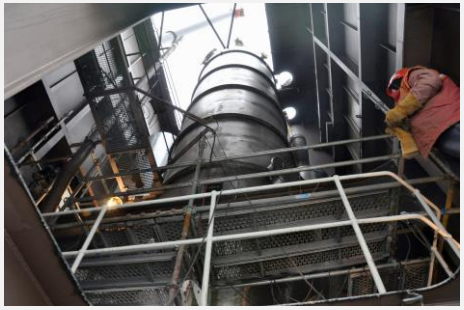


EXPERIANCE AND CHALLANGES DURING DESIGNING AND INSTALLATION OF SCRUBBER RELATED SYSTEMS

REMONTOWA SHIPREPAIR YARD

REMONTOWA SHIPBUILDING

REMONTOWA MARINE DESIGN

REMONTOWA HYDRAULIC SYSTEMS

REMONTOWA ELECTRICAL SOLUTIONS

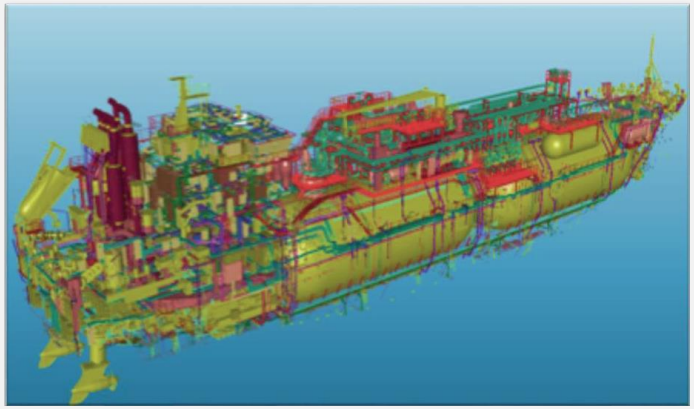
REMONTOWA LNG SYSTEMS

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

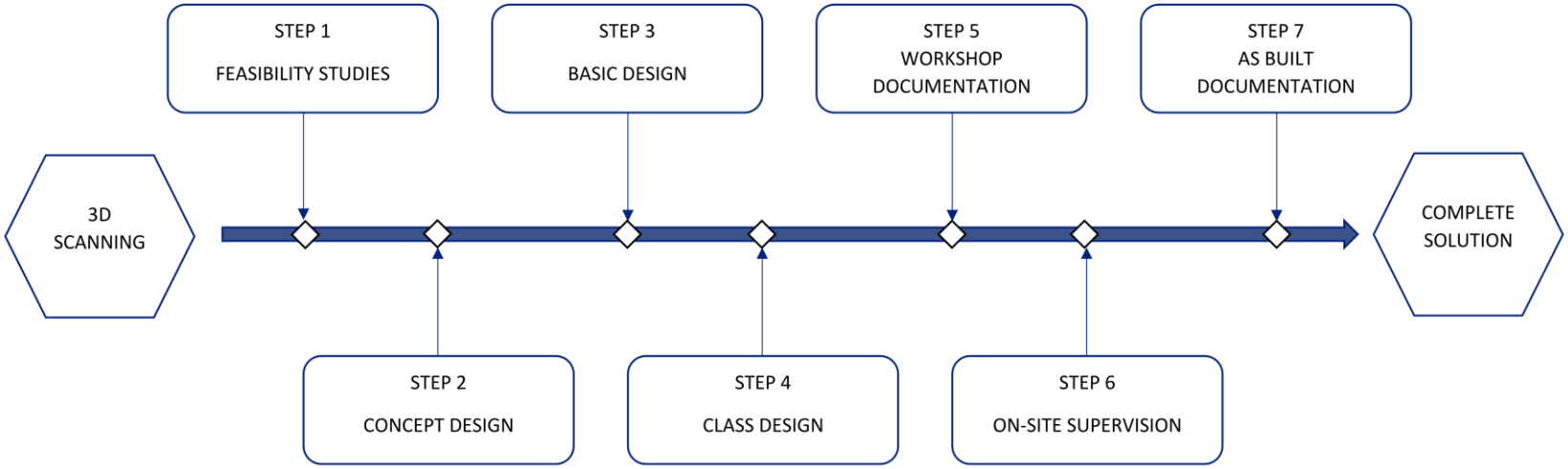
REMONTOWA MARINE DESIGN & CONSULTING

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
Intrumenty	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	
Δp_{SIL} =	73	55	47	67	mm WC
Δp_{ECON} =	70	111	109	109	mm WC
Δp_{SCR} =	122	96	130	142	mm WC

Calculations

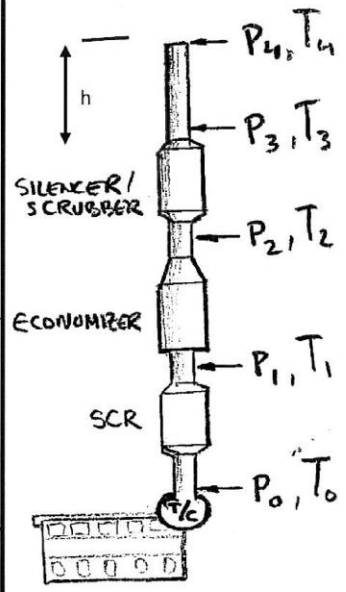
Pressure

	ME1	ME2	ME3	ME4	
Engine load	98	98	98	95	% of MCR
Δp_{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

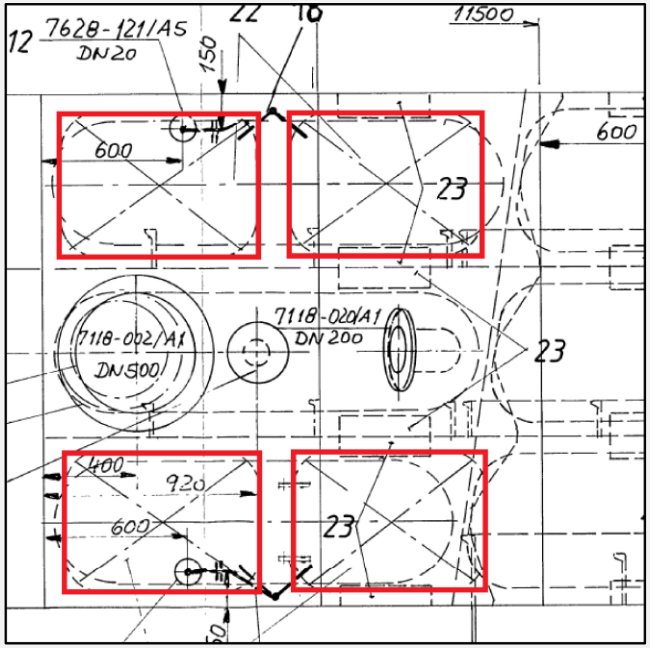
Ambient temperature, Engine Room =	29	°C
Ambient temperature, Outside =	9	°C
Ambient pressure, Outside =	1024	hPa(mbar)
Ambient pressure, Outside =	10240	mm WC

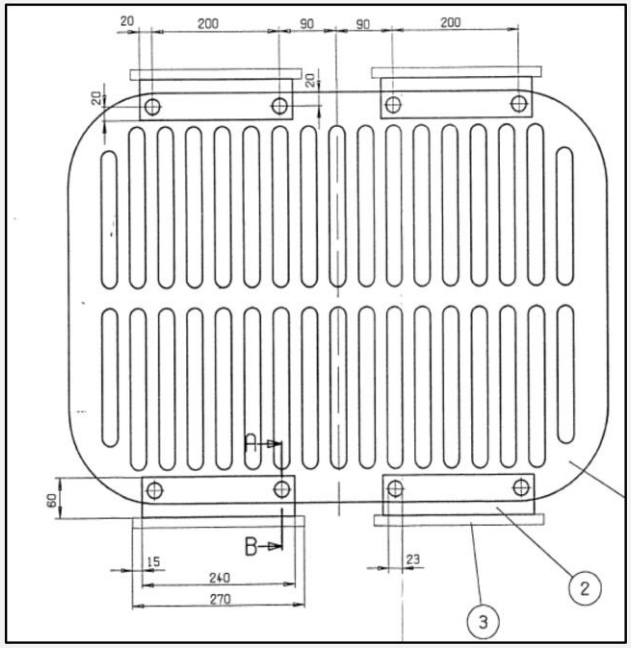


Ev. kan skorstenseffekten kontrolleras med formeln: med $\Delta p = 0{,}0435 \cdot h \cdot \Delta T$

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

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

   $\Delta Q = Q - Qr = 1575 - 1303 =$ **272 m3/h**

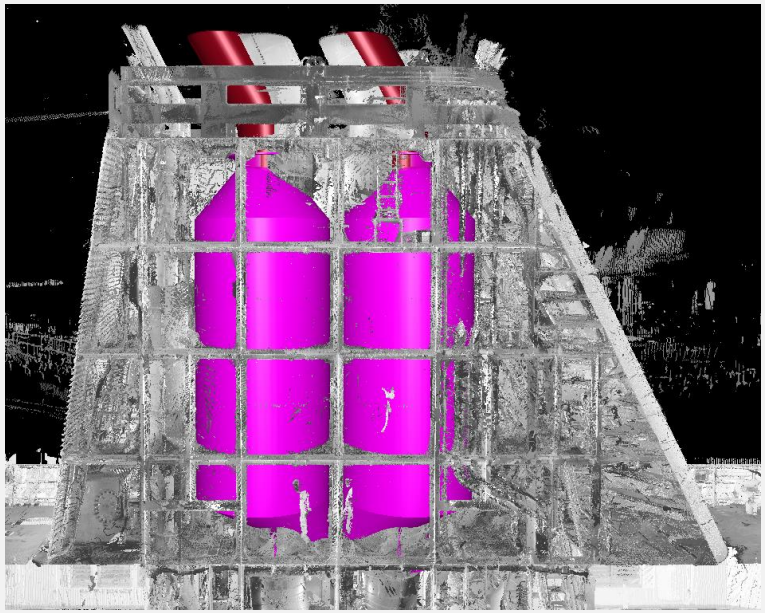
SCRUBBER SYSTEM – FESIBILITY STUDY

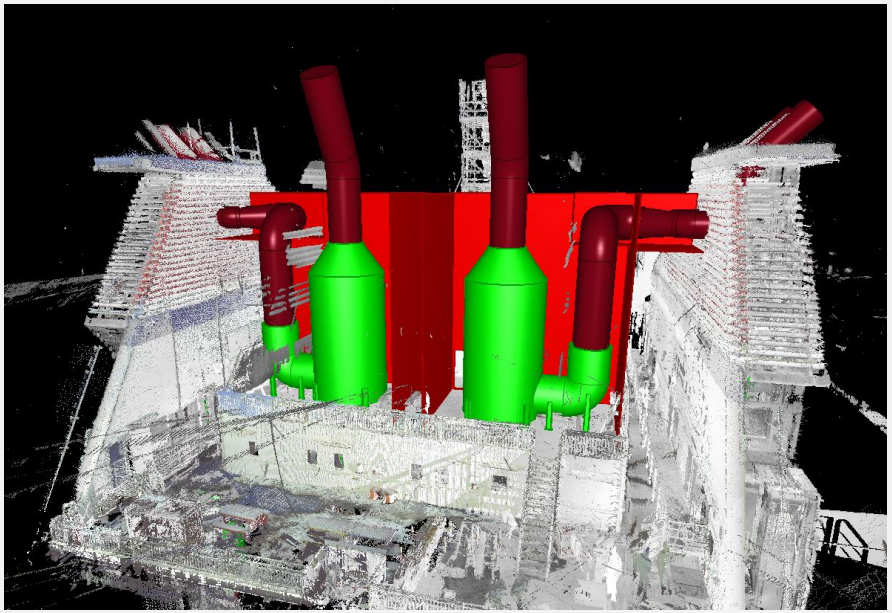
POWER CONSUMPTION BALANCE

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 DIRTI OIL PUMP	1	5,50														
147	AUTOMATIKFILTER FUER HAUPTMASCHINE 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 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 STARTING AIR COMOPRESSOR	2	21,00						1,00							21,00 T	
150	ARBEITSLUT KOMPRESSOREN 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 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 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 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 SEA WATER PUMP FOR FRESH WATER GENERATOR	1	10,00	1,00	1,00						10,00 X	10,00 X					
155	DESTILLATPUMPE FUER FRISHWASSERZEUGER DESTILATE PUMP FOR FRESH WATER GENERATOR	1	1,00	1,00	1,00						1,00 X	1,00 X					
156	WERKSTATT - AUSRUESTUNG WORKSHOP EQUIPMENT	1	7,50														
157	HEIZUNGSROHRNETS SYSTEMEN 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 GROUP I		**1346,19**														
P =	**STAENDIGE VERBRAUCHER PERMANENT CONSUMERS**										**347,09**	**347,09**	**347,09**	**119,67**	**119,67**	**3,00**	
T =	**ZEITWEISE VERBRAUCHER PERIODICALLY CONSUMERS**										**115,69**	**115,87**	**236,87**	**49,37**	**49,37**	**24,50**	
N =	**STAENDIGE UNWICHTIGE VERBRAUCHER PERMANENT UNINTENDED LOAD**										**18,20**	**18,20**	**18,20**				
X =	**ZEITWEISE UNWICHTIGE VERBRAUCHER 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

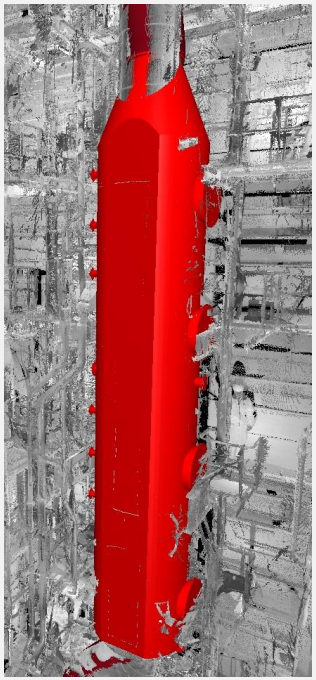


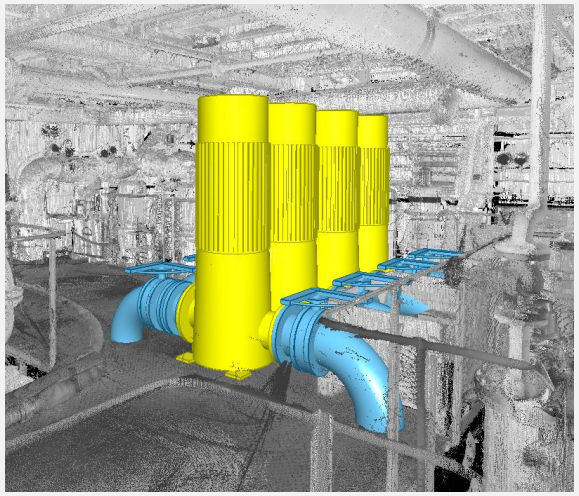


SCRUBBER SYSTEM – CONCEPT DESIGN

Main equipment arrangement

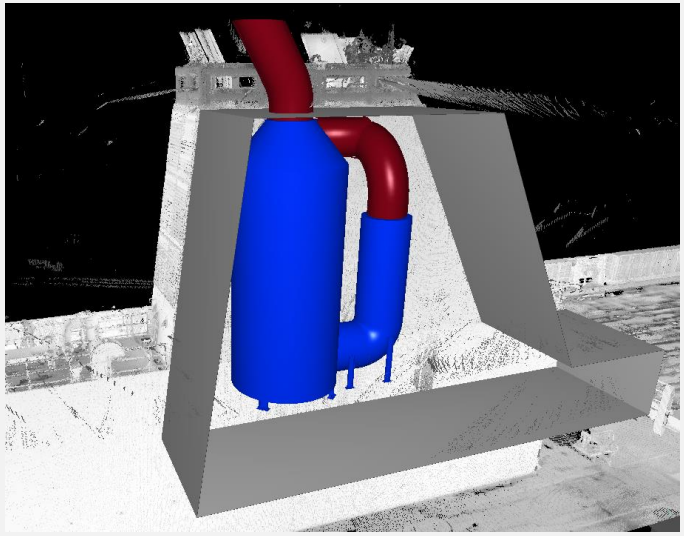
Inline scrubber





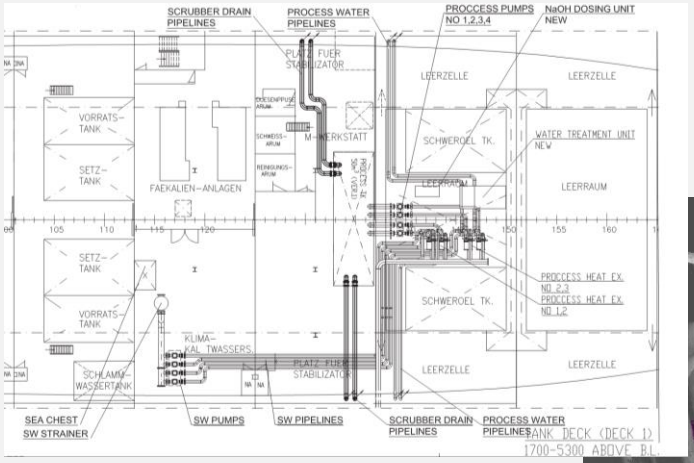
Sea Water pumps

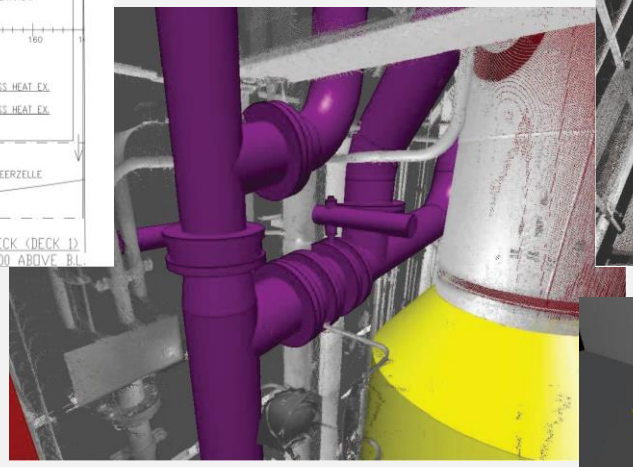
U-type scrubber

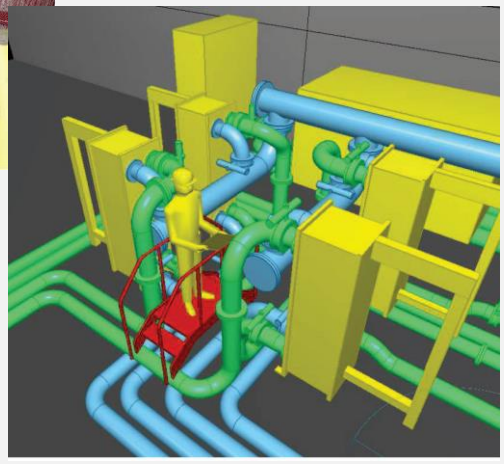


SCRUBBER SYSTEM – CONCEPT DESIGN

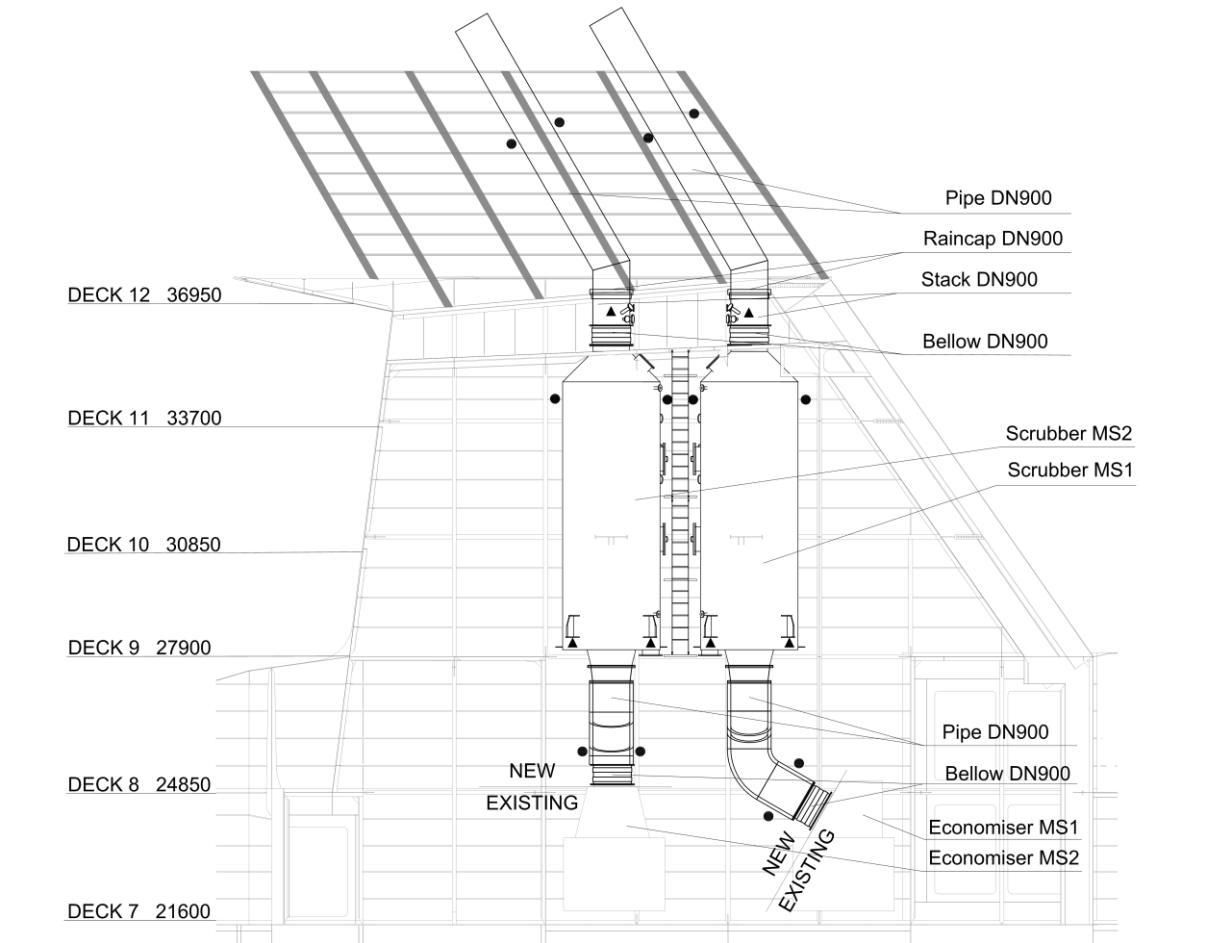
Main proces pipes arrangement





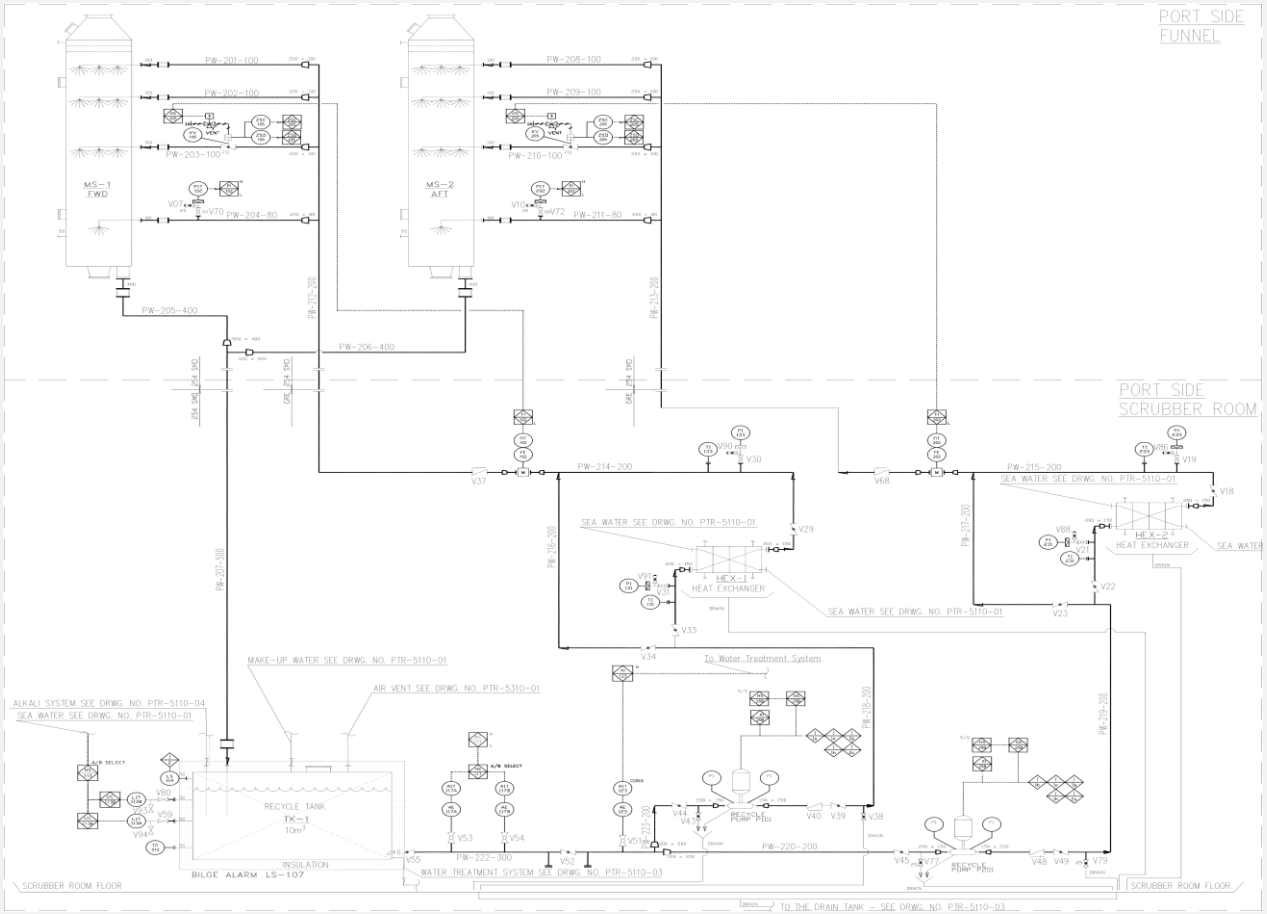


SCRUBBER SYSTEM – BASIC DESIGN



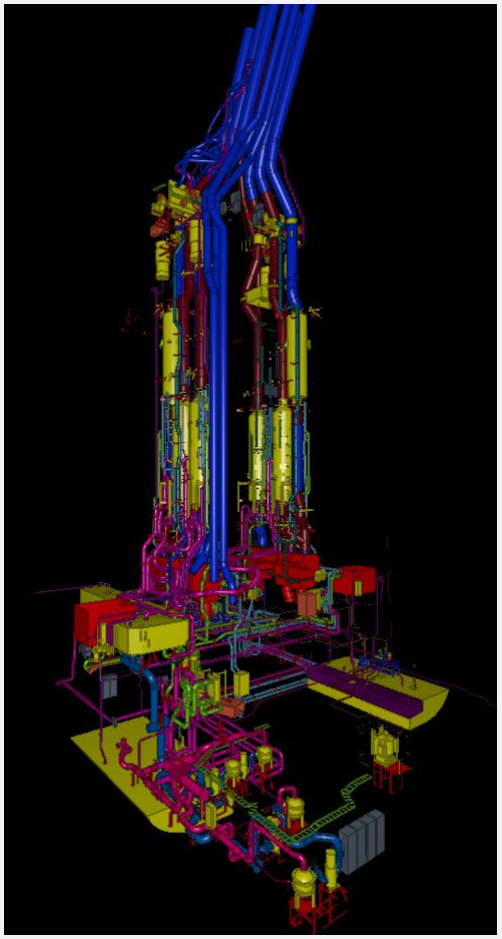
EXHAUST GAS SYSTEM MODIFICATION

SCRUBBER SYSTEM – BASIC DESIGN

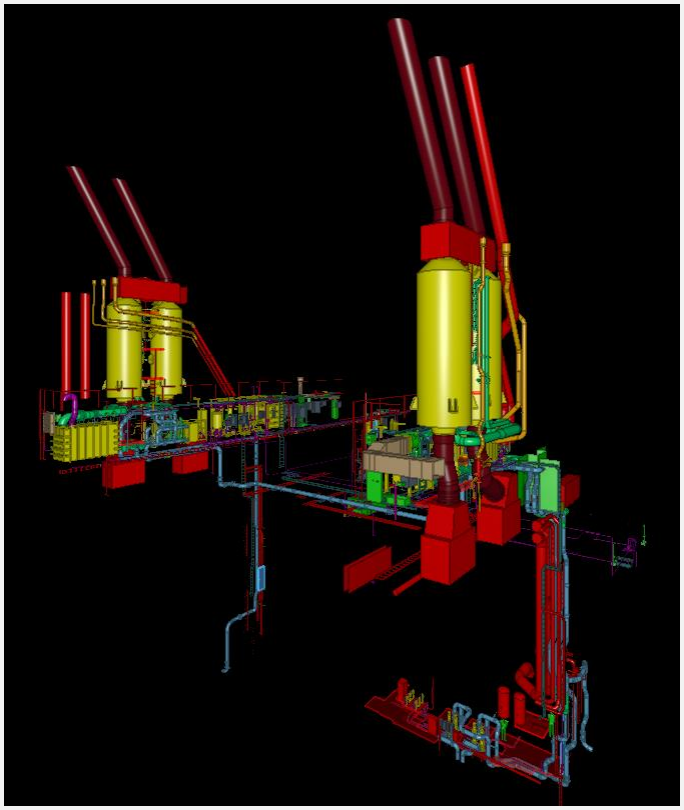


SCRUBBING WATER DIAGRAM

SCRUBBER SYSTEM – DETAIL DESIGN

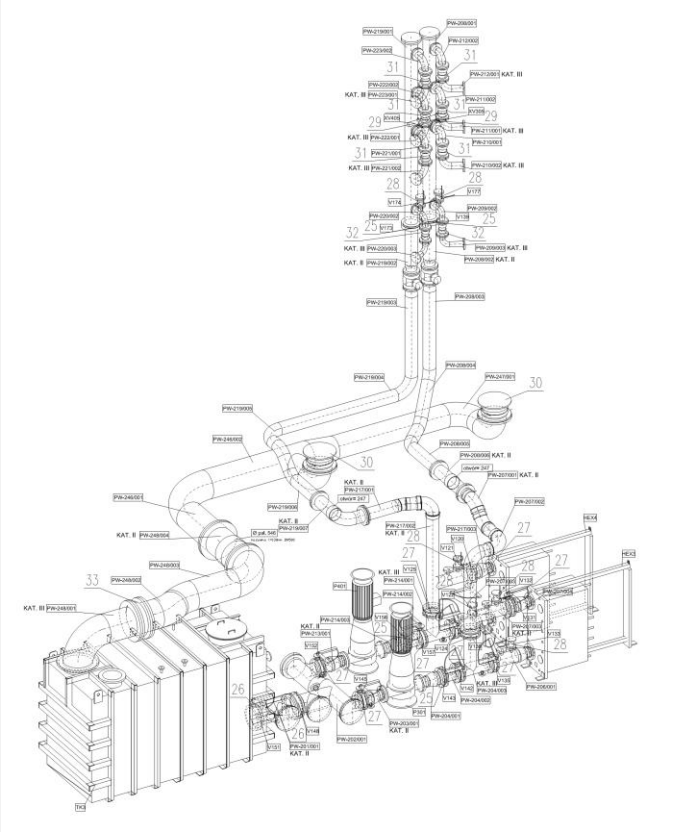


HYBRID TYPE SCRUBBER ON CRUISE VESSEL

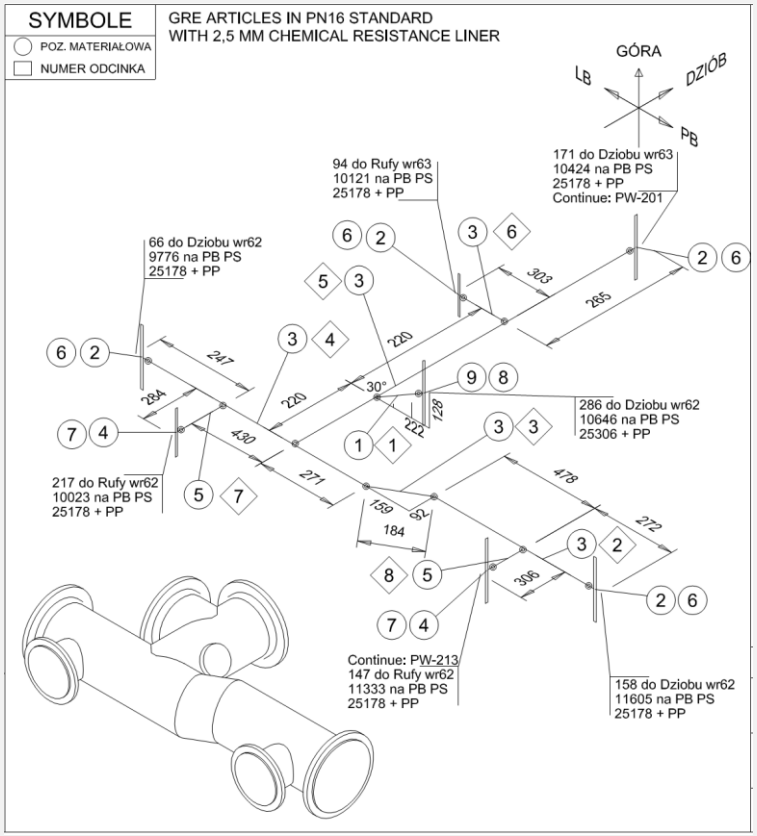


CLOSED LOOP TYPE SCRUBBER ON RO-RO VESSEL

SCRUBBER SYSTEM – DETAIL DESIGN



SCRUBBER CLOSED LOOP INSTALATION PLAN

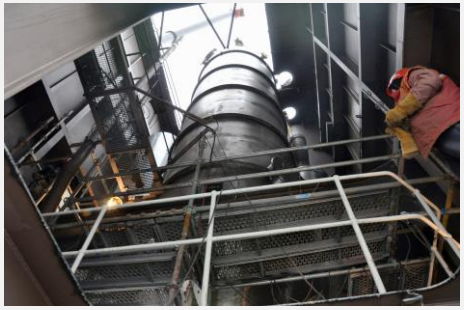


ISOMETRIC CATALOG

SCRUBBER SYSTEM – INSTALLATION

SCRUBBER SYSTEM – INSTALLATION

SCRUBBER SYSTEM – INSTALLATION



Thank you for your attention