

WÄRTSILÄ

Scrubber Solutions

The intelligent way to be compliant

CLEAN AIR

CLEAN OCEAN

CLEAN CONSCIENCE



NO_x

ACID RAINS

US ECA

TIER III

SO_x

ACID RAINS

0.1% IN ECA/EU

0,5% IN GLOBAL

CO₂ / PM

UNDER EVALUATION

PM RESTRICTION IN

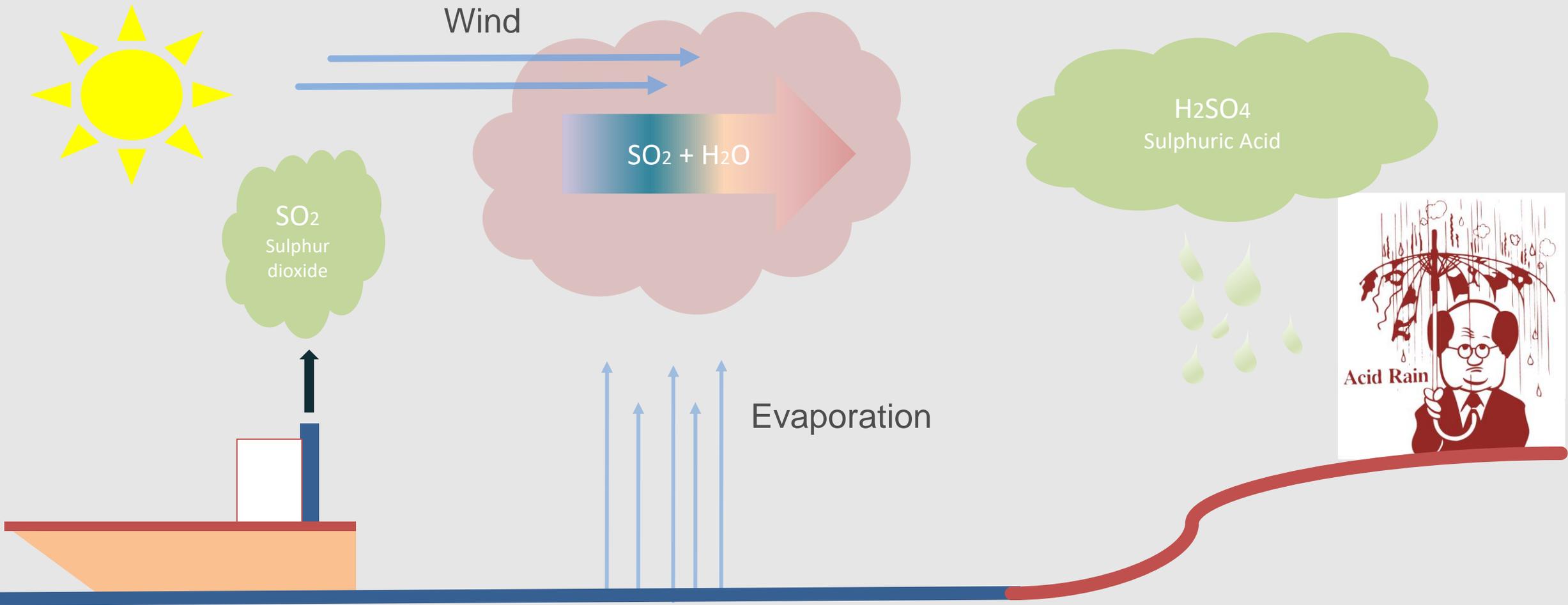
SOME AREAS

AND FOR SMALLER

MACHINERY



What is Sulphur emissions and its effects!?



Oceans Emission Control



**GLOBAL 0,5 %
SULPHUR CAP IN 2020**



ARE YOU PREPARED FOR 2020?
WE ARE

CHANGE FUEL

Run full time with low Sulphur bunker fuel.

LNG CONVERSION

Convert engines to run on Gas (LNG).

USE SCRUBBER

Install exhaust gas cleaning system.



CHANGE FUEL

Run full time with low Sulphur bunker fuel.



- Convenient
- Small investment cost



- High operating cost
- Fuel change over procedures
- Future availability

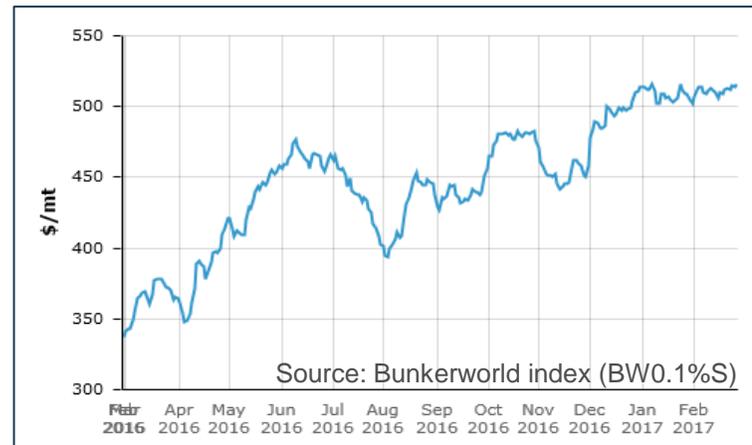


LNG CONVERSION

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CHANGE FUEL

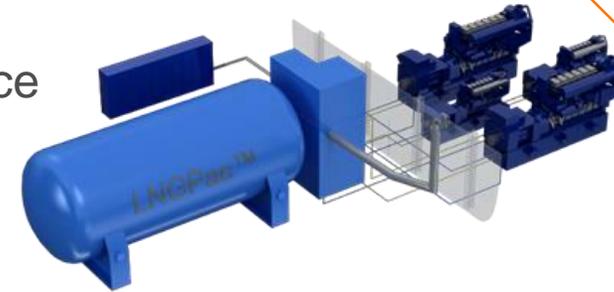
Run full time with low Sulphur bunker fuel.



- Solution which also reduce NOx and Particulates.



- Investment cost
- Future availability of LNG fuel



LNG CONVERSION

Convert engines to run on Gas (LNG).



Bit Viking

- Wärtsilä Dual fuel conversion
- Wärtsilä LNGpac

[Read more](#)

CHANGE FUEL

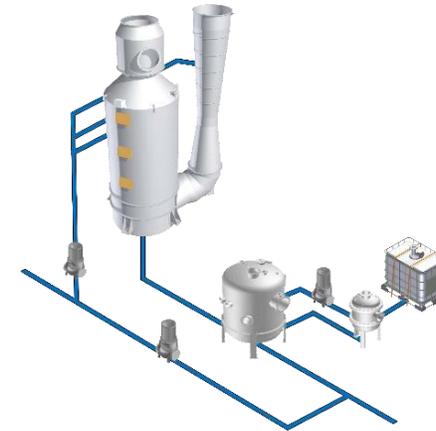
Run full time with low Sulphur bunker fuel.



- Continue to use HFO
- Low lifecycle cost



- ROI is subject to the fuel spread between low Sulphur fuel and HFO



LNG CONVERSION

Convert engines to run on Gas (LNG).

USE SCRUBBER

Install exhaust gas cleaning system.



Bothniaborg

- Wärtsilä VSOX Hybrid Scrubber System
- Retrofit installation

[Read more](#)

WE **CUSTOMIZE** YOUR SCRUBBER SOLUTION



WÄRTSILÄ SCRUBBER SOLUTIONS



Wärtsilä I-SOx

1 – 18MW



Footprint

Wärtsilä V-SOx

1 – 20MW



Efficiency and PM

Wärtsilä V-SOx multiple

1 – 35MW



Efficiency and PM

Wärtsilä Q-SOx

40 – 70MW



Efficiency, footprint and robust

System Arrangements

Open loop

Ships operating in waters with sufficient alkalinity and no restriction on discharge water.



Closed loop

Ships operating in low alkalinity waters or operating in zero discharge zones.



Hybrid

Ships operating in all types of waters or requiring full operation flexibility.



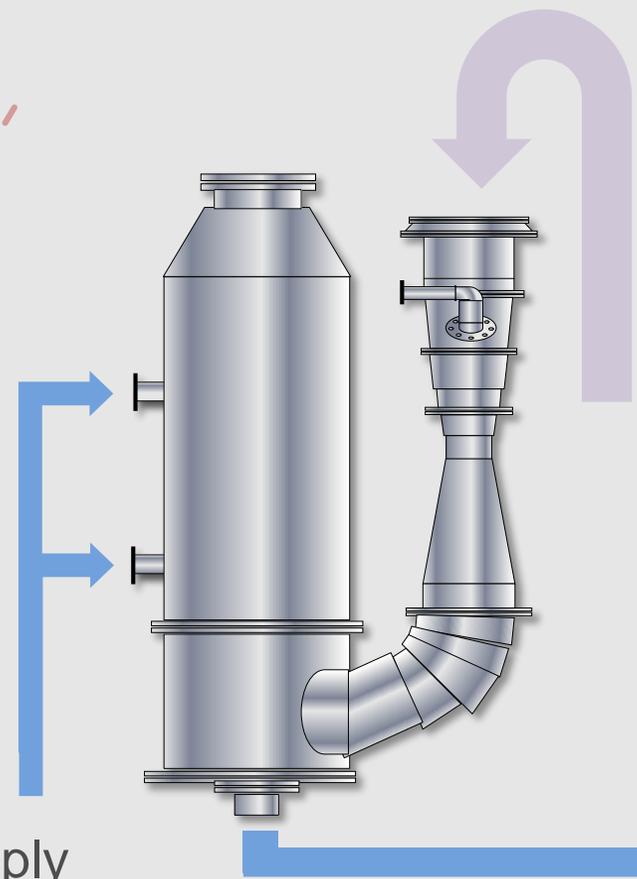
OPEN LOOP SCRUBBING CHEMISTRY

What happens in the Scrubber:



Seawater reactions:

Alkalinity (Bicarbonates (HCO_3^-) / carbonates (CO_3^{2-}))
 – neutralize the pH rapidly
 $2\text{CO}_3^{2-} + \text{Sulphuric acid} \rightarrow 2\text{HCO}_3^- + \text{SO}_4^{2-}$ (Sulphate)
 $2\text{HCO}_3^- + \text{Sulphuric acid} \rightarrow 2\text{H}_2\text{CO}_3 + \text{SO}_4^{2-}$ (Sulphate)



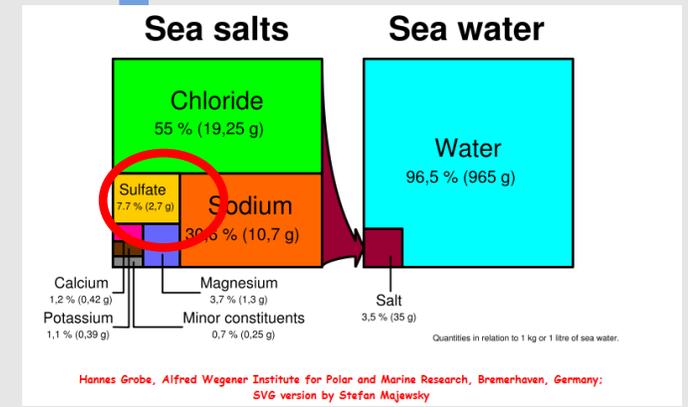
Exhaust gas 3.5% S

Engine Exhaust Chemistry:
 Sulphur and oxygen $\rightarrow \text{SO}_2$ (~95%) + SO_3 (~5%)

Sea water supply
 Containing: HCO_3^- and CO_3^{2-}

Sulphate:
 Natural substance in seawater

Approximate amount:
 2 700 mg/l



Hannes Grobe, Alfred Wegener Institute for Polar and Marine Research, Bremerhaven, Germany: SVG version by Stefan Majewsky



WÄRTSILÄ

HYBRID SCRUBBER
HOW DOES IT WORK?

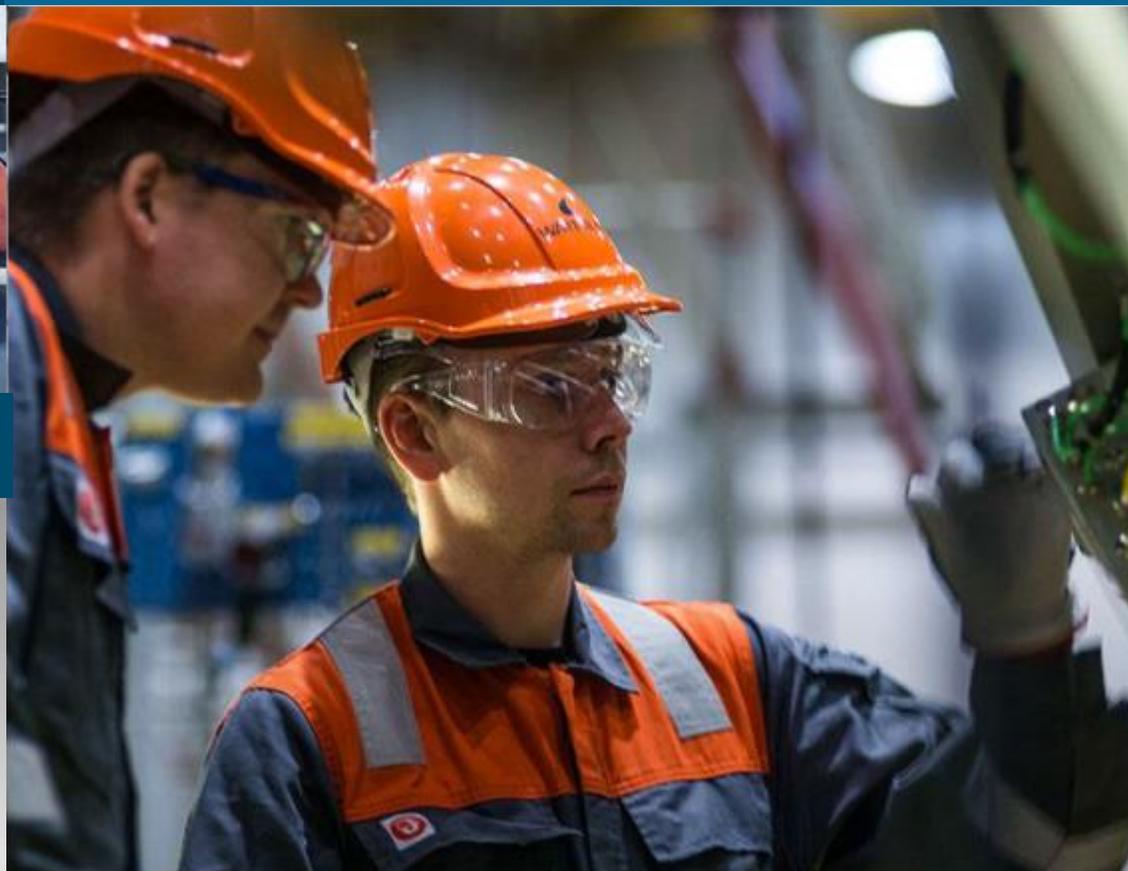
EQUIPMENT ONLY



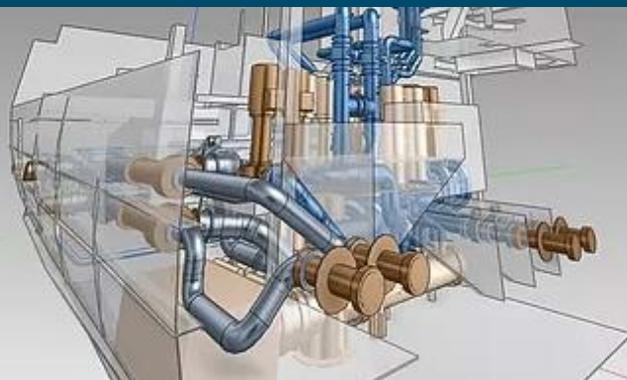
SITE ADVISORY



INSTALLATION



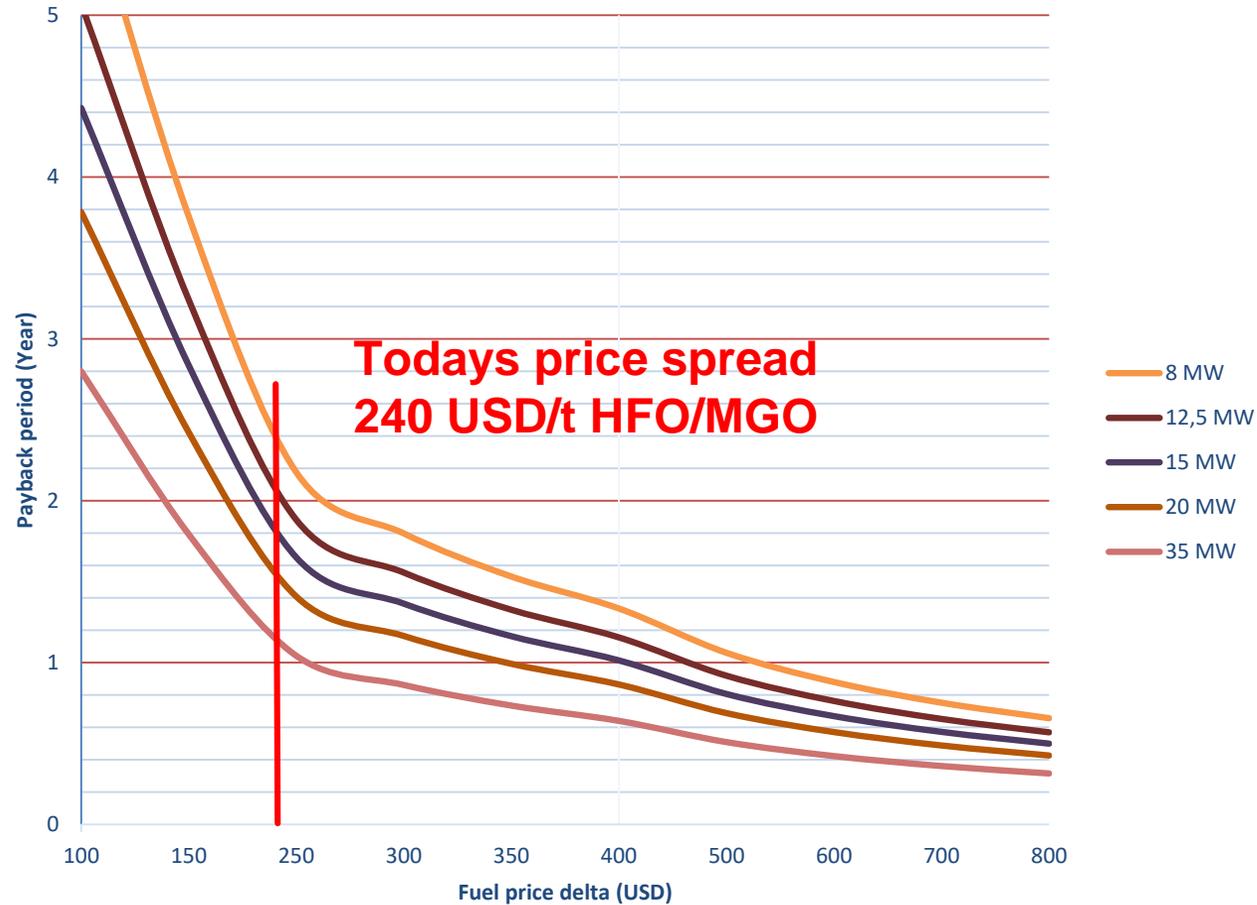
ENGINEERING



EPC

+ POSSIBILITY FOR SCRUBBER INVESTMENT FINANCING

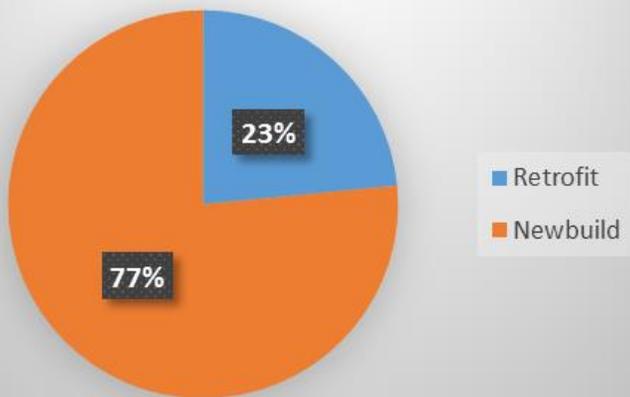
Fuel price difference – Payback time (open loop system)



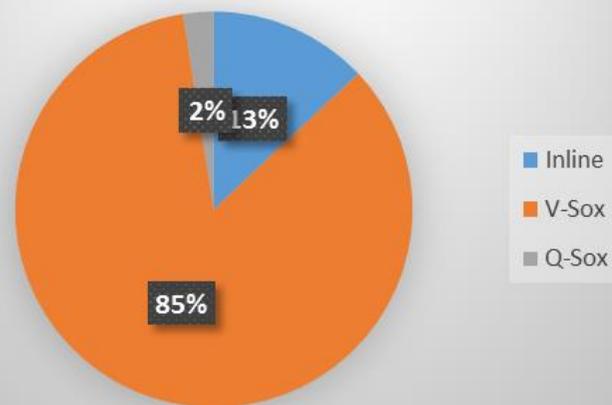
To be considered

- Equipment cost
- Installation cost
- Total project cost
- Running cost

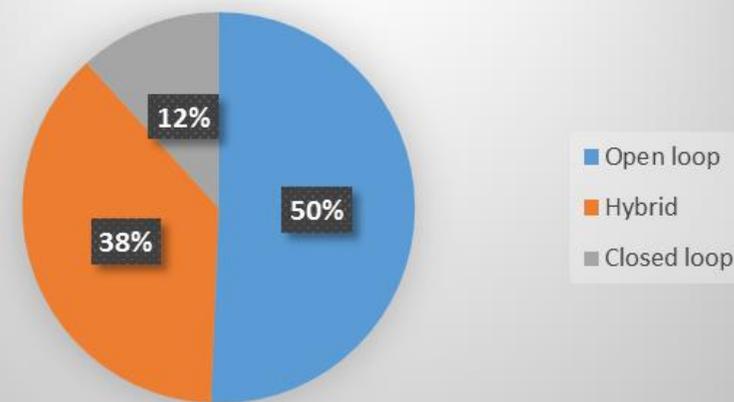
Retrofit/New build



Scrubber Type



System Type



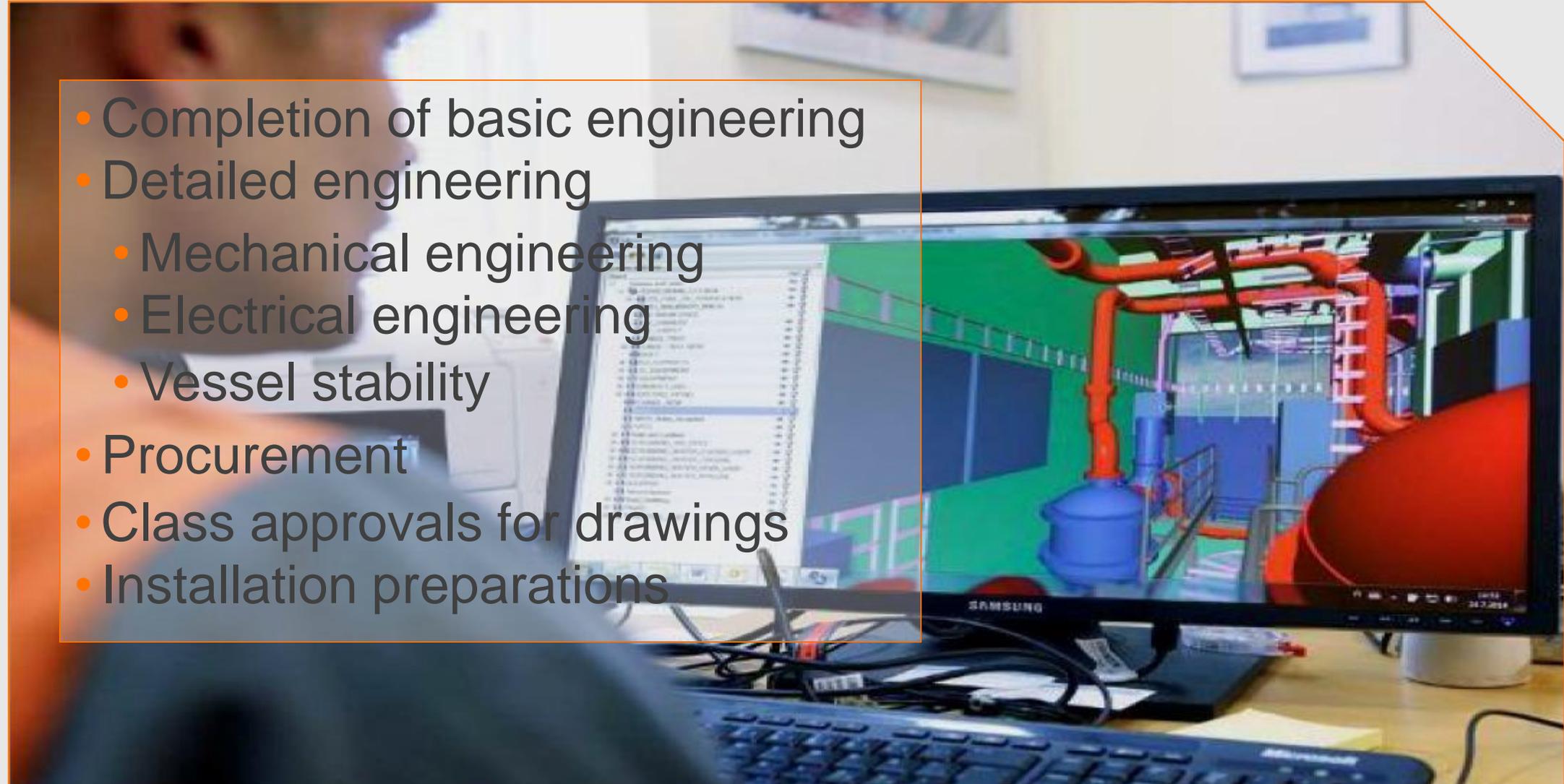
**~ 300 VESSELS
~ 350 SCRUBBERS**

Basic design phase

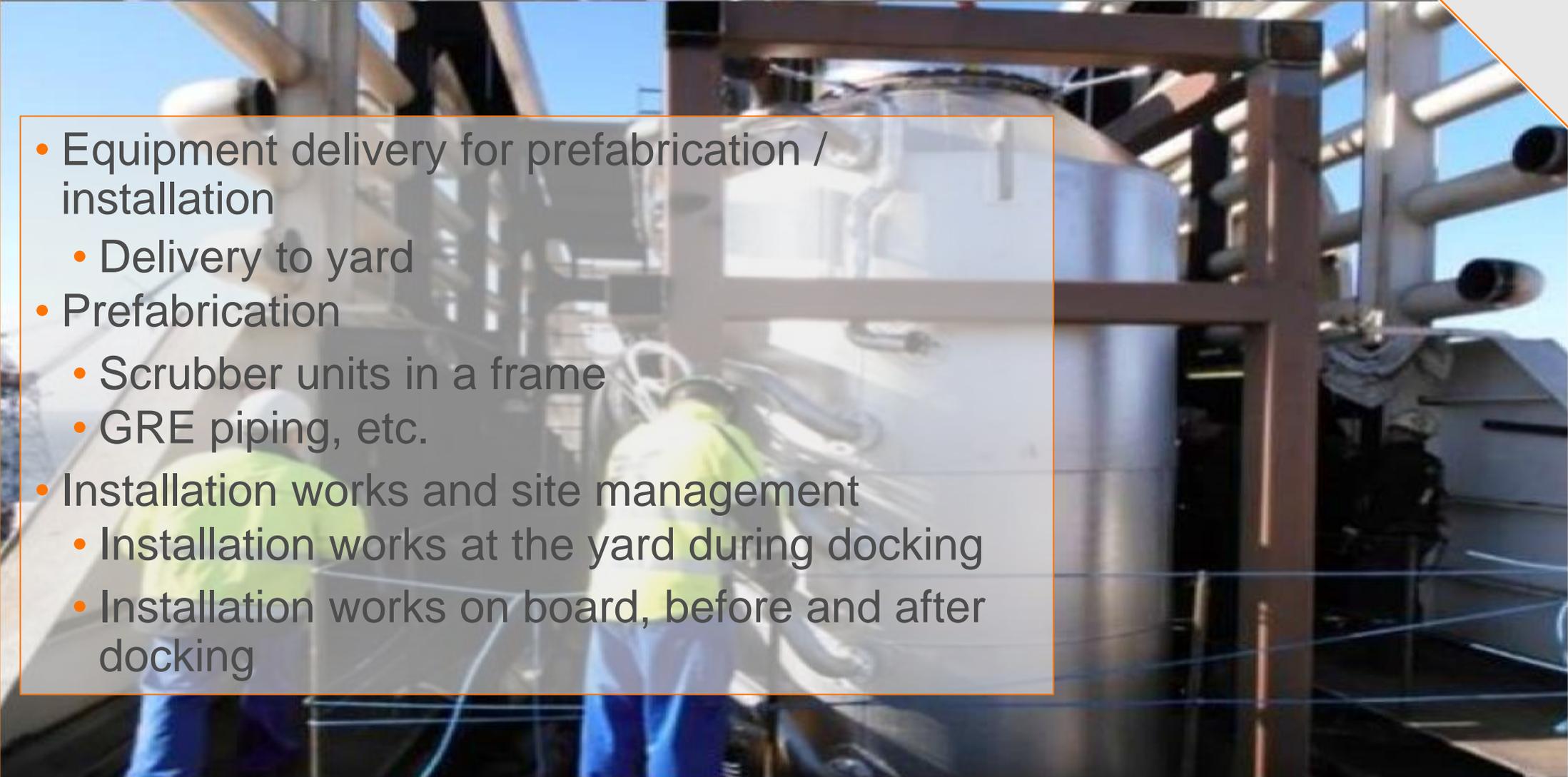
- 
- 3D laser scanning
 - Basic engineering
 - Mechanical
 - Electrical
 - Preliminary approvals
 - Opening the dialogue with the class
 - Final project plan
 - Selection of sub-contractors
 - Firm offer and contract for an EPC delivery

Detailed design phase

- Completion of basic engineering
- Detailed engineering
 - Mechanical engineering
 - Electrical engineering
 - Vessel stability
- Procurement
- Class approvals for drawings
- Installation preparations



Installation phase

- 
- Equipment delivery for prefabrication / installation
 - Delivery to yard
 - Prefabrication
 - Scrubber units in a frame
 - GRE piping, etc.
 - Installation works and site management
 - Installation works at the yard during docking
 - Installation works on board, before and after docking

Commissioning and Tests

- Installation inspections
 - Pre-commissioning
 - Performance tests
- MARPOL tests (approvals)
 - Emission compliance
 - Water discharge compliance
- Crew training
- Hand over and start of lifecycle support



Optimised use of space

- Our solution (patent pending) is based on two prefabricated modules: the scrubber unit (module A) and control and water treatment (module B)
- This approach reduces the amount of piping and cabling in the engine room and funnel area
- The footprint of the modules matches standard TEU dimensions to ensure a perfect fit onboard



BENEFITS



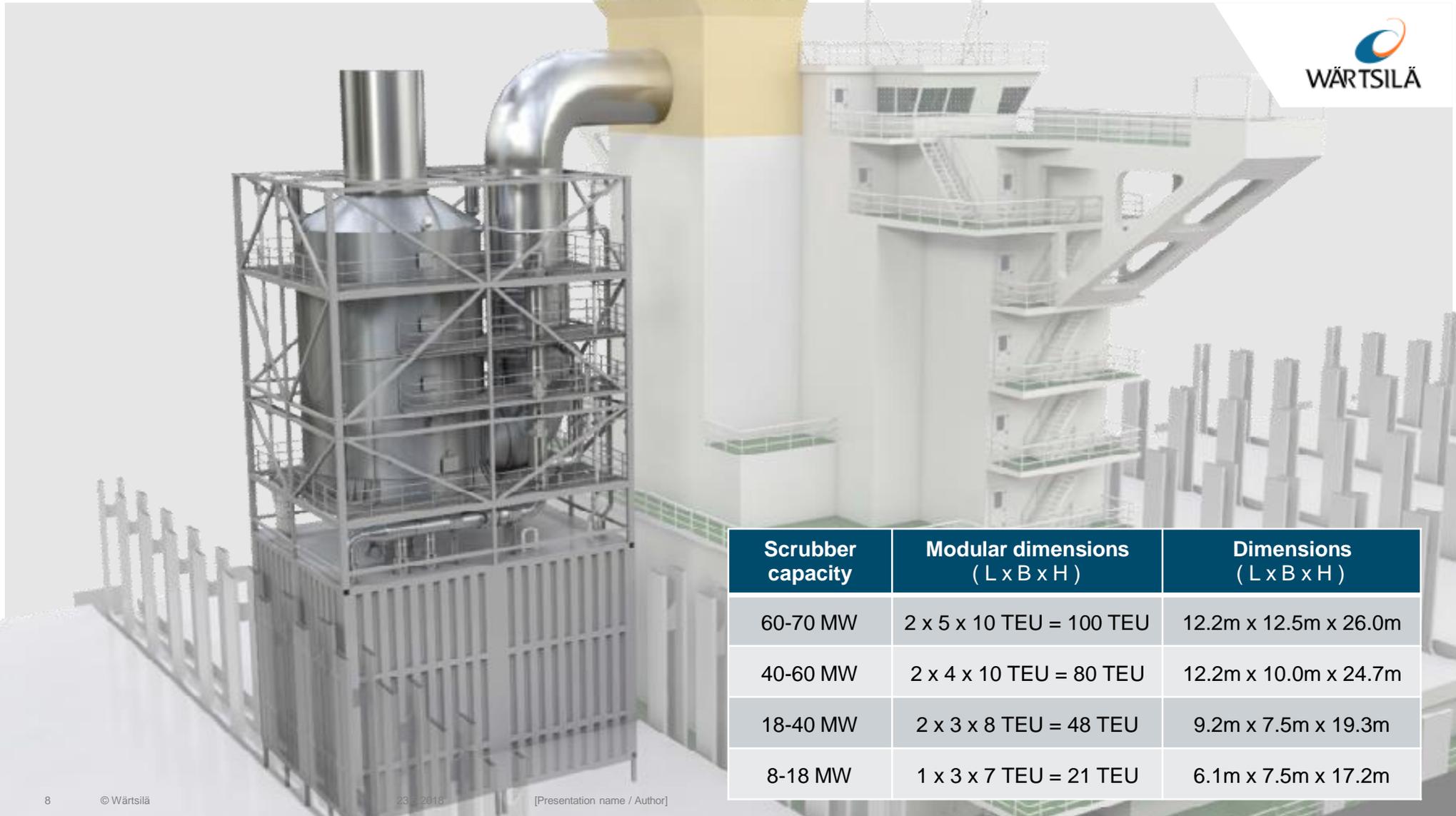
Fast, cost-efficient installation

- Easy access and centralised equipment
- Minimised off-hire time
- No need to empty the vessel before installation (excluding tankers)
- Increased flexibility and safety
- Minimised loss of valuable cargo space
- Shorter payback time

	Wärtsilä modular retrofit concept	Traditional installation
Installation time	15–20 days	30–90 days
Engineering	Standard design, only connection points to ship require custom engineering	Tailored engineering for the whole installation
Fabrication	Mostly pre-assembled at workshop	Mostly onboard
Installation	Can be done alongside	Requires dry docking
Testing	Main components can be pre-commissioned	Testing only possible once installation is complete
Safety	Most equipment installed outdoors above main deck, increasing safety	Most equipment located in engine room, increasing the risk of water and exhaust-gas leakages
Piping & cabling	Short distances between equipment require less piping and cabling	Longer distances mean more piping and cabling
Flexibility	Hybrid scrubber upgrade is an intrinsic part of the design	Upgrading to hybrid scrubber system afterwards can be challenging

Simplified installation

- Modules are easy to lift and fit into place on the deck next to the funnel
- Integration with existing vessel systems is straightforward
- Installation is far less complex than with conventional approach, and can even be done alongside
- Modules are hybrid-ready by design, making it easier to upgrade later if desired



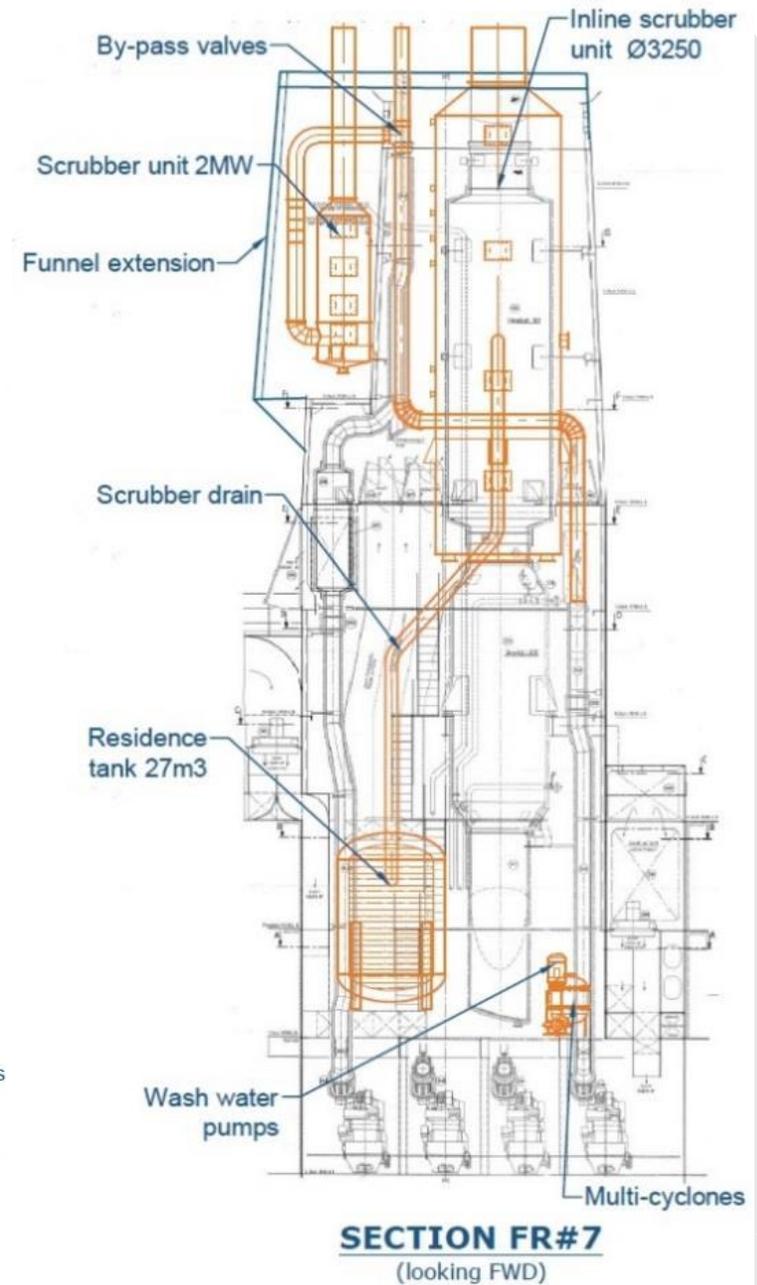
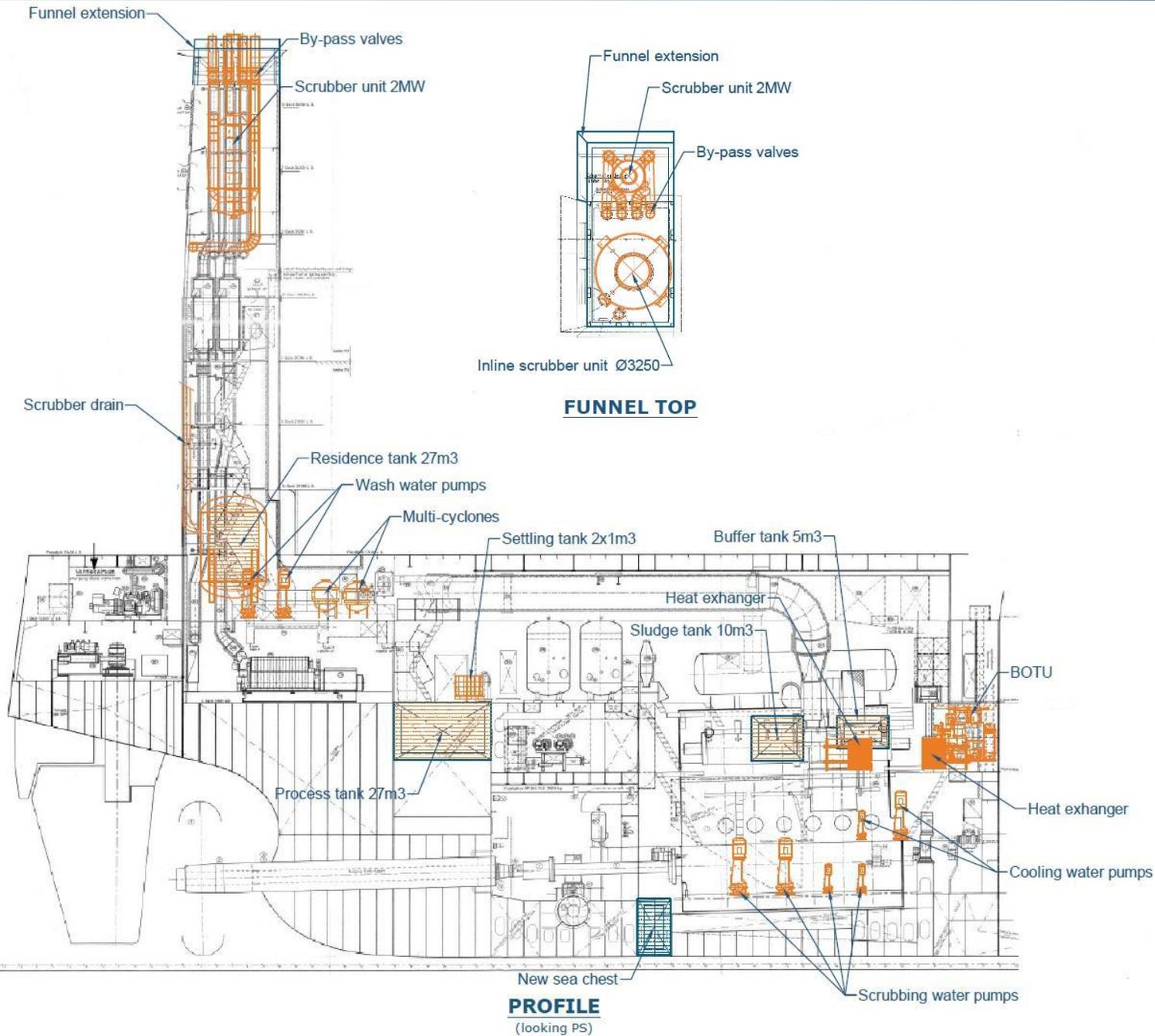
Scrubber capacity	Modular dimensions (L x B x H)	Dimensions (L x B x H)
60-70 MW	2 x 5 x 10 TEU = 100 TEU	12.2m x 12.5m x 26.0m
40-60 MW	2 x 4 x 10 TEU = 80 TEU	12.2m x 10.0m x 24.7m
18-40 MW	2 x 3 x 8 TEU = 48 TEU	9.2m x 7.5m x 19.3m
8-18 MW	1 x 3 x 7 TEU = 21 TEU	6.1m x 7.5m x 17.2m

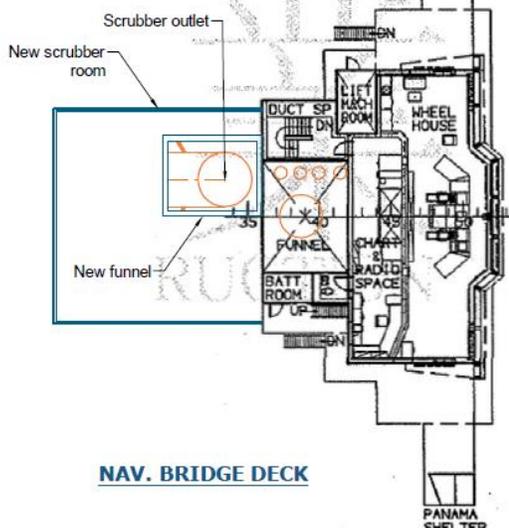
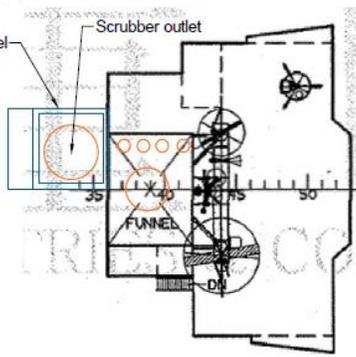
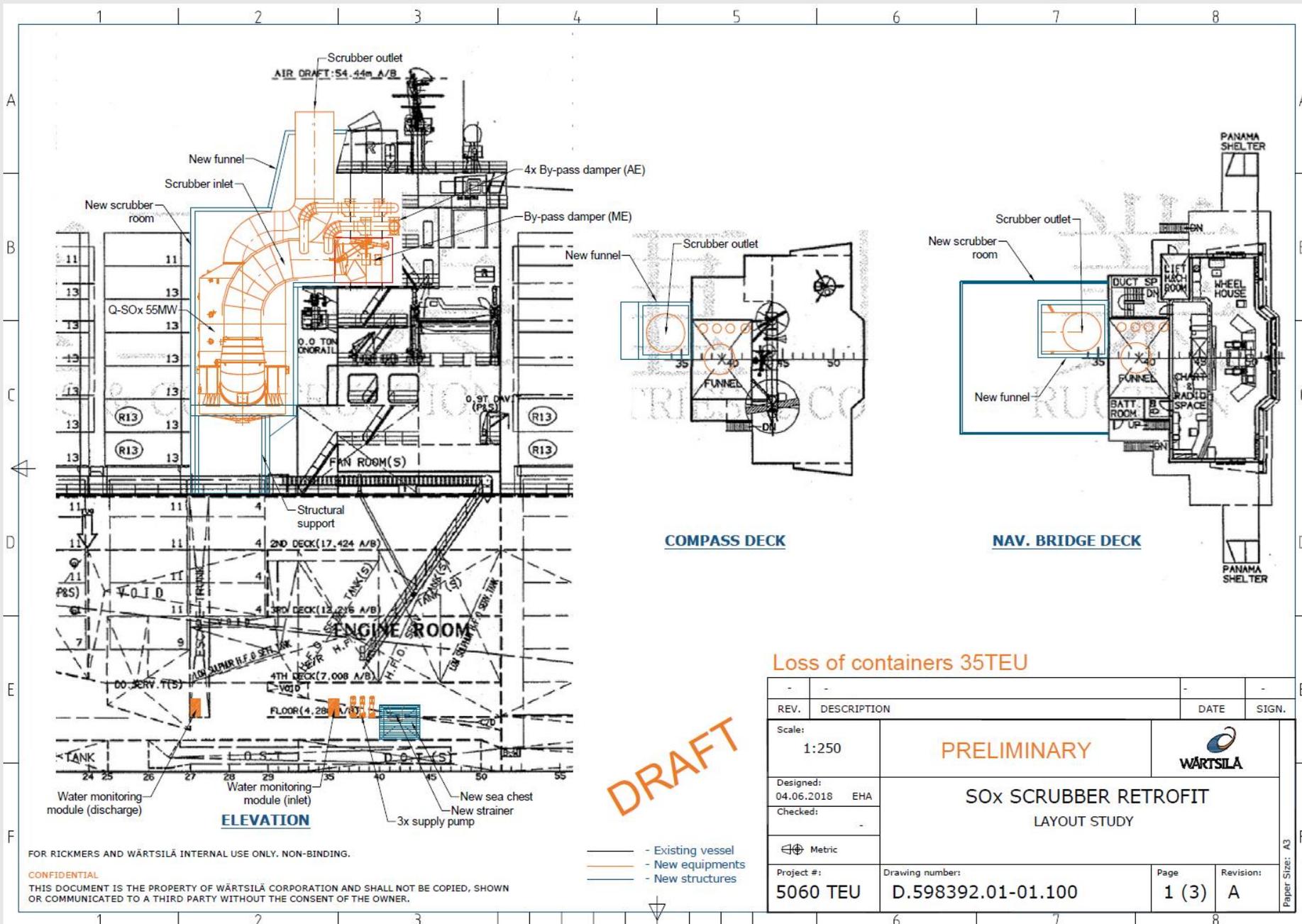
Wärtsilä EGC system approved by all major classification societies



SAMPLE OF SCRUBBER INSTALLATIONS

LAYOUT STUDY: 22 000 DWT CONTAINER VESSEL (1 700 TEU) – 20 MW I-SO_x SCRUBBER





Loss of containers 35TEU

REV.	DESCRIPTION	DATE	SIGN.
Scale:	1:250		
Designed:	04.06.2018 EHA		
Checked:			
PRELIMINARY			
SO_x SCRUBBER RETROFIT LAYOUT STUDY			
Project #: 5060 TEU		Drawing number: D.598392.01-01.100	Page: 1 (3)
Revision: A		Paper Size: A3	

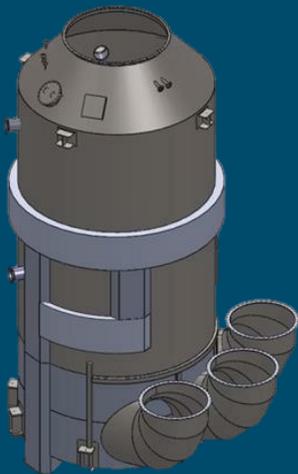
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- Existing vessel
- New equipments
- New structures

HARMONY OF THE SEAS

The biggest cruise vessel with the biggest scrubber.

- RCCL – STX France
- 15000 DWT Cruise Vessel
- 22 knots cruising speed, 18 decks
- 6780 guest passengers
- 4 x 12V46F + 2 x 16V46F Wärtsilä engines
- 2 x 48 MW scrubber with 3 inlets
- Hybrid V-SOx scrubber system



Wilhelmsen - Thalatta

3rd scrubber installation of five for Wilhelmsen

- Wallenius Wilhelmsen / Daewoo HI
- 24000 DWT Vehicles Carrier
- 25 MW V-SOx Hybrid Scrubber system
- Combined scrubber for ME and AE's



Clipper Quito & Clipper Posh

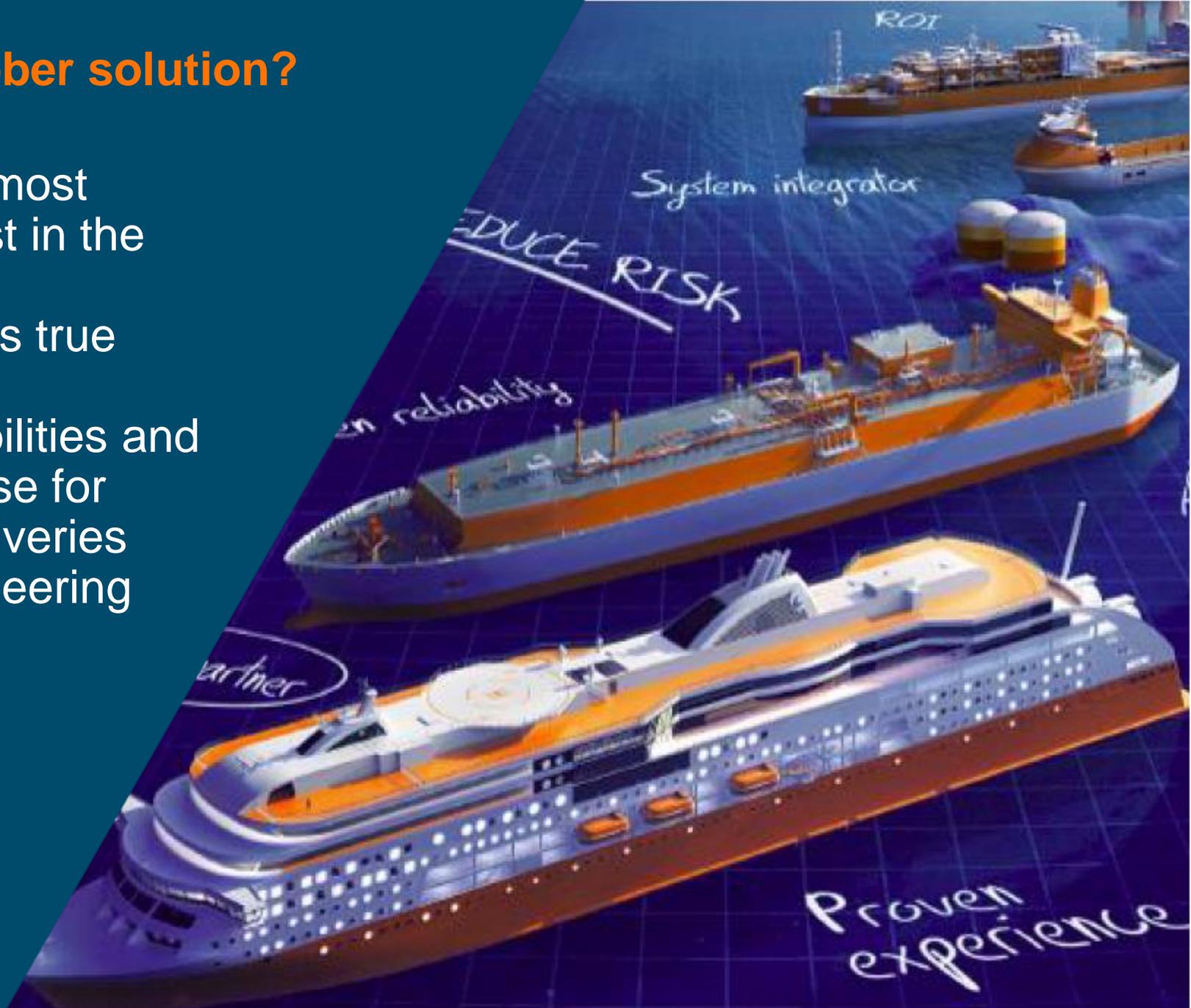
The first in a series of VLGC

- Solvang – HHI
- 55000 DWT LPG Tankers
- 5 repeat orders from first installation
- 1 x 15MW + 1 x 4MW Scrubbers (ME & AE)
- V-SOx Open Loop Systems
- Approx. 12000 running hours each



Why choose Wärtsilä scrubber solution?

- Technology leader with the most comprehensive reference list in the market
- Several repeat orders proves true customer satisfaction
- Global manufacturing capabilities and established sub-supplier base for timely and cost effective deliveries
- Best in class in-house engineering capabilities





GENERAL CARGO
CRUDE CARRIERS
CONTAINER
BULKER
CC/LGC
RO-RO

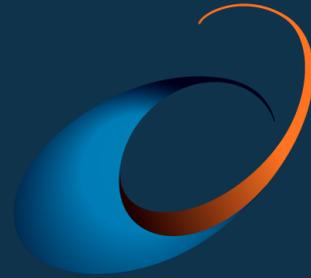
~ 350 SCRUBBERS

12% CLOSED LOOP SYSTEMS
38% HYBRID SYSTEMS
50% OPEN LOOP SYSTEMS



CRUISE
RO-PAX

READY FOR 2020



WÄRTSILÄ

Thank you for your attention!