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HEAVY
INDUSTRIES
GROUP

EXHAUST GAS CLEANING SYSTEM

DIA-SOx[®]



DIA-SOx[®] WEB SITE

<http://www.msb.mhi.co.jp/products/AF/index.html>

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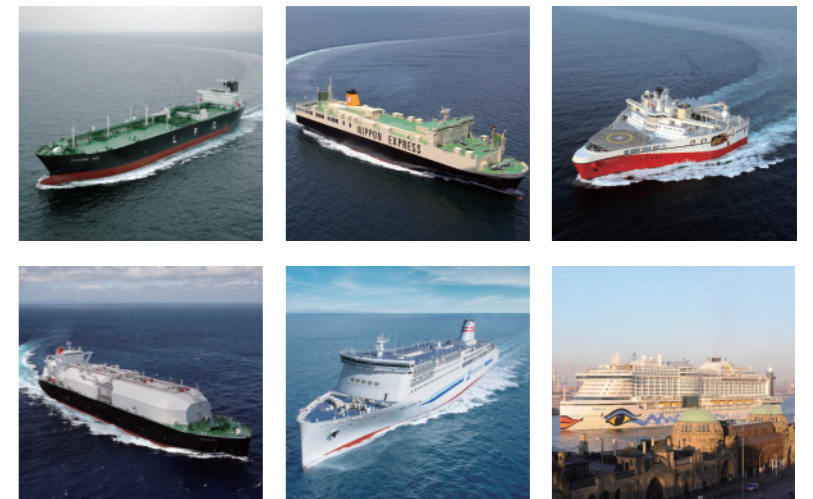


FULL STEAM AHEAD FOR CLEANER OCEANS

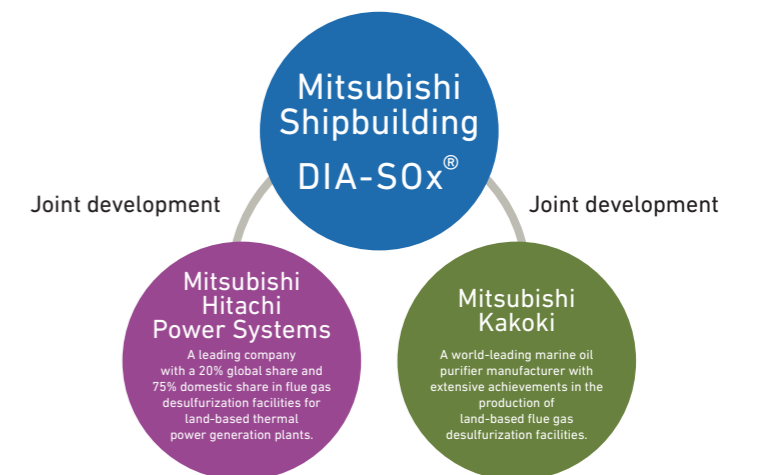
Mitsubishi Hitachi Power Systems, with the world's top market share and experience and achievements over more than half a century in flue gas desulfurization facilities for land-based power generation plants. Mitsubishi Kakoki Kaisha, who offers a wide range of marine products such as oil purifiers. We have commercialized a distinctive SOx scrubber system by integrating Mitsubishi Shipbuilding's marine engineering capabilities with the technologies possessed by both companies. This product is "DIA-SOx®".

FULL STEAM AHEAD FOR CLEANER OCEANS

With this phrase in mind, Mitsubishi Shipbuilding is striving to develop and popularize marine solutions such as "DIA-SOx®", to contribute to further development of marine logistics and a reduction of environmental impacts that are expanding on a global scale.



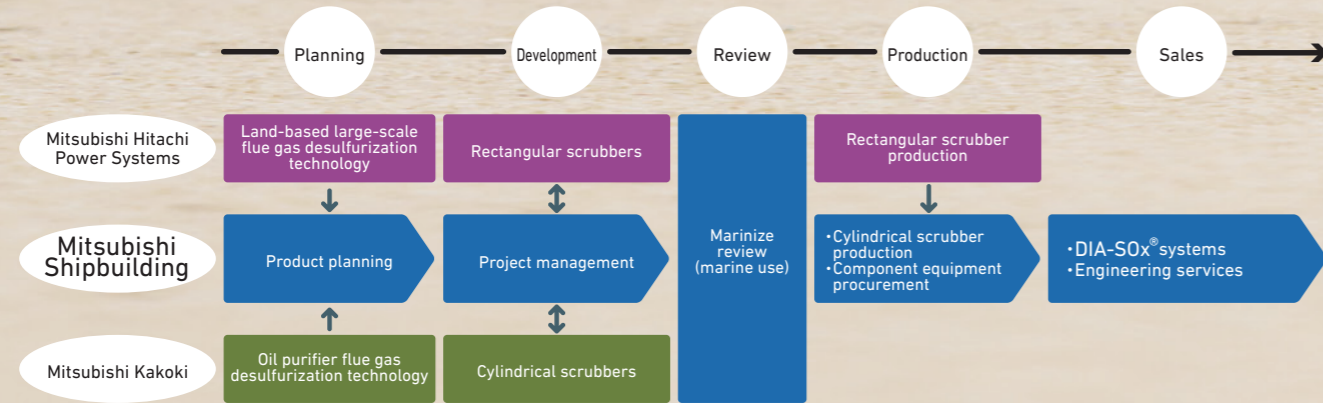
Major Ships Built by Mitsubishi Shipbuilding



DIA-SOx® is a registered trademark of Mitsubishi Shipbuilding Co., Ltd.

DIA-SOx[®] value chain

The outstanding technology possessed by our development partners has undergone strict procedures for marine-use verification, attaining high safety and reliability while being reborn as a marine SOx scrubber system which can be easily applied to existing engine plants. By utilizing the global supply chain of the Mitsubishi Heavy Industries Group, we can not only ensure quality but can meet requests for short delivery times and multiple lots.



* Mitsubishi Kakoki Kaisha, Ltd. shares jointly-developed technology, and engages in production and sales through various independent brands.

With our advanced technology,
we can contribute to a reduction of
environmental impacts that are
expanding on a global scale

Our Strengths

① Exceptional product capabilities

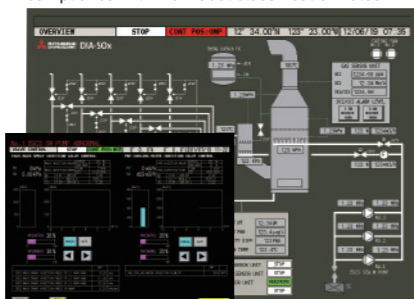
1 Reliable exhaust gas washing performance

Large-capacity SOx removal processes can clean exhaust gases from large-power as well as small-scale engines.



2 Scrubber plant control technology

Protection devices with thorough considerations made using failure mode and effect analysis, and control systems to ensure safe operation, in compliance with individual classification rules.



3 Monitoring and recording systems

Advanced continuous monitoring and recording systems follow the IMO EGCS Guidelines to ensure compliance.



4 Reliable project supervision

Powerful support to successfully carry out customer plans by strict adherence to schedules (drawing issue, delivery deadlines, commissioning, trial operation).



5 Ability to offer proposals with high flexibility

Proposals can be offered for SOx scrubber systems fully integrated with the piping systems and electrical control systems of engine plants which differ for each planned ship.



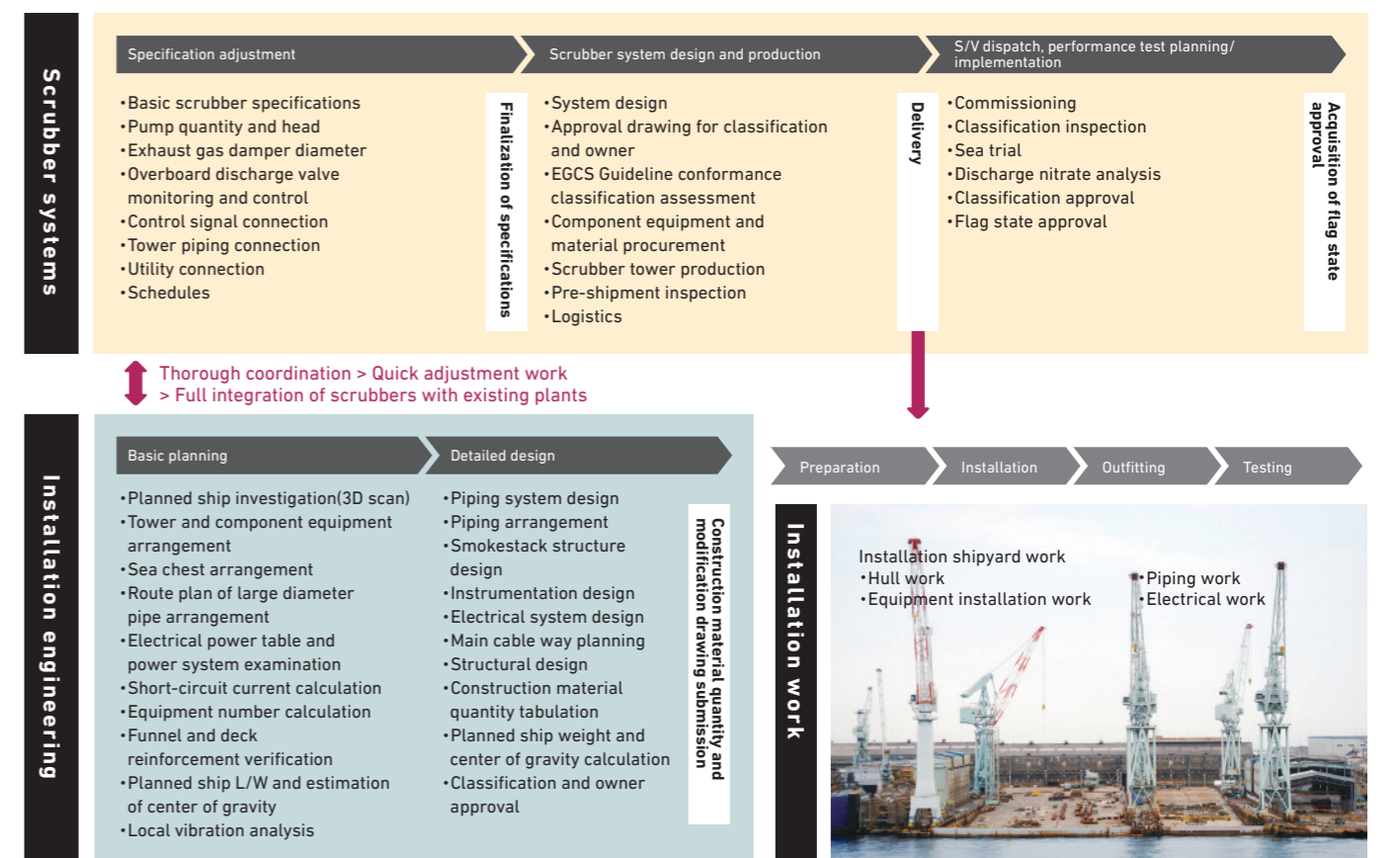
6 Acquisition of classification AIP

DIA-SOx[®] system has acquired AIP(Approval in Principle) which indicates fulfillment of regulation requirements after undergoing EGCS Guideline conformance assessments by individual classification societies.



② Detailed installation engineering services

Our professional group members combine the knowledge of an SOx scrubber manufacturer with the experience of a shipbuilding yard to provide dedicated support for customer installation plans.



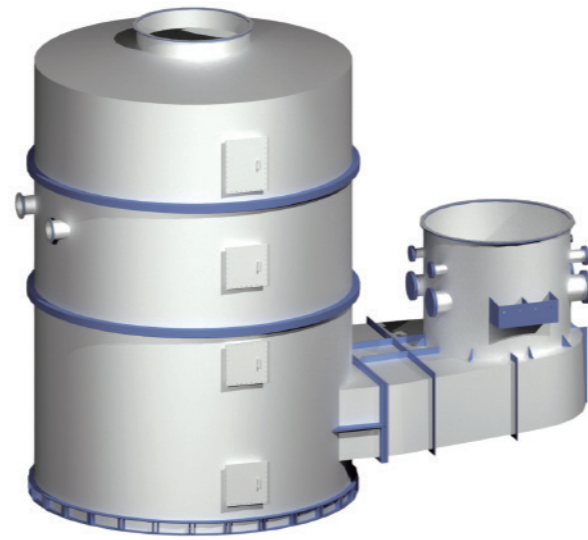
* Refer to pg. 9 for an example of installation engineering.

DIA-SOx[®]

Product Lineup

Our complete lineup of scrubber systems can meet a wide range of requirements for planned ships.

DIA-SOx[®] C-SERIES



✓ Features

- Main tower unit requires no troublesome assembly at shipyards, enabling integrated installation immediately after delivery.
- Low overall tower height allows relatively simple retrofitting on ships with insufficient clearance for air drafts, such as PCTC or RoRo ships.

Cylindrical scrubber tower that can handle all types of ships

A multi-stream scrubber system that excels in versatility and processes multiple engine exhaust gases with a single cylindrical tower.

✓ Exhaust gas washing system

Open loop

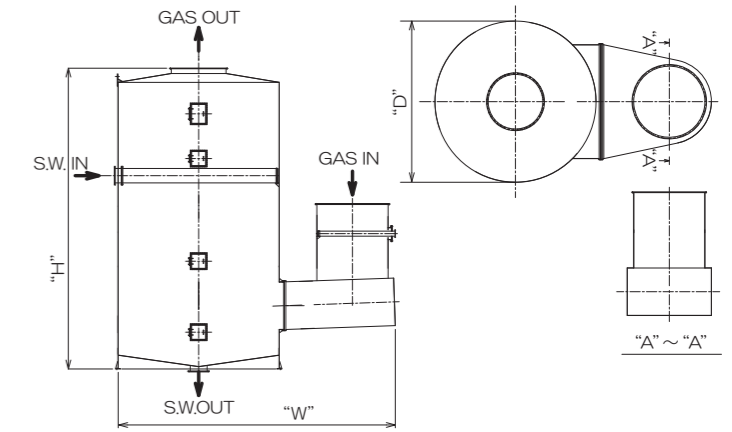
Hybrid

✓ SOx removal capability

ECA compliance
(3.5%S → 0.1%S)

GLOBAL compliance
(3.5%S → 0.5%S)

Reference engine power	5 - 30 MW
Reference ship types	Bulk carriers, tankers, RoRo ships, container ships, etc.



Reference engine power	kW	5,200	6,600	7,900	9,300	11,000	14,000	15,000	16,000	18,000	20,000	22,000	24,000	25,000	26,000
Model		230L	260L	290L	320L	350L	370L	390L	410L	430L	450L	470L	490L	510L	520L
D	mm	2,300	2,600	2,900	3,200	3,500	3,700	3,900	4,100	4,300	4,500	4,700	4,900	5,100	5,200
W	mm	4,850	5,300	5,750	6,150	6,600	6,900	7,200	7,550	8,000	8,250	8,600	8,950	9,250	9,400
H	mm	6,300	6,450	6,700	6,900	7,000	7,100	7,200	7,200	7,300	7,600	7,700	7,750	7,850	7,900

DIA-SOx[®] R-SERIES



✓ Features

- Zero cargo loss can be achieved with tower shapes optimized for 2-island type ultra-large container ships.

Rectangular scrubber tower that can handle even ultra-large container ships and large-power engines

A scrubber system for large-power engines that adopts a rectangular tower and offers superior arrangement especially for container ships.

✓ Exhaust gas washing system

Open loop

Hybrid

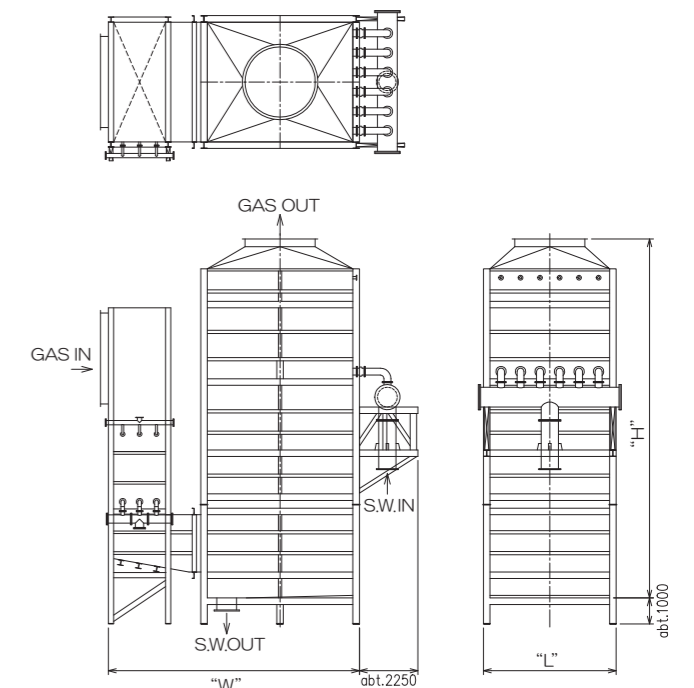
✓ SOx removal capability

ECA compliance
(3.5%S → 0.1%S)

GLOBAL compliance
(3.5%S → 0.5%S)

Reference engine power	30 - 75MW
Reference ship types	Large container ships, etc.

Reference engine power	kW	40,000	50,000	55,000	65,000	75,000
Model		M - 01	M - 02	M - 03	M - 04	M - 05
L	mm	5,100	5,100	5,100	5,100	5,100
W	mm	9,700	11,100	12,300	13,700	15,200
H	mm	13,800	14,400	15,050	15,650	16,350



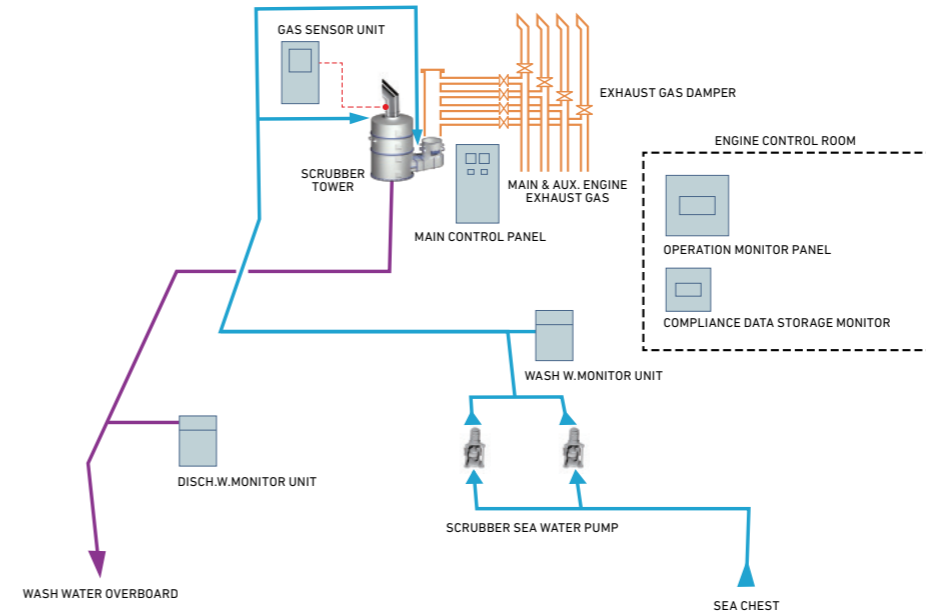
DIA-SOx[®]

Exhaust gas washing system

We can propose optimal system specifications to suit the routes, engine loads, and fuel oil types used by planned ships.

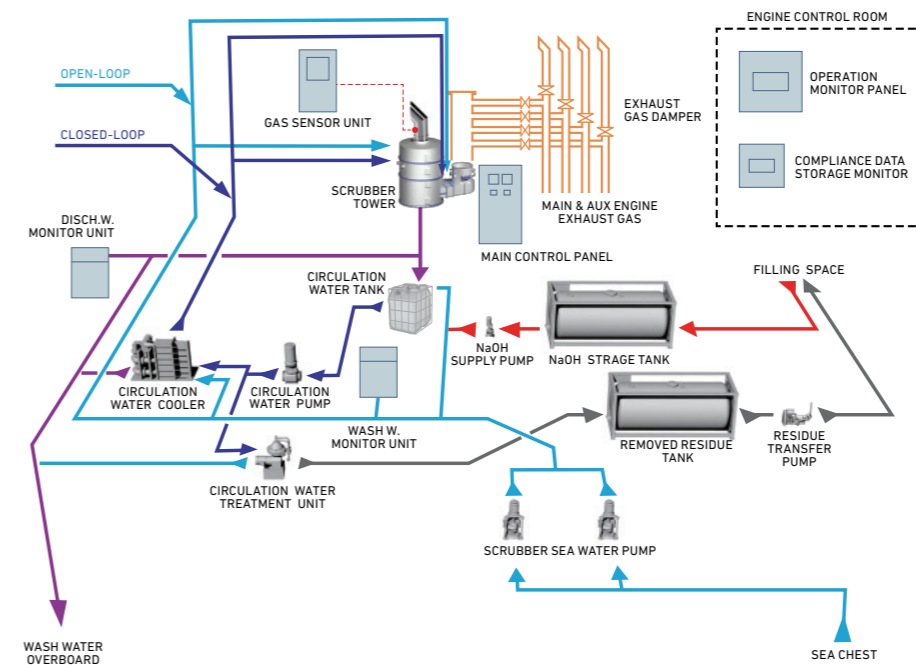
Open Loop System

Seawater taken from outside the ship is sprayed inside the scrubber tower to wash the exhaust gas, and SOx is then separated and absorbed. Since this washing system utilizes the alkalinity of seawater, no additional chemicals are required and the seawater used for cleaning is discharged outside the ship as drainage. It is suitable for retrofitting because the equipment configuration is simple and installation work is relatively easy.



Hybrid System

Since it is equipped with a washing system known as a "closed loop" in addition to an open loop system, it is widely referred to as a "hybrid system". In a closed loop system, fresh water or seawater is sprayed inside the scrubber tower to wash the exhaust gas, and SOx is then separated and absorbed. The washing water is collected in a circulation water tank and then used as washing water again. After cleaning the exhaust gas, the washing water absorbs SOx and becomes acidic, so sodium hydroxide is injected as suitable while monitoring the pH in the circulation line, to control the pH and maintain it within a fixed range. Also, while monitoring the increase in specific weight of the circulation water, part of the water is fed to a wastewater treatment device as appropriate and treated to keep its properties constant. Furthermore, in order to keep the temperature of the circulation water which is exposed to high-temperature exhaust gas at a constant level, this water is cooled by a heat exchanger which uses seawater as its cold source.



DIA-SOx[®] GALLERY



DIA-SOX[®]

Installation engineering

Achieving greater speed, simplicity, and reliability for customers.

Retrofit Engineering

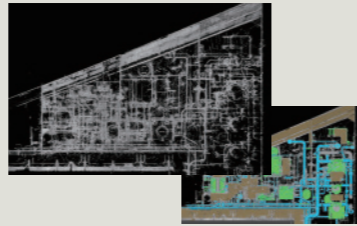
Scrubber installation not only changes the engine room, but also brings about a need to re-examine the basic plan of the entire ship including the appearance, stability, longitudinal strength, equipment number and so on. Furthermore, the scrubber system does not function independently of other components. For example, the scrubber tower itself is incorporated into the engine exhaust gas pipe system, the pump for the scrubber is connected to the seawater system, and the scrubber monitoring and recording system is connected to the GPS and the engine control system, and is used to receive related signals. Unlike other marine auxiliaries, this system must be laid out so that it can be fully integrated with the conventional piping system and electrical system. Mitsubishi Shipbuilding will organize an engineering team of professional members with expertise in planning, hull structures and outfitting of hull part, machinery part and electric part to proceed with installation design while referring closely to classification rules.

Engineering Examples

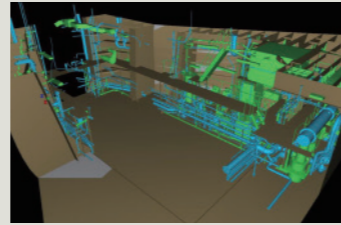
On-board investigation
3D scan



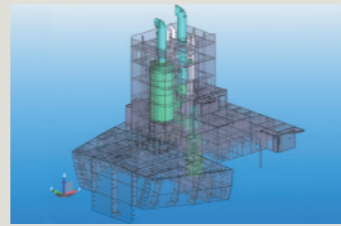
3D model creation



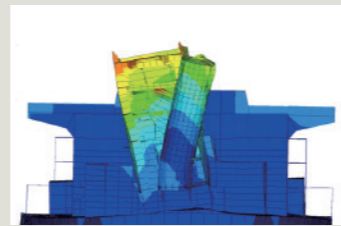
Arrangement and
piping design



Tower casing
Structural design

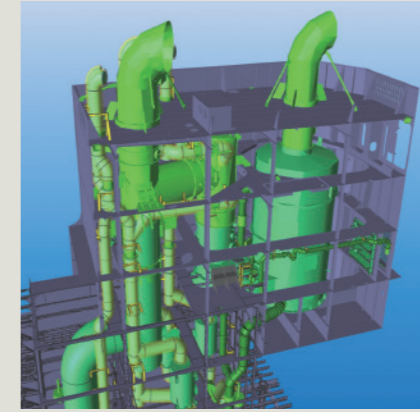


Tower casing
Structural analysis

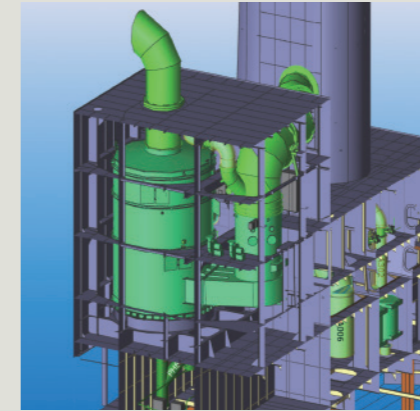


Scrubber Tower Installation Examples

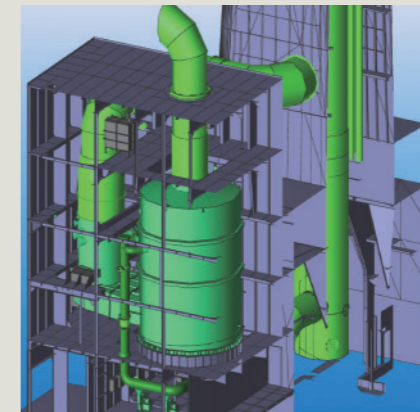
Pure Car &
Truck Carrier (PCTC)
L: 200m
B: 32m
D: 35m



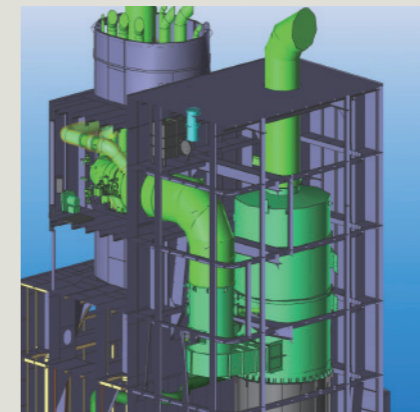
Very Large
Crude Carrier (VLCC)
L: 333m
B: 60m
D: 29m



Ultra Large
Crude Carrier (ULCC)
L: 333m
B: 60m
D: 29m



LPG Carrier
L: 230m
B: 37m
D: 22m



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