** through the strums holes - acc. to DNV-GL Pt.5 Ch.7 Sec.7 F305:

   $vmax$ =2 m/s

   **Design water velocity v** through the strums holes – assumed for calculations, based on design and oparation experience in order to avoid trouble with cruising in shallow water and in harbor area caused by contamination and settlements in sea water flow:

   $v$ =0,5 m/s

3. Total seachest capacity for **design water velocity** – for one seachest

   $Q = v * As = 0{,}5 * 0{,}875 = 0{,}4375 \frac{m3}{s} = \mathbf{1575\ m3/h}$

Design consumptions:

| | | | |
|---|---|---|---|
| a. | Pump 7242.03 | - | 140 $m^3$/h |
| b. | Pump 7112.06 (7112.05 in stand-by mode) | - | 135 $m^3$/h |
| c. | Pump 7962.01 | - | 408 $m^3$/h |
| d. | Pump 7112.04 (7112.03 in stand-by mode) | - | 310 $m^3$/ |
| e. | Pump 7112.02 (7112.01 in stand-by mode) | - | 310 $m^3$/h |
| | Total Qr | - | **1303 $m^3$/h** |

5. Remained seachest capacity

   $\Delta Q = Q - Qr = 1575 - 1303 = \mathbf{272\ m3/h}$

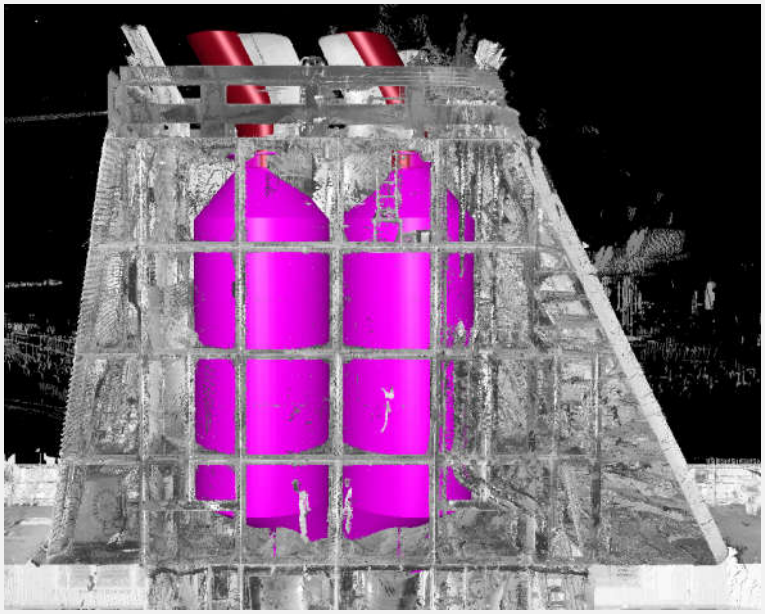
# SCRUBBER SYSTEM – FESIBILITY STUDY

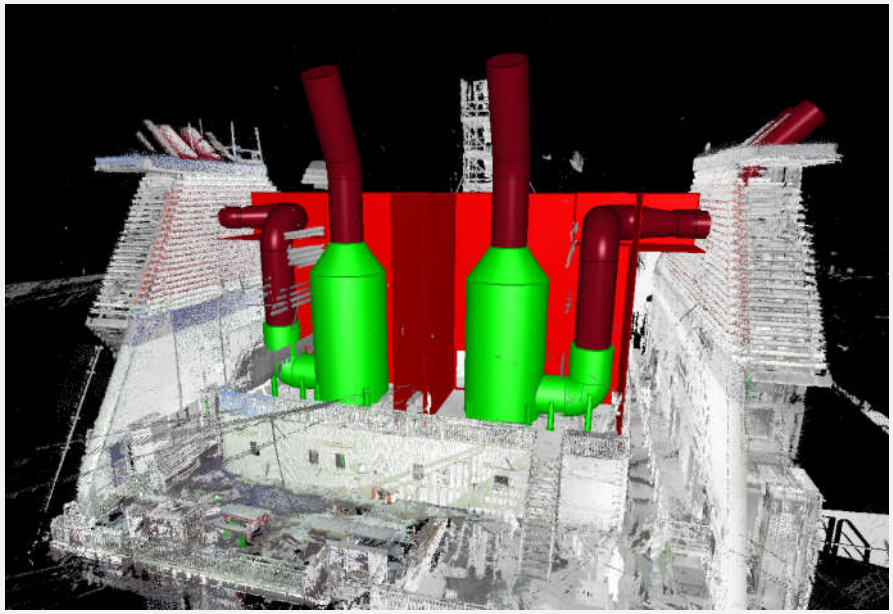
## POWER CONSUMPTION BALANCE

| No. | Consumer | | Power (rated) | ZEIT DER ZUSTAND TIME OF DUTY: SEEBETRIEB NORMAL SEA GOING | SEEBETRIEB + WAGENDECK LÜFTER NORMAL SEA GOING + CARDECK VENTILATION | MANÖVERBETRIEB + WAGENDECK LÜFTER MANOUVERING + CARDECK VENTILATION | LADEN + WAGENDECK LÜFTER SHORE + CARDECK VENTILATION | HAFENBETRIEB HARBOUR | NOTBETRIEB EMERGENCY | | SEEBETRIEB NORMAL SEA GOING | SEEBETRIEB + WAGENDECK LÜFTER NORMAL SEA GOING + CARDECK VENTILATION | MANÖVERBETRIEB + WAGENDECK LÜFTER MANOUVERING + CARDECK VENTILATION | LADEN + WAGENDECK LÜFTER SHORE + CARDECK VENTILATION | HAFENBETRIEB HARBOUR | NOTBETRIEB EMERGENCY | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | (kW) | (-) | (-) | (-) | (-) | (-) | (-) | (-) | (kW) | (kW) | (kW) | (kW) | (kW) | (kW) | (kW) |
| 146 | SCHMUTZ ÖLPUMPE<br>DIRTI OIL PUMP | 1 | 5,50 | | | | | | | | | | | | | | |
| 147 | AUTOMATIKFILTER FUER HAUPTMASCHINE<br>AUTOMATIC FILTERS FOR MAIN ENGINE | 2 | 0,06 | 2,00 | 2,00 | 2,00 | 2,00 | 2,00 | | | 0,12 T | 0,12 T | 0,12 T | 0,12 T | 0,12 T | | |
| 148 | AUTOMATIKFILTER FUER HILFSDIESEL<br>AUTOMATIC FILTERS FOR AUXILIARY DIESEL | 2 | 0,50 | 2,00 | 2,00 | 2,00 | | | | | 1,00 T | 1,00 T | 1,00 T | | | | |
| 149 | ANLASSLUFT KOMPRESSOREN<br>STARTING AIR COMOPRESSOR | 2 | 21,00 | | | | | | 1,00 | | | | | | | 21,00 T | |
| 150 | ARBEITSLUT KOMPRESSOREN<br>WORKING AIR COMOPRESSOR | 2 | 30,00 | 1,00 | 1,00 | 1,00 | 1,00 | 1,00 | | | 30,00 T | 30,00 T | 30,00 T | 30,00 T | 30,00 T | | |
| 151 | STEUERLUFTER KOMPRESSOREN<br>CONTROL AIR COMOPRESSOR | 1 | 11,00 | 1,00 | 1,00 | 1,00 | 1,00 | 1,00 | | | 11,00 T | 11,00 T | 11,00 T | 11,00 T | 11,00 T | | |
| 152 | LUFTTROCKNUNGSANLAGE<br>AIR DRYER | 1 | 5,00 | 1,00 | 1,00 | 1,00 | 1,00 | 1,00 | | | 5,00 P | 5,00 P | 5,00 P | 5,00 P | 5,00 P | | |
| 153 | SEEWASSER - ECKFILTR<br>SEA WATER - ECK FILTER | 3 | 0,06 | 3,00 | 3,00 | 3,00 | 3,00 | 3,00 | | | 0,18 X | 0,18 T | 0,18 T | 0,18 T | 0,18 T | | |
| 154 | SEEWASSERPUMPE FUER FRISHWASSERZEUGER<br>SEA WATER PUMP FOR FRESH WATER GENERATOR | 1 | 10,00 | 1,00 | 1,00 | | | | | | 10,00 X | 10,00 X | | | | | |
| 155 | DESTILLATPUMPE FUER FRISHWASSERZEUGER<br>DESTILATE PUMP FOR FRESH WATER GENERATOR | 1 | 1,00 | 1,00 | 1,00 | | | | | | 1,00 X | 1,00 X | | | | | |
| 156 | WERKSTATT - AUSRUESTUNG<br>WORKSHOP EQUIPMENT | 1 | 7,50 | | | | | | | | | | | | | | |
| 157 | HEIZUNGSROHRNETS SYSTEMEN<br>HEATING PIPING SYSTEM | 1 | 18,00 | 1,00 | 1,00 | 1,00 | 1,00 | 1,00 | | | 18,00 T | 18,00 T | 18,00 T | 18,00 T | 18,00 T | | |
| | **GRUPPE I<br>GROUP I** | | **1346,19** | | | | | | | | | | | | | | |
| **P =** | **STAENDIGE VERBRAUCHER<br>PERMANENT CONSUMERS** | | | | | | | | | | **347,09** | **347,09** | **347,09** | **119,67** | **119,67** | **3,00** | |
| **T =** | **ZEITWEISE VERBRAUCHER<br>PERIODICALLY CONSUMERS** | | | | | | | | | | **115,69** | **115,87** | **236,87** | **49,37** | **49,37** | **24,50** | |
| **N =** | **STAENDIGE UNWICHTIGE VERBRAUCHER<br>PERMANENT UNINTENDED LOAD** | | | | | | | | | | **18,20** | **18,20** | **18,20** | | | | |
| **X =** | **ZEITWEISE UNWICHTIGE VERBRAUCHER<br>PERIODICALLY UNINTENDED LOAD** | | | | | | | | | | **11,18** | **11,00** | | | | | |
| | **= P+ N + 0,5*(T+X)** | | | | | | | | | | **428,73** | **428,73** | **483,73** | **144,36** | **144,36** | **15,25** | |

# SCRUBBER SYSTEM – FESIBILITY STUDY

## MAIN EQUIPMENT ARRANGEMENT

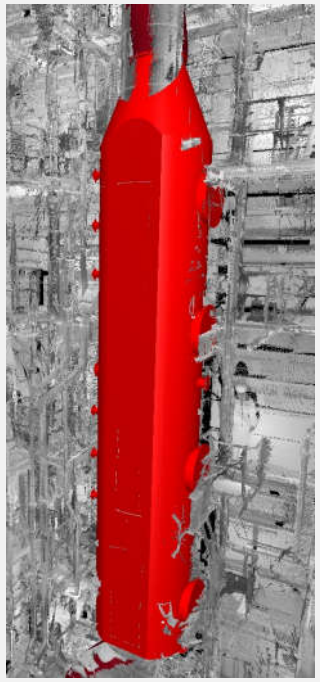


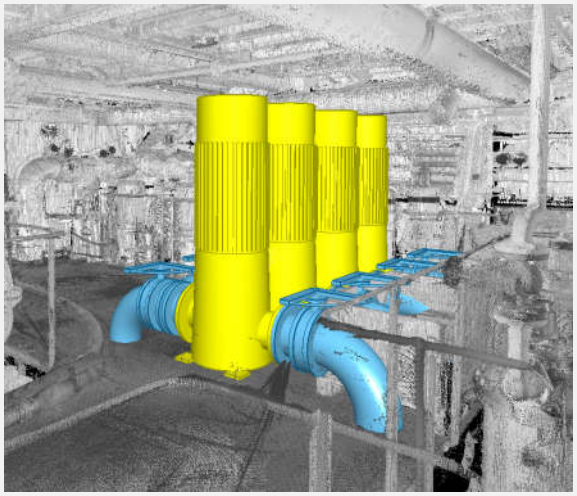


# SCRUBBER SYSTEM – CONCEPT DESIGN

## Main equipment arrangement

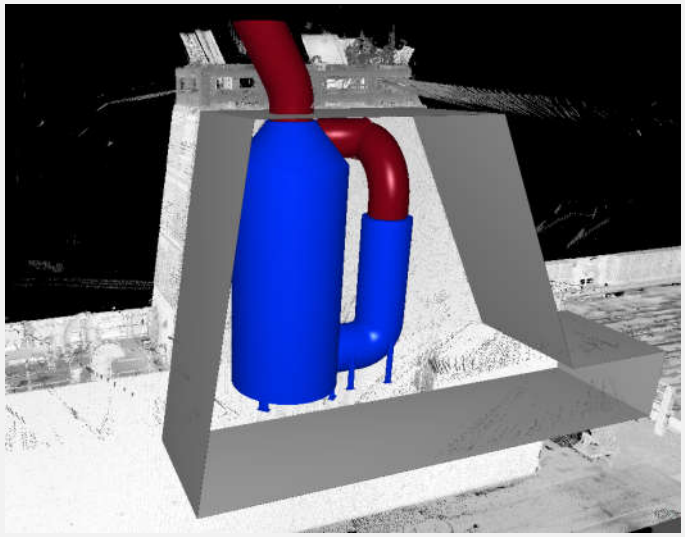
### Inline scrubber





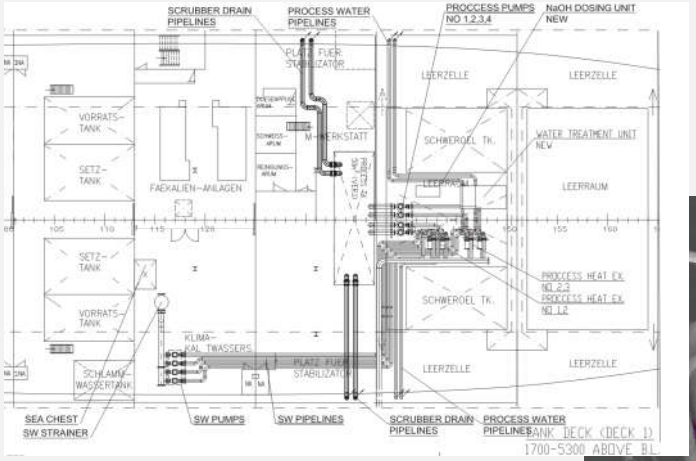
Sea Water pumps

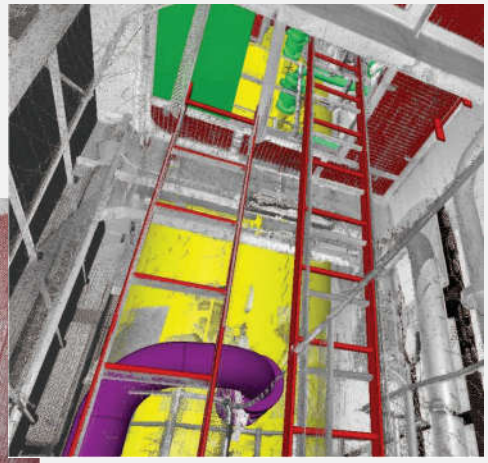
U-type scrubber

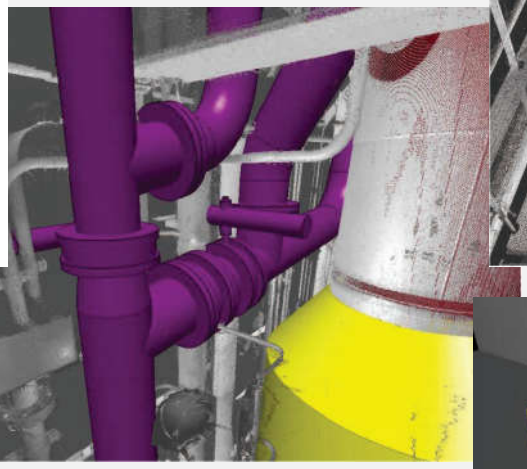


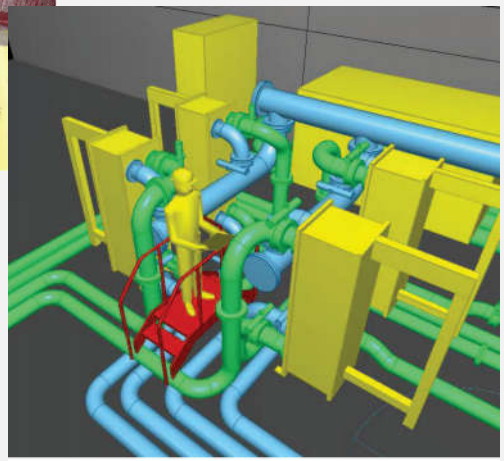
# SCRUBBER SYSTEM – CONCEPT DESIGN

## Main proces pipes arrangement

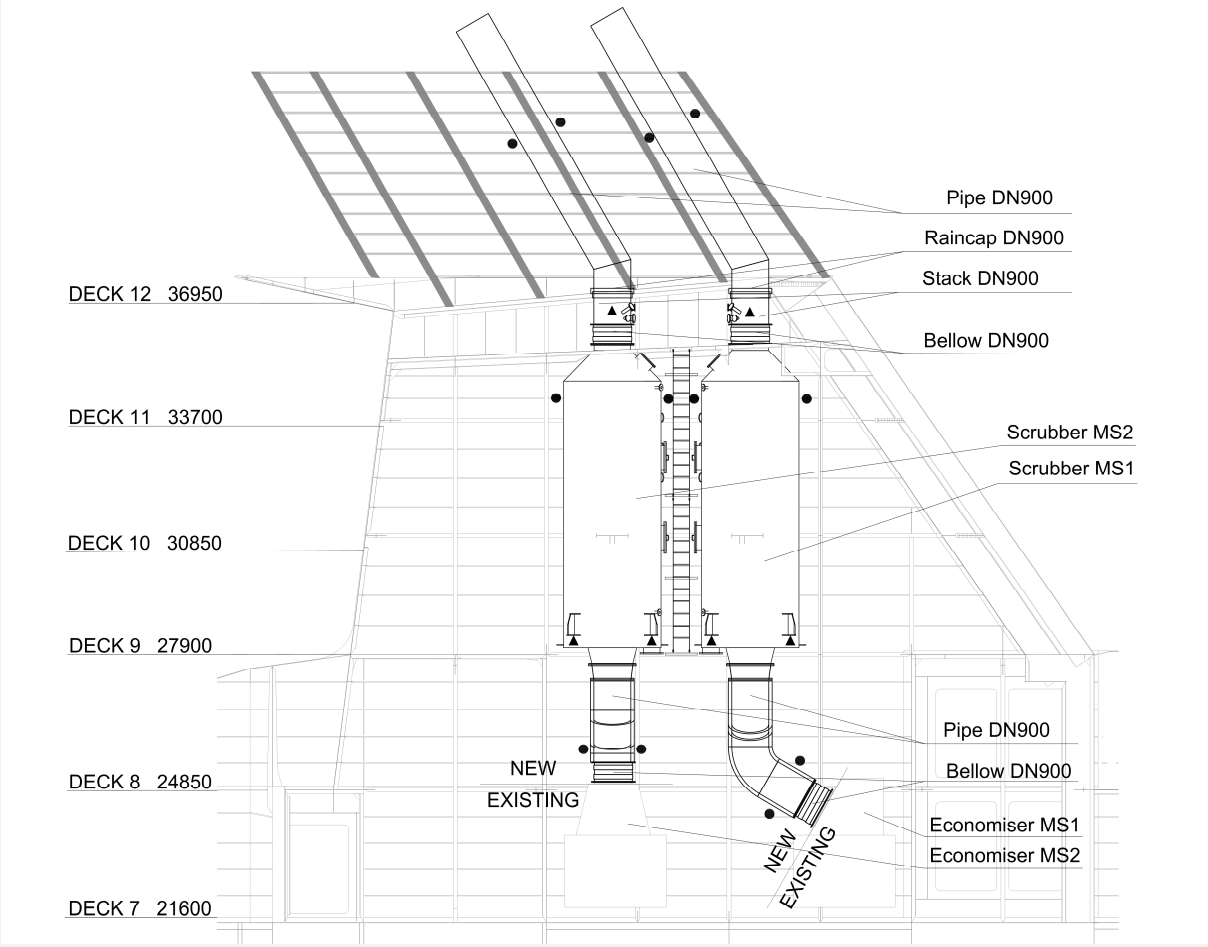




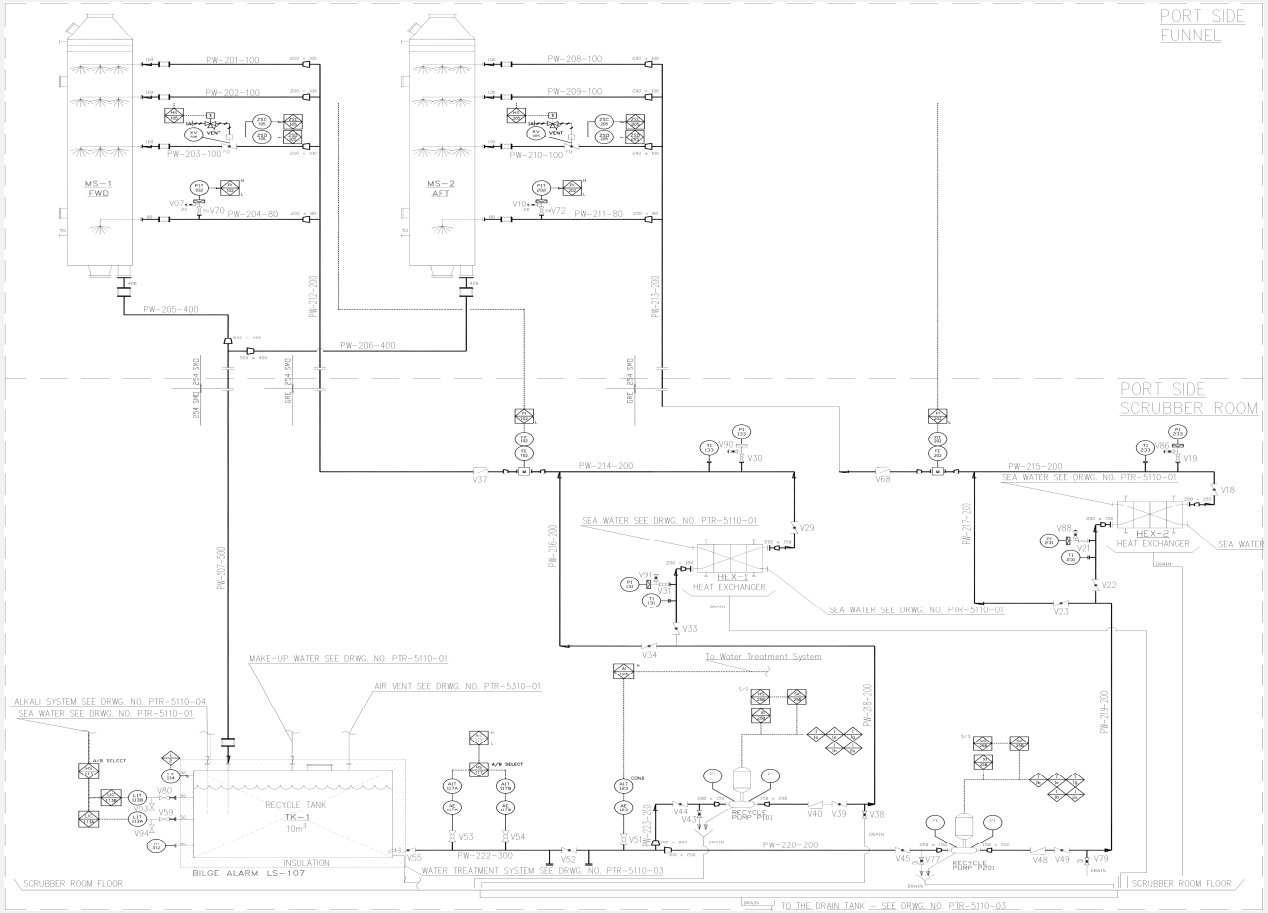


# SCRUBBER SYSTEM – BASIC DESIGN



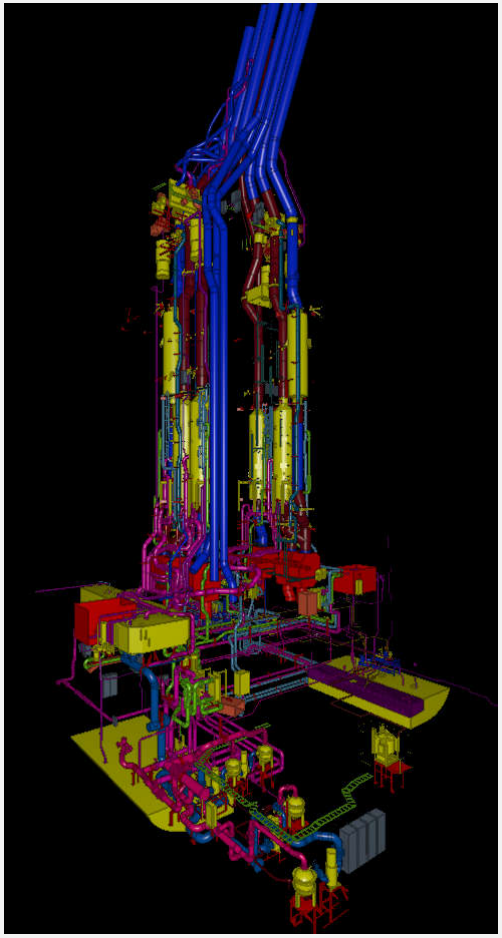

EXHAUST GAS SYSTEM MODIFICATION

# SCRUBBER SYSTEM – BASIC DESIGN

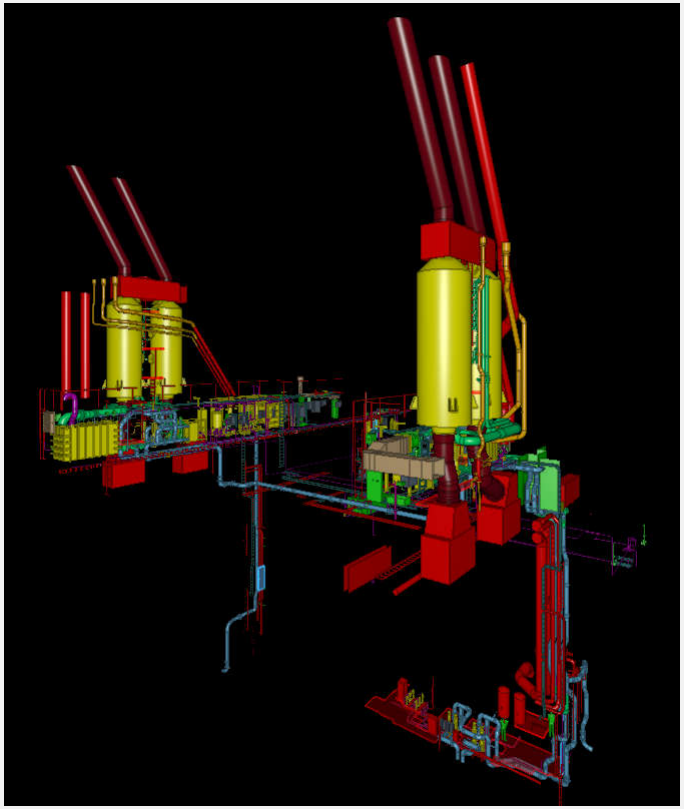



SCRUBBING WATER DIAGRAM

# SCRUBBER SYSTEM – DETAIL DESIGN

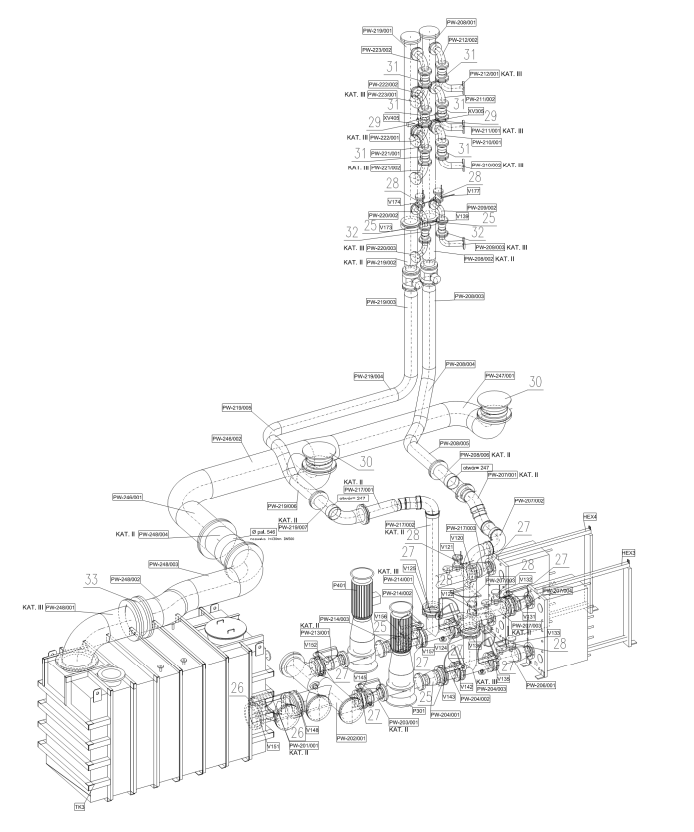


HYBRID TYPE SCRUBBER ON CRUISE VESSEL

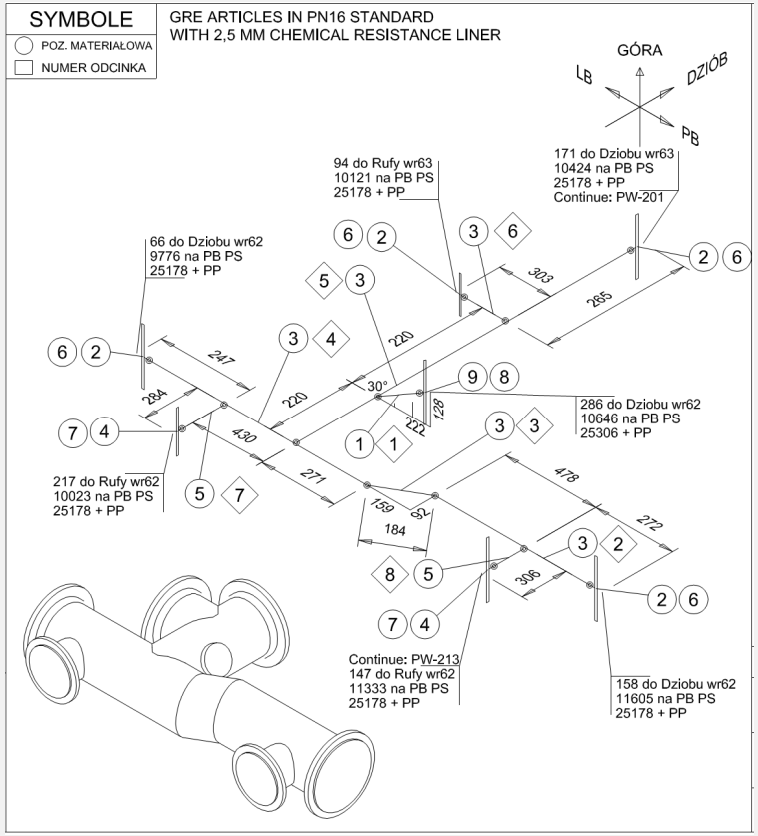


CLOSED LOOP TYPE SCRUBBER ON RO-RO VESSEL

# SCRUBBER SYSTEM – DETAIL DESIGN



SCRUBBER CLOSED LOOP INSTALATION PLAN




ISOMETRIC CATALOG

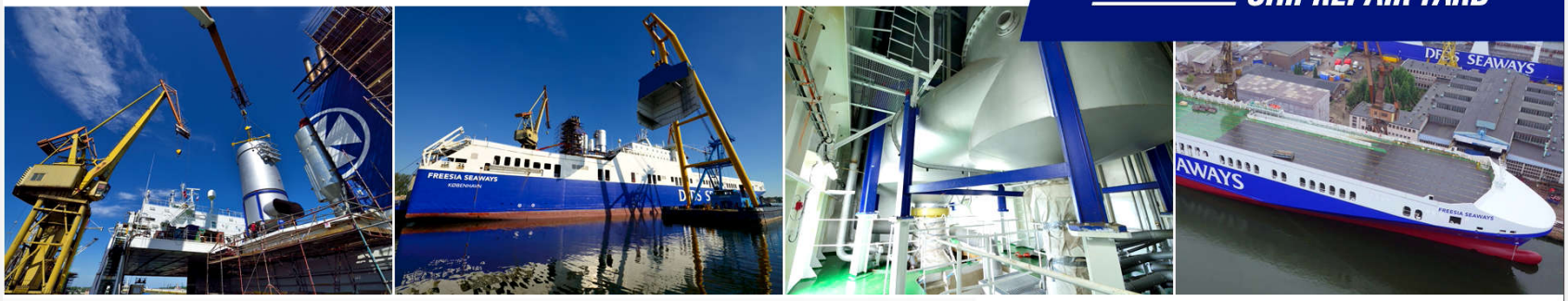
# SCRUBBER SYSTEM – INSTALLATION

# SCRUBBER SYSTEM – INSTALLATION

# SCRUBBER SYSTEM – INSTALLATION

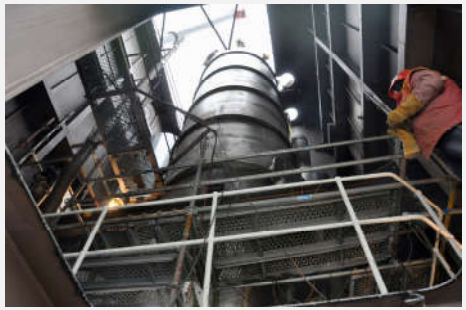
MEMBER OF REMONTOWA HOLDING S.A.

REMONTOWA SHIPREPAIR YARD




## SCRUBBERS RETROFITS

m/v Freesia Seaways

# Thank you for your attention