

ANAVE – Circular de Régimen Interior

Madrid, 22 de octubre de 2018

Ref.: SMA 35/2018/MC

Asunto: Scrubbers en buques existentes. Presentación y webinar de DNV GL

Muy Srs. nuestros:

La entrada en vigor, el 1 de enero de 2020, del nuevo límite de 0,5% de azufre en los combustibles marinos, ha despertado un creciente interés por analizar la opción de instalar depuradores de gases de exhaustación (*scrubbers*). Actualmente entre los buques que tienen scrubbers ya instalados y los que los han encargado, son ya unos 1630. Las incertidumbres sobre estos asuntos son muy elevadas, por ello pensamos que puede ser útil que aportemos a las empresas la información de interés que vamos recibiendo.

Hace unos días, DNV GL ofreció un webinar sobre la problemática de la instalación de scrubbers en buques existentes, que puede interesante y que se puede ver en este [enlace](#). Adicionalmente, adjuntamos como **Anexo** la presentación que se utilizó en la misma, que ya de por sí resulta de interés.

Muy cordialmente

Manuel Carlier
Director General

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MARITIME

Scrubber retrofit

Meeting the Global Sulphur Cap 2020 limits

DNV GL webinar

10 October 2018

Welcome to today's webinar

The team today:



Stine Mundal

Project Manager Approval
DNV GL Maritime

*Presenter and specialist class
approval scrubbers*



Dag Sandal

Principal Consultant
DNV GL Maritime

*Presenter and specialist
scrubber advisory*



Daniel Springer

Head of Digital Communications
DNV GL Maritime

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Your webinar host and facilitator

Introduction

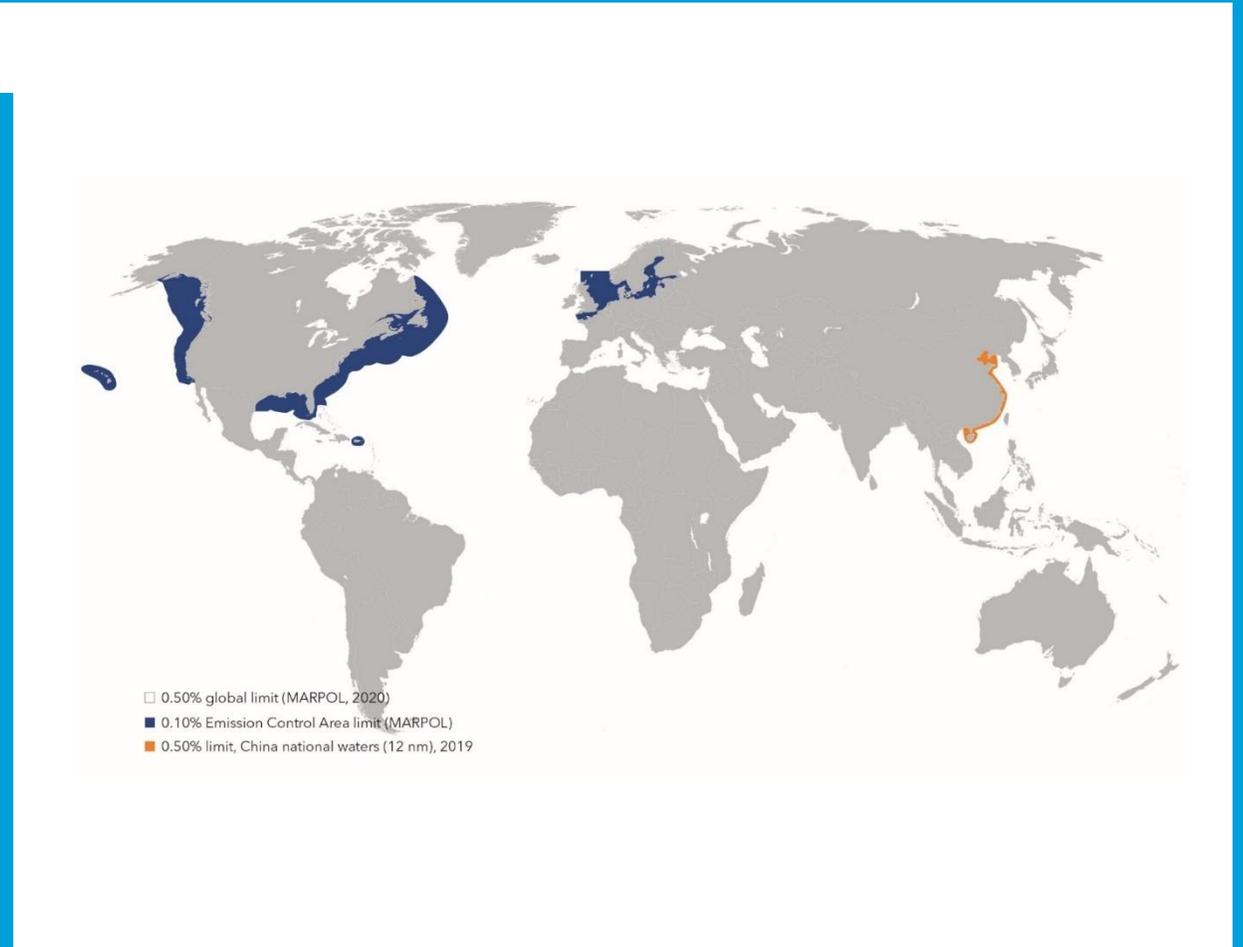
Business case

Scrubber system design principles

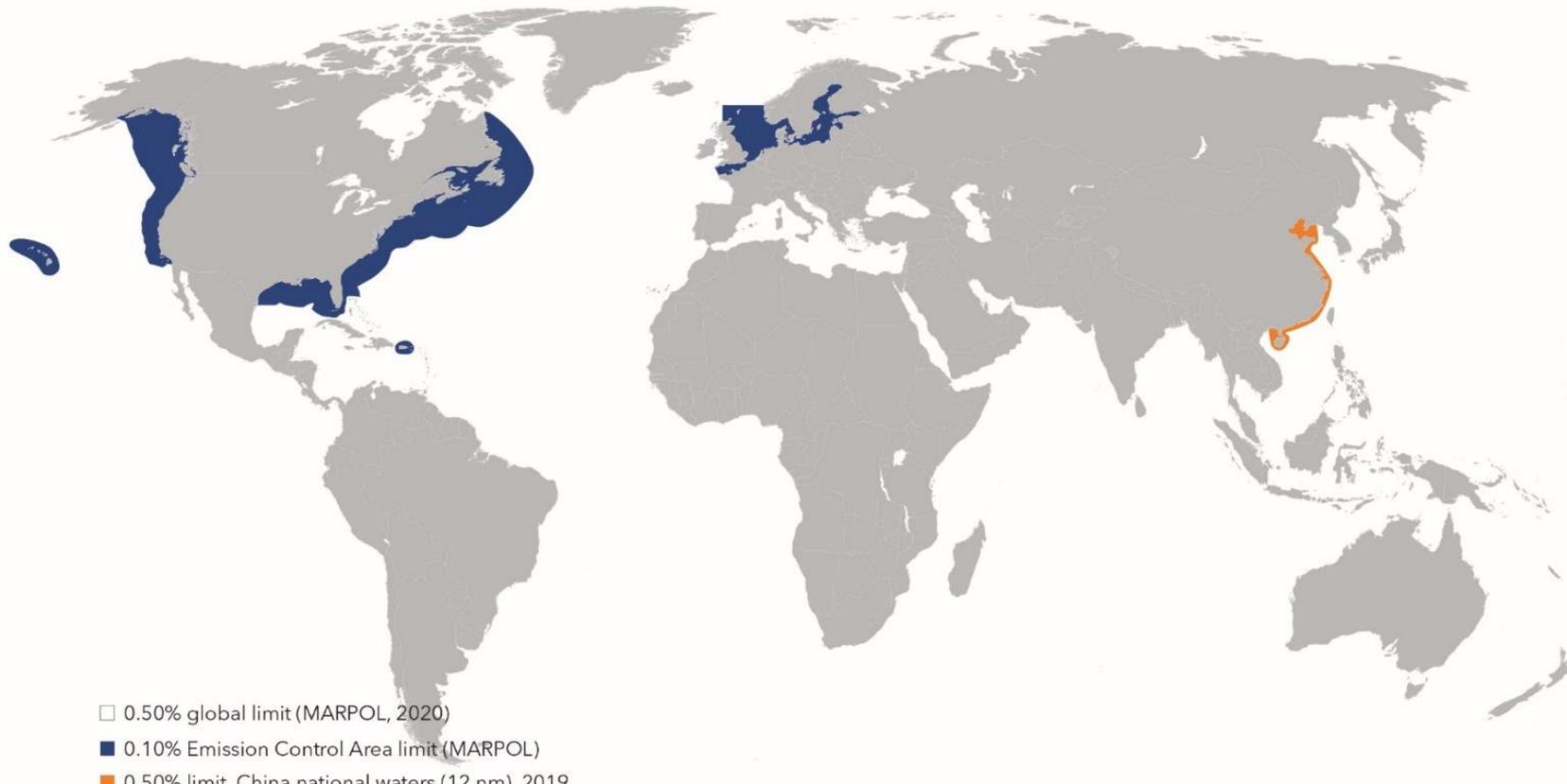
Safety, reliability and operation

How DNV GL can support

Summary and Q & A



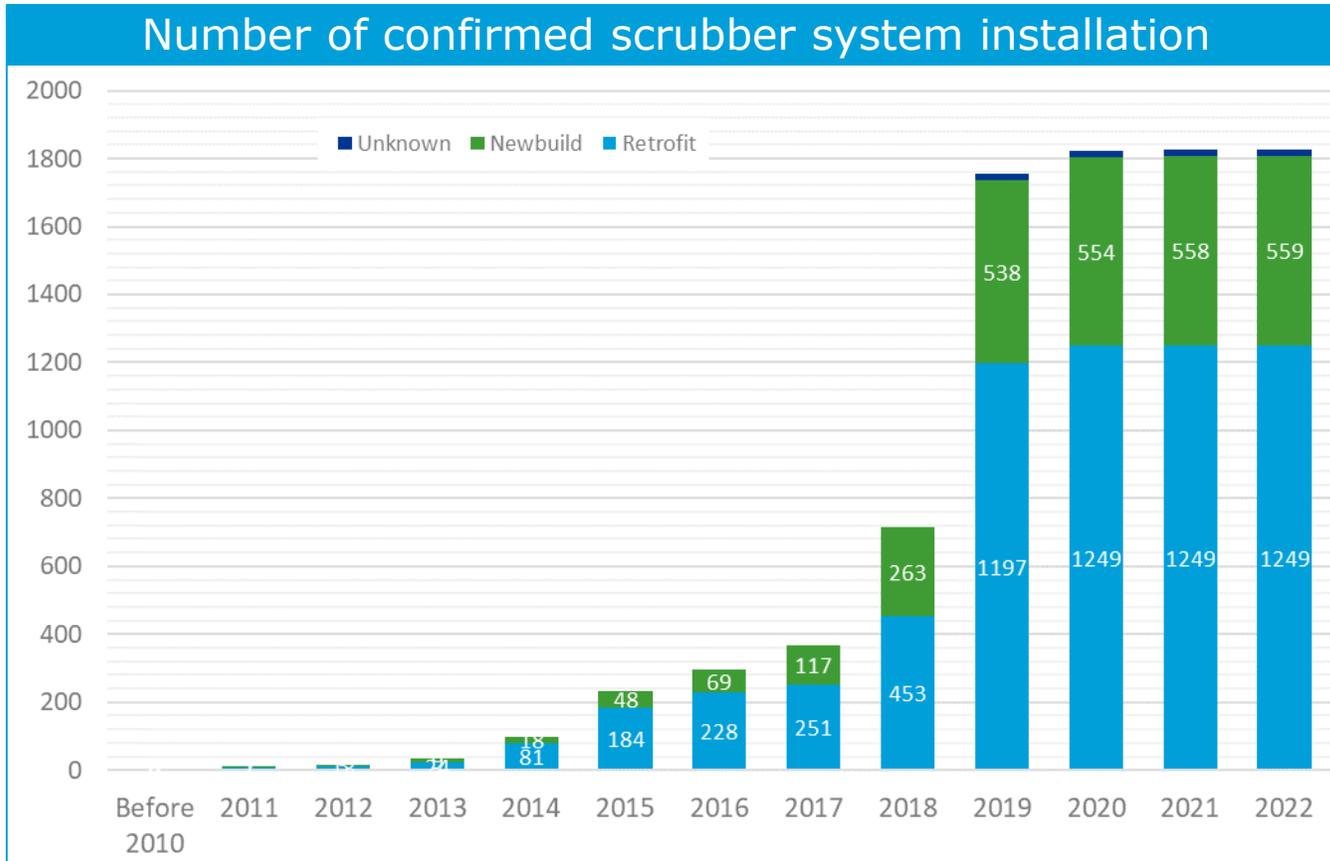
A paradigm shift in marine fuels is on our door step with the introduction of global sulphur cap of 0.50% Sulphur in 2020



Today's topic

HFO + Scrubber	MGO / MDO	New Compliant Fuels? (0.5%S)	Alternative Fuels
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There has been a significant uptake in scrubber orders in 2018

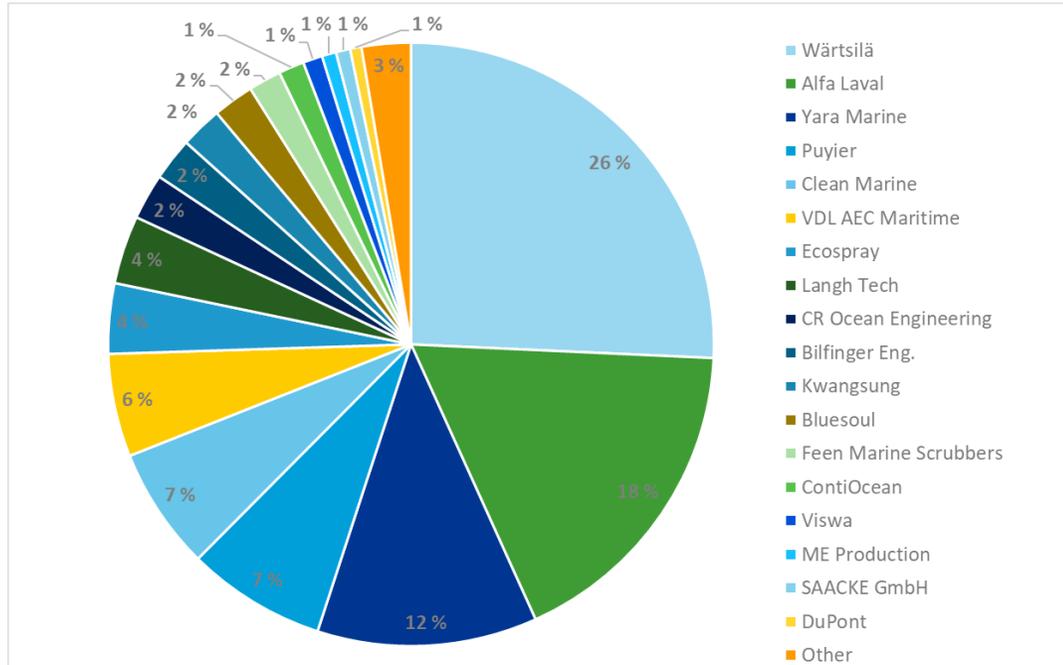


- There are about 1850 ships with installed or confirmed scrubber systems installations
- The “first scrubber wave” started in 2014 in preparation of SECA in North America
- The “second scrubber wave” is now on its way with over 1000 confirmed projects in the past 6 months
- A majority of the orders are for retrofits

Early predication by the IMO indicated that 4000 ships would be fitted with scrubber systems by 2020

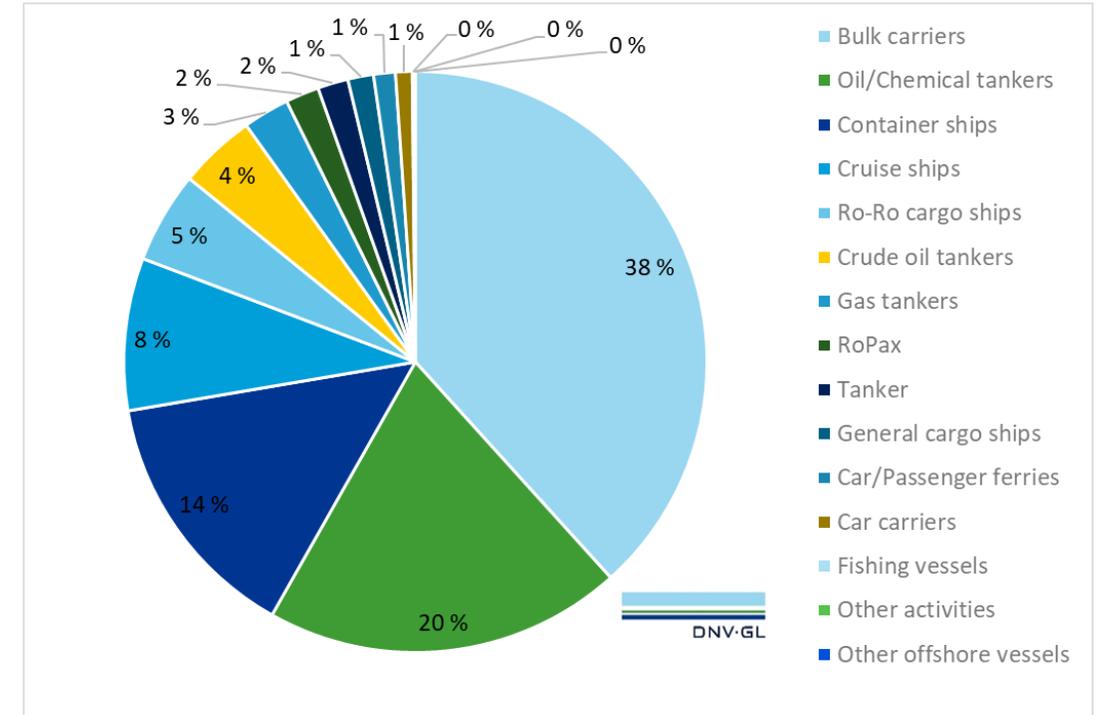
There are >20 different scrubber suppliers as per DNV GL's statistics

Market share per supplier



- The 3 largest scrubber suppliers has over 50% market share
- The supplier base is a mix of "known" maritime equipment manufacturers and shore based process industry suppliers

Segment distribution



- Cruise and RoPax were initially the largest segments
- Now bulk, tankers and containers are the largest segments

Introduction

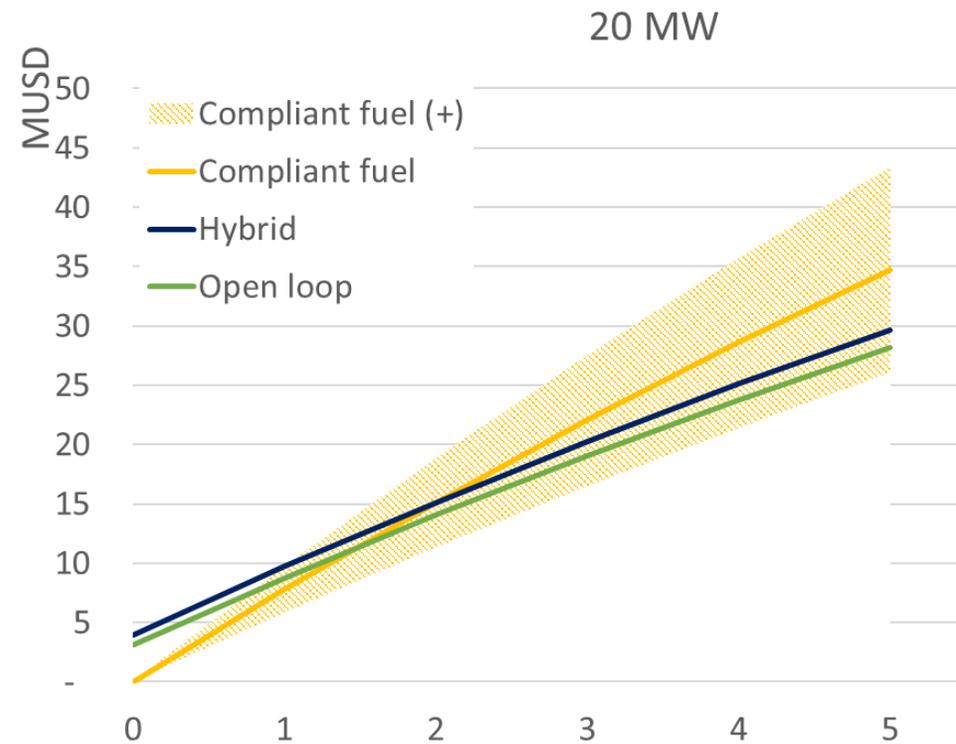
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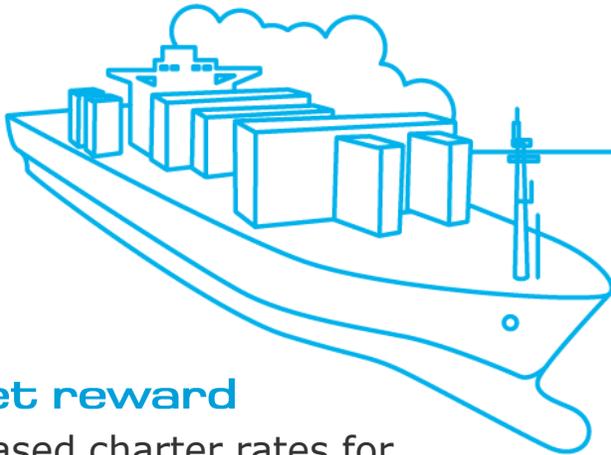
Summary and Q & A



Strategic decisions must be made and technical challenges solved to ensure a competitive edge in the market beyond 2020

Trade

- Time in ECA / EU ports (SO₂ 0.1% compliance)?
- Local regulations impacting system operation?

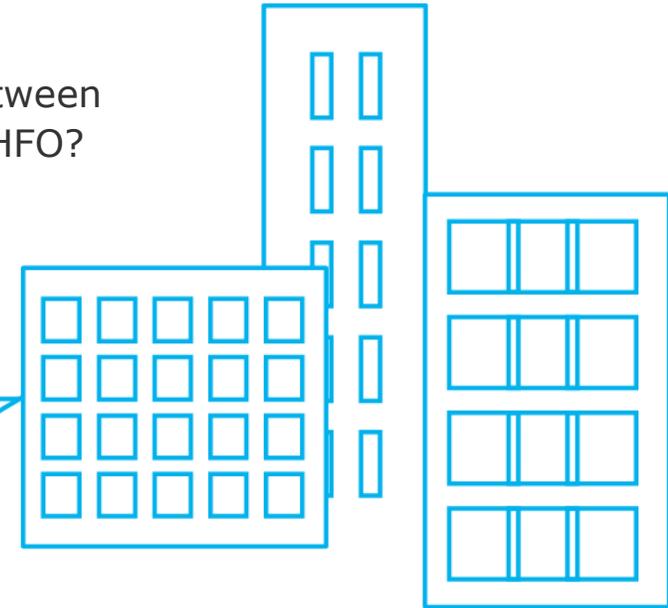


Market reward

- Increased charter rates for ships with scrubbers?

Fuel market

- Price differential between compliant fuel and HFO?
- Availability of HFO?



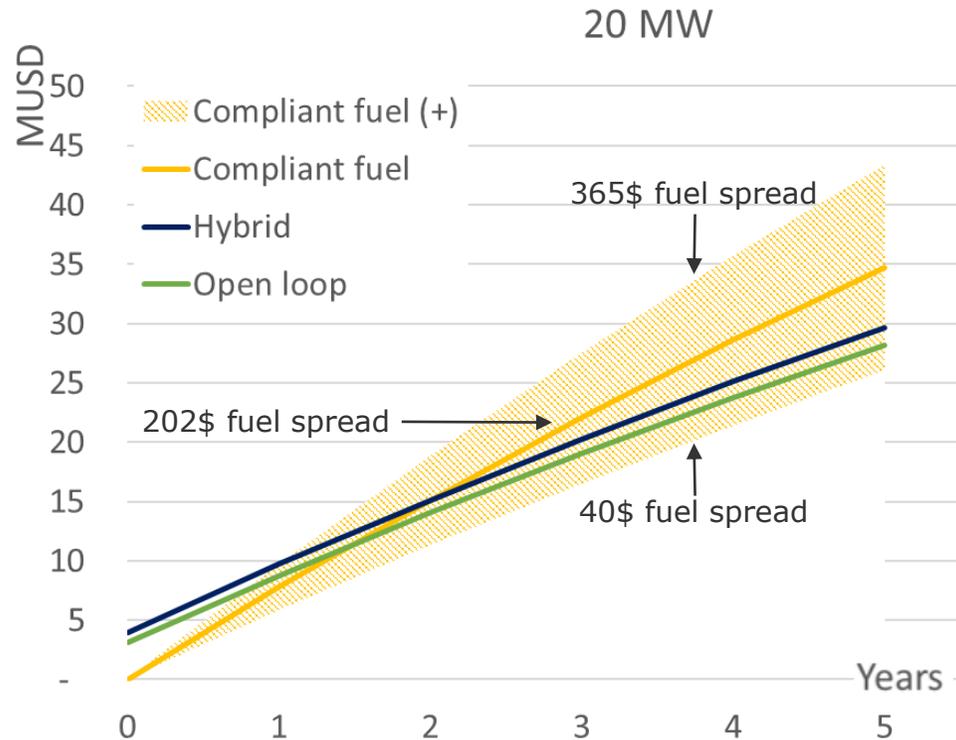
OPEX

- Cost of increased power consumption?
- Maintenance, repairs and downtime costs?
- Alkali bunkering / sludge landing costs?

Scrubbers can significantly mitigate the cost impact from the 2020 sulphur cap and the decision if to invest should be made yesterday

Business case example

Accumulated 5 year cost [20MW installed power / 6% discount rate]

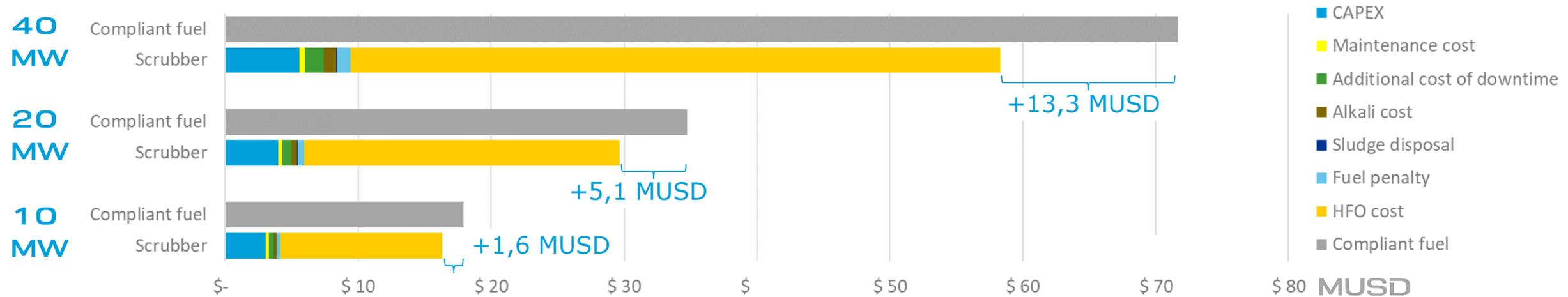


- Scenario based on a ship with 20MW installed power, assumption:
 - HFO price: 450USD/ton
 - Compliant fuel: 652USD/ton
- Resulting **payback time** is 1,3 years for open loop and 1,7 for hybrid
- Fuel **price spread** is key
 - at 40USD/ton there is **no business case** for scrubbers on ships with 20MW power
 - at 100USD the pay **back time** is less than **two years** for an open loop system

Assuming a price spread between HFO and compliant fuel greater than 100USD/ton there is a positive business case and short pay back time for most ship sizes

The importance of fuel cost

Accumulated 5 year costs compliant fuel vs costs scrubber + HFO



- Scrubber systems will increase the ship's fuel consumption of approx. 2%
- Downtime of the scrubber systems will introduce a cost for running of compliant fuel
- Installation of scrubber systems will increase the maintenance cost (more for closed loop)
- For closed loop systems there will be an additional cost for alkali bunkering and sludge disposal

Although scrubber systems are a significant investment, the CAPEX is small compared to fuel costs while other cost centres are negligible

Introduction

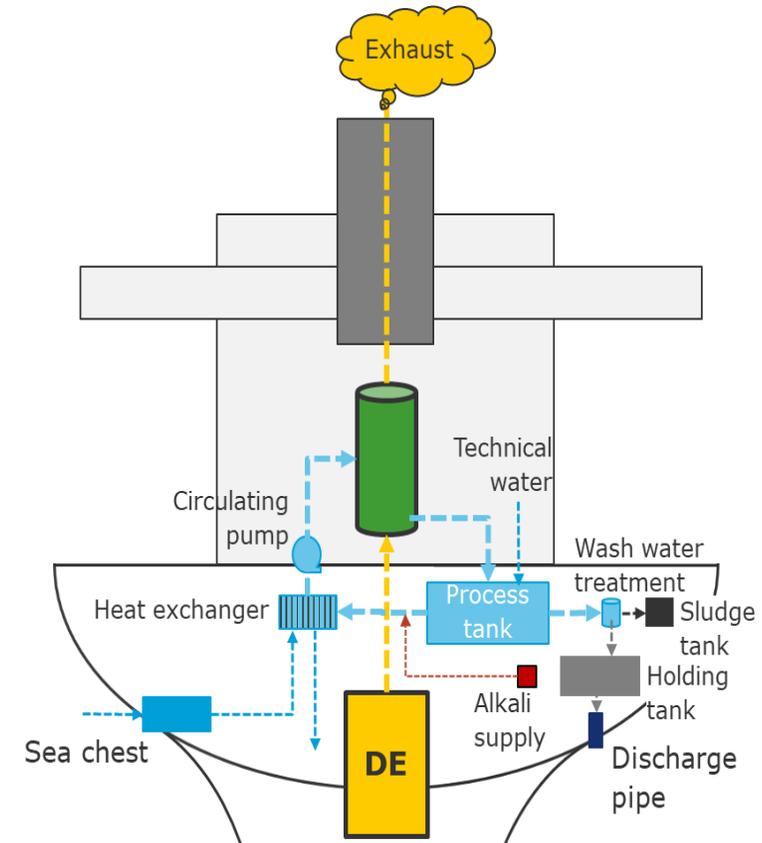
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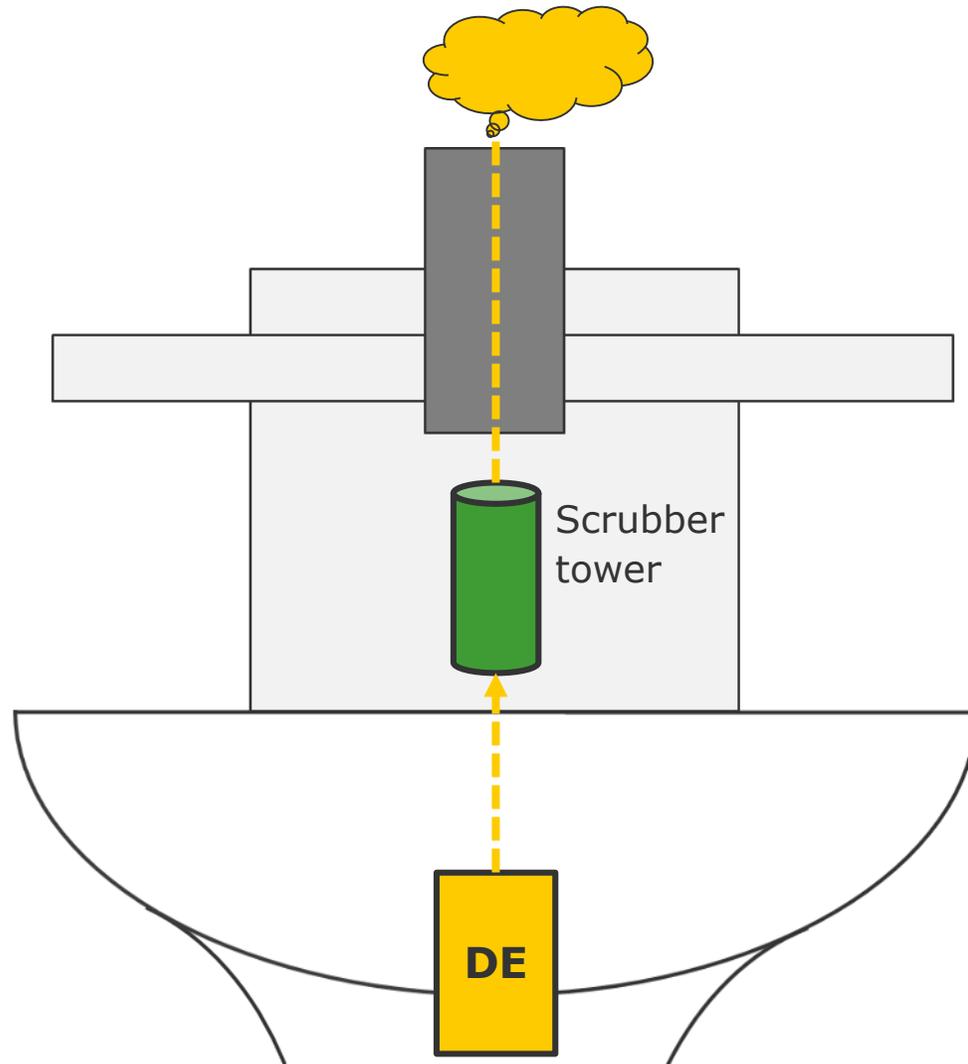
Safety, reliability and operation

How DNV GL can support

Summary and Q & A



A quick intro: Sulphur in the exhaust gas is neutralized by an absorbent



- The sulphur in the exhaust gas is neutralized in the scrubber tower by the absorbent

Different absorbents can be used:



- Sea water
 - Caustic soda
 - Magnesium hydroxide
 - Limestone*
- The most common solution is to use sea water as the absorbent in an «open loop» system
 - While most suppliers also offer «closed loop» and «hybrid» systems using caustic soda or magnesium hydroxide

Scrubber systems are large



Large multi-inlet tower



Typical multi-inlet tower

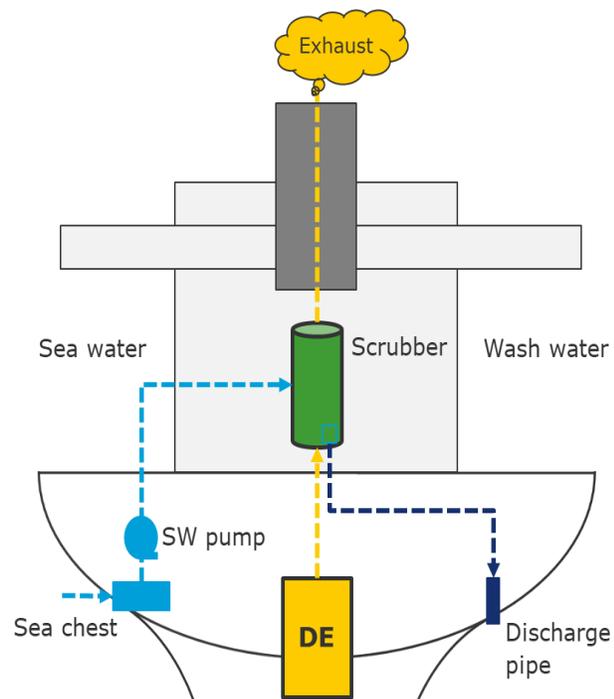


VLCC with scrubber and SCR / EGR

Overview of system types: open loop vs hybrid / closed loop

Open loop

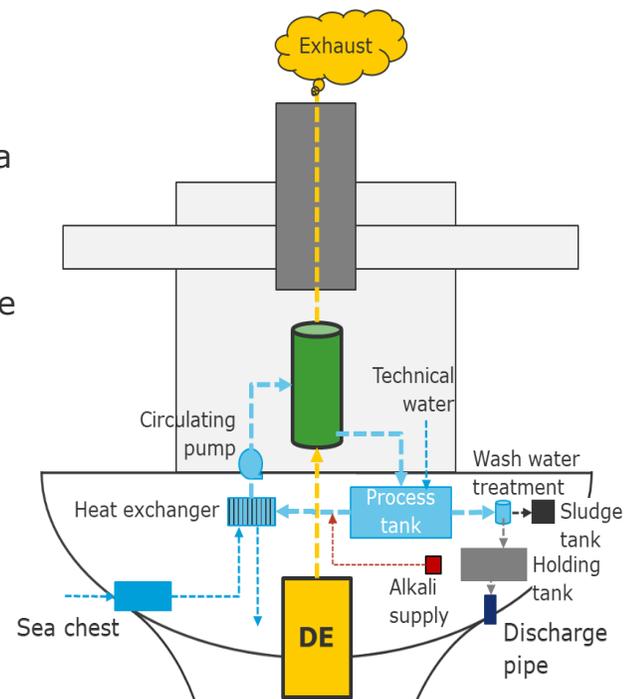
- Sea water flows through the tower and is discharged overboard.



- + Few components (→ lower cost)
- + Utilises seawater directly from sea, no hazardous chemicals are required.
- Not allowed in some ports and areas
- Unsuitable in brackish and fresh waters
- US VGP ph compliance require a "dilution" pump

Hybrid / closed loop

- Process water flows through the tower and re-circulates in a closed loop.
- Treated wash water is held onboard then discharged where permitted.



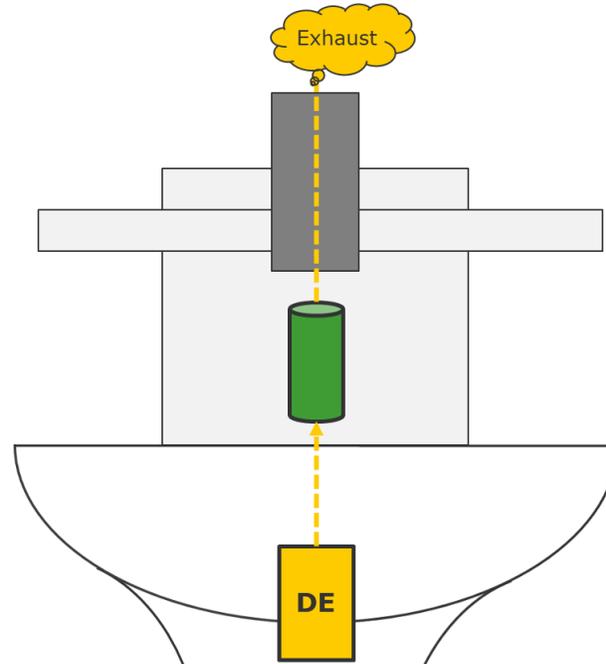
- + Increased flexibility
- + Can operate in all areas regardless of seawater alkalinity or temperature.
- Increased complexity (→ higher costs)
- Requires a constant supply of an alkaline medium. NaOH is hazardous and require special handling.

Most retrofits are open loop installations while hybrid / closed loop systems allow for increased operational flexibility

Overview of system types: in-line vs multi-inlet tower

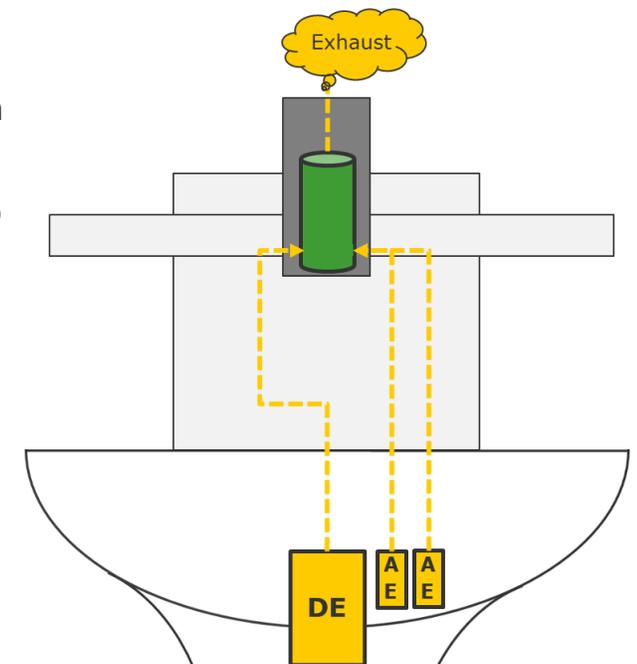
In-line tower

- Handles the exhaust flow from one DE
 - Typically installed in the location of the silencer
 - Can be operated in open or closed loop (as fitted)
- + Small footprint if the tower can replace the silencer
 - + Lower centre of gravity reducing impact on stability
 - + Lower energy consumption
 - + Are designed to sustain dry running
 - Possibly more complicated tower installation
 - Requires additional towers to cover more engines



Multi-inlet tower

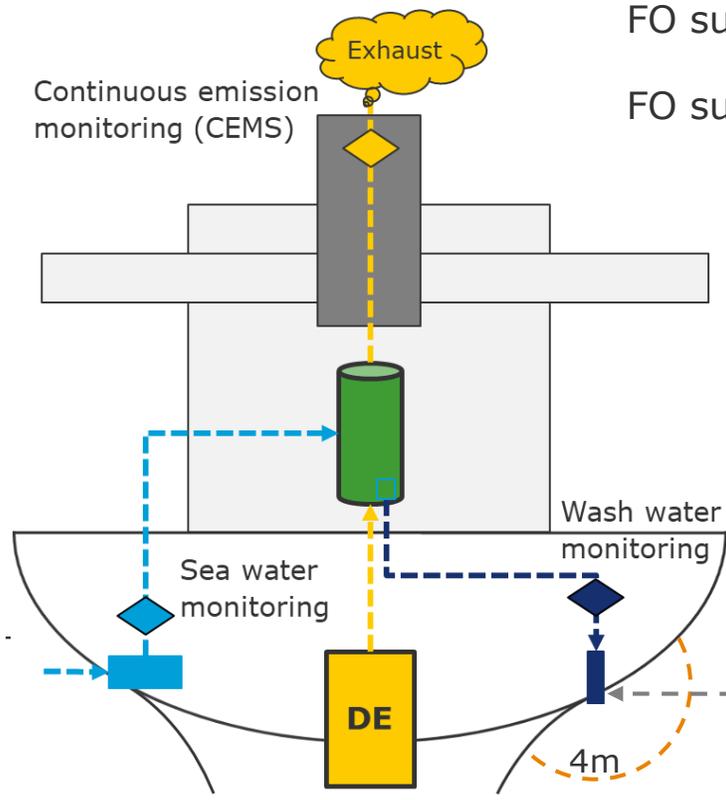
- Handles the exhaust flow from several engines
 - Typically installed in or next to the funnel
 - Can be operated in open or closed loop (as fitted)
- + Can handle multiple exhaust streams with one tower
 - + Possibly easier installation
 - + Typically more cost efficient solution for all engines
 - Possibly more complicated pipe routing
 - Require by-pass solutions



Most retrofits are of multi-inlet tower design while the optimal solution will depend on ship specific considerations

The scrubber system must be in compliance with air emission and wash water discharge requirements [MEPC.259(68)]

Emissions to air:



$$\text{FO sulphur } 0.5\% = \frac{SO_2 \text{ (ppm)}}{CO_2 \text{ (\%v)}} = 21,7$$

$$\text{FO sulphur } 0.1\% = \frac{SO_2 \text{ (ppm)}}{CO_2 \text{ (\%v)}} = 4,3$$

Emissions to sea:

pH

Alternative ph criteria

pH inlet ——— delta ——— pH outlet = < 2

PAH*

PAH inlet ——— delta ——— PAH outlet = < 50 µg/L PAHphe

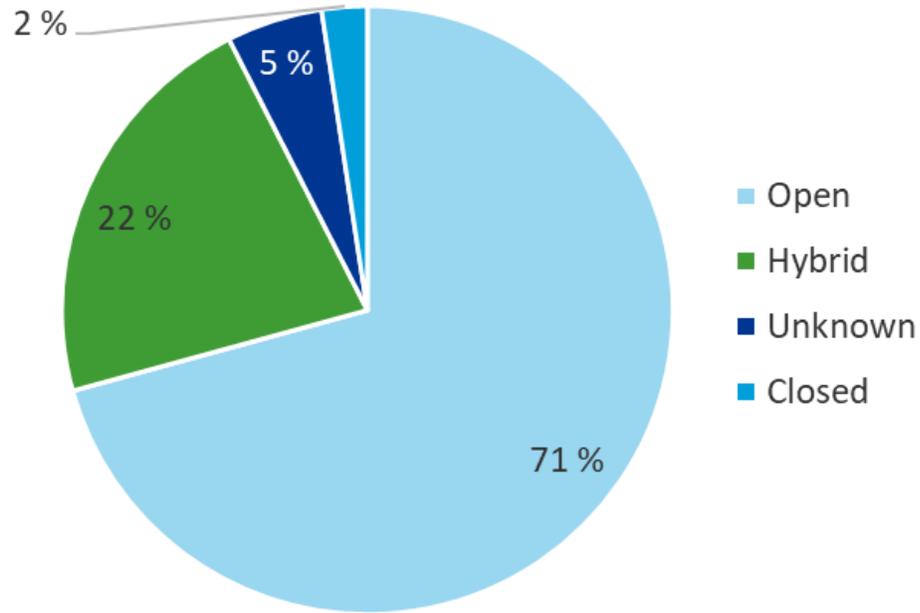
Turbidity

Turbidity inlet ——— delta ——— Turbidity outlet = < 25 FNU / NTU

US VGP: ph outlet > 6
pH outlet > 6.5 at 4m

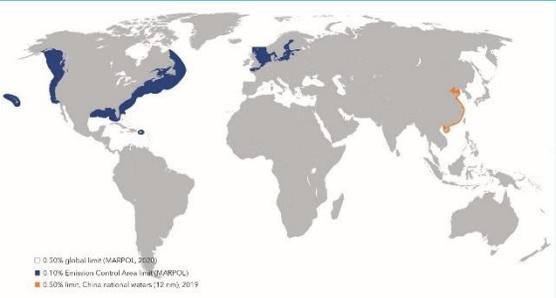
Open loop scrubber systems are the preferred choice

System types



- Most scrubber suppliers are offering both open loop and closed loop / hybrid systems
- Open loops system with a “closed loop ready” option is currently the most popular system design
- The most common scrubber tower design are multi-inlet

In addition to international regulations there are local requirements that must be considered



- Coastal states or port authorities restriction on wash water discharge
 - US EPA Vessel General Permit
 - wash water requirement pH =>6.0 at overboard discharge*
 - No wash water discharge
 - Connecticut, USA
 - Belgium
 - Germany (some areas and ports)
 - Under consideration: Sweden, Norwegian Heritage Fjords, some other
- Restrictions on HFO in California, Antarctica and around Svalbard
- Scrubber ban in California unless research exemption is granted
- Visible plume/“smoke” due to increased water vapour for wet scrubbers may cause reactions from local authorities

To meet the requirements of no wash water discharge a more complicated and costly “closed loop” or hybrid scrubber system must be installed

Introduction

Business case

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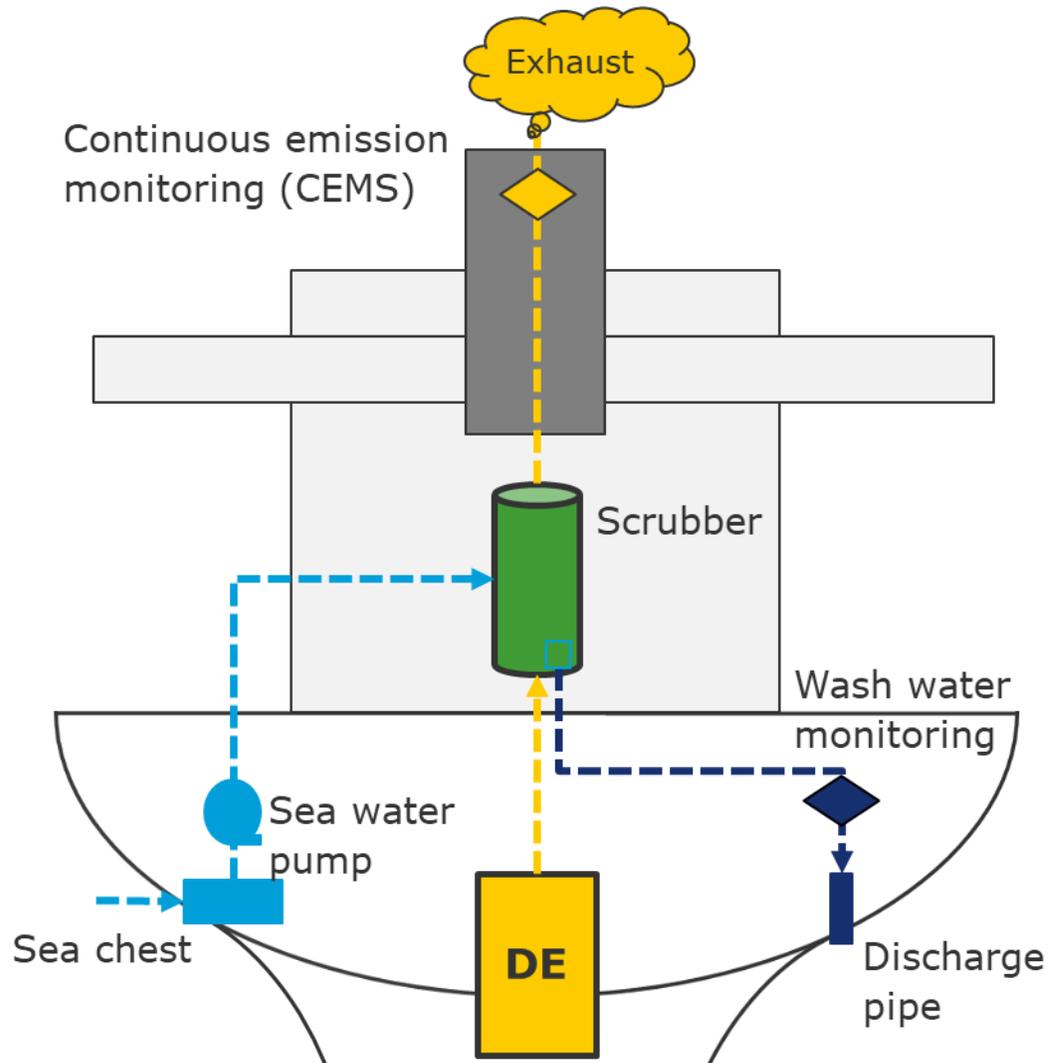
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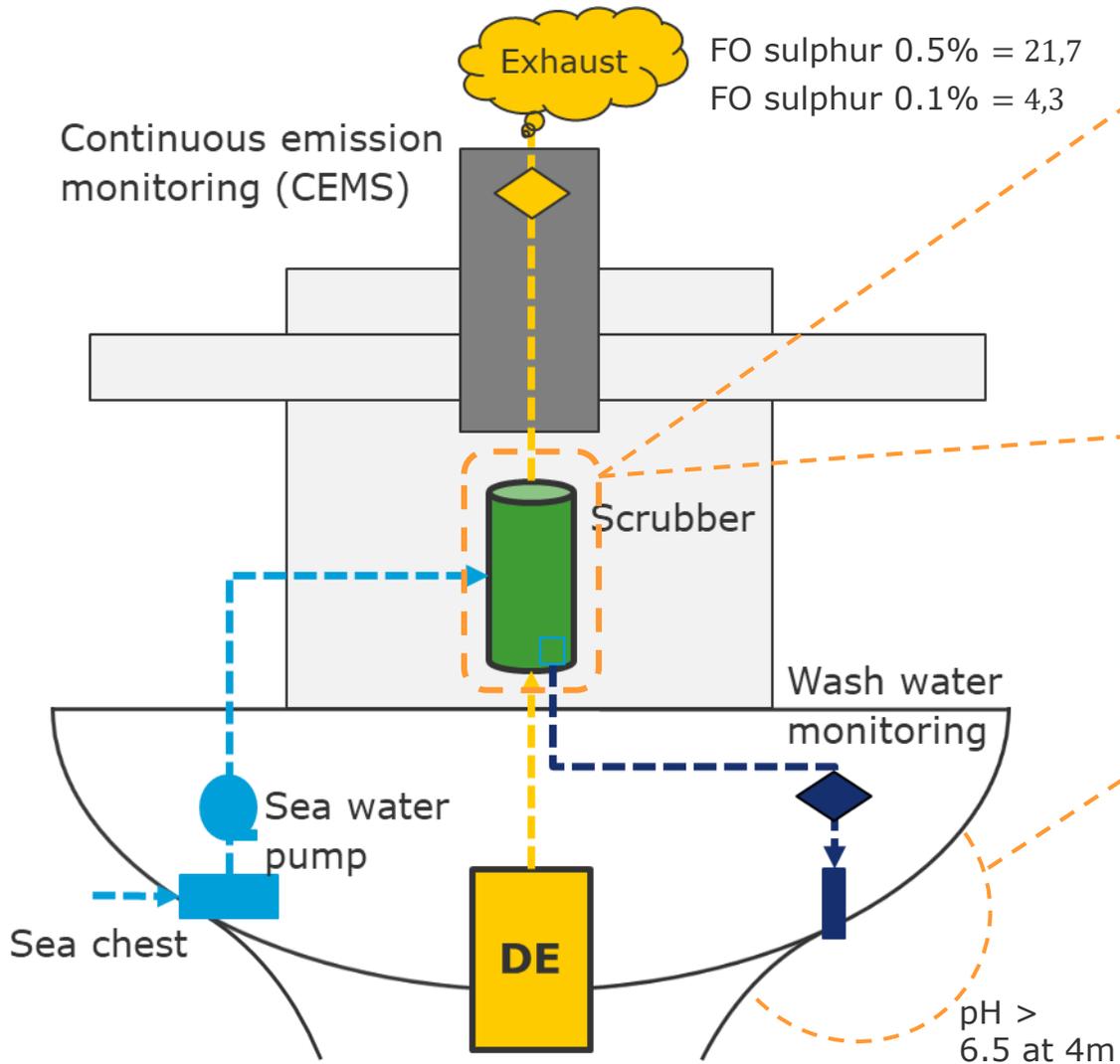


Scrubbers are technical feasible solution while good system design and material selection is critical to minimize downtime



- Scrubber efficiency and compliance
- Corrosion challenges
- System reliability
- Monitoring equipment calibration and maintenance
- Closed / hybrid systems

Scrubber efficiency and compliance



Scrubber efficiency

- Most scrubbers in operation are able to meet the air emission requirement with some margin
- Spray nozzle design and location, droplet size, retention time combined with water flow are the main parameters to consider

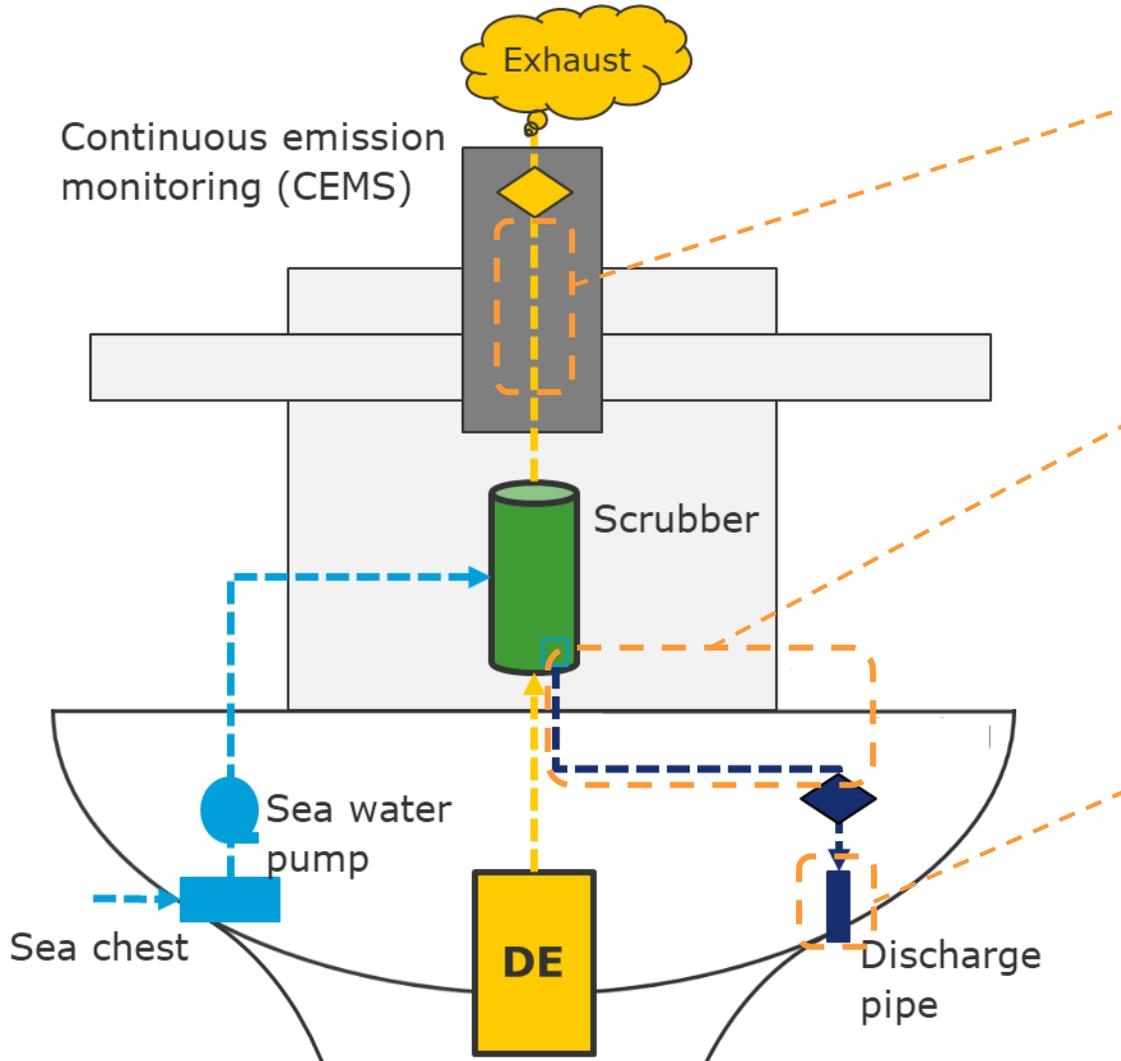
Engine backpressure

- Scrubbers increase the back pressure with about 1000 – 1500 Pa which may affect the performance of the ME
- It must be verified that the exhaust back pressure limits are not exceeded (NOx rating)
- Exhaust gas fans are generally not recommended

Wash water discharge compliance

- Methodology for documenting pH compliance using CFD is established
- Key factor is size and number of discharge outlets, diffusers should be avoided
- New suppliers still require some direction on design solutions

Corrosion challenges



Corrosion of exhaust pipe

- The exhaust line after the scrubber tower must be corrosion resistant
- For in-line design the existing exhaust piping should be replaced

Corrosion of wash water piping, bellows and valves

- Wash water has low pH and is highly corrosive!
- GRE/GRP piping is frequently applied due to their corrosive resistant properties
- Design should aim to minimize penetration of existing structures (bulkheads, deck) to avoid steel penetrations

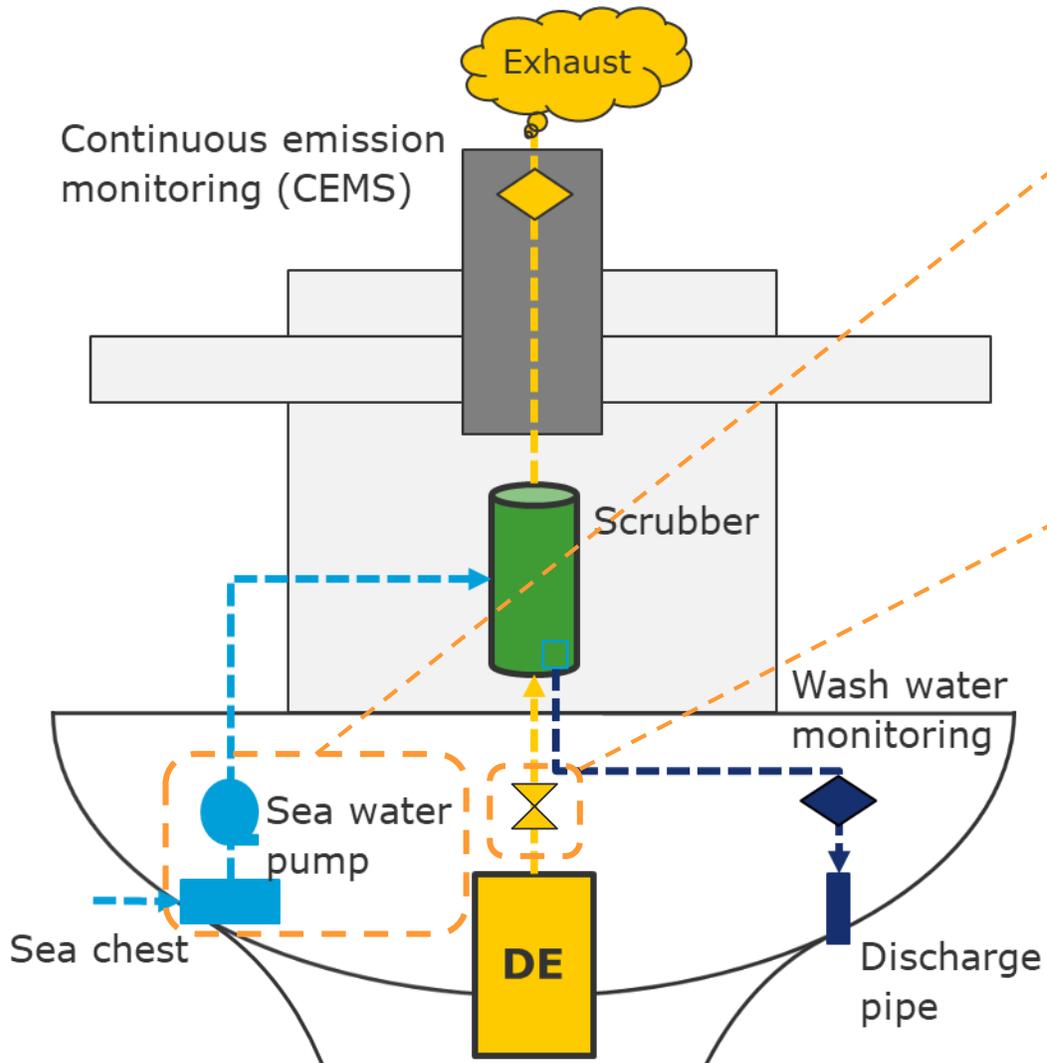


Corrosion of discharge pipe and side shell

- Class rules require replacement of overboard valves every 5 years
- Discharge pipe must be UT tested every year (recommended every 6m)
- Appropriate coating must be applied to side shell



System reliability



Sea water supply

- The scrubber system can be supplied by existing sea chests if there are sufficient capacity
- Most systems are only connected to one sea chest which introduce a single-point of failure
- It is recommended to install redundant sea water pumps

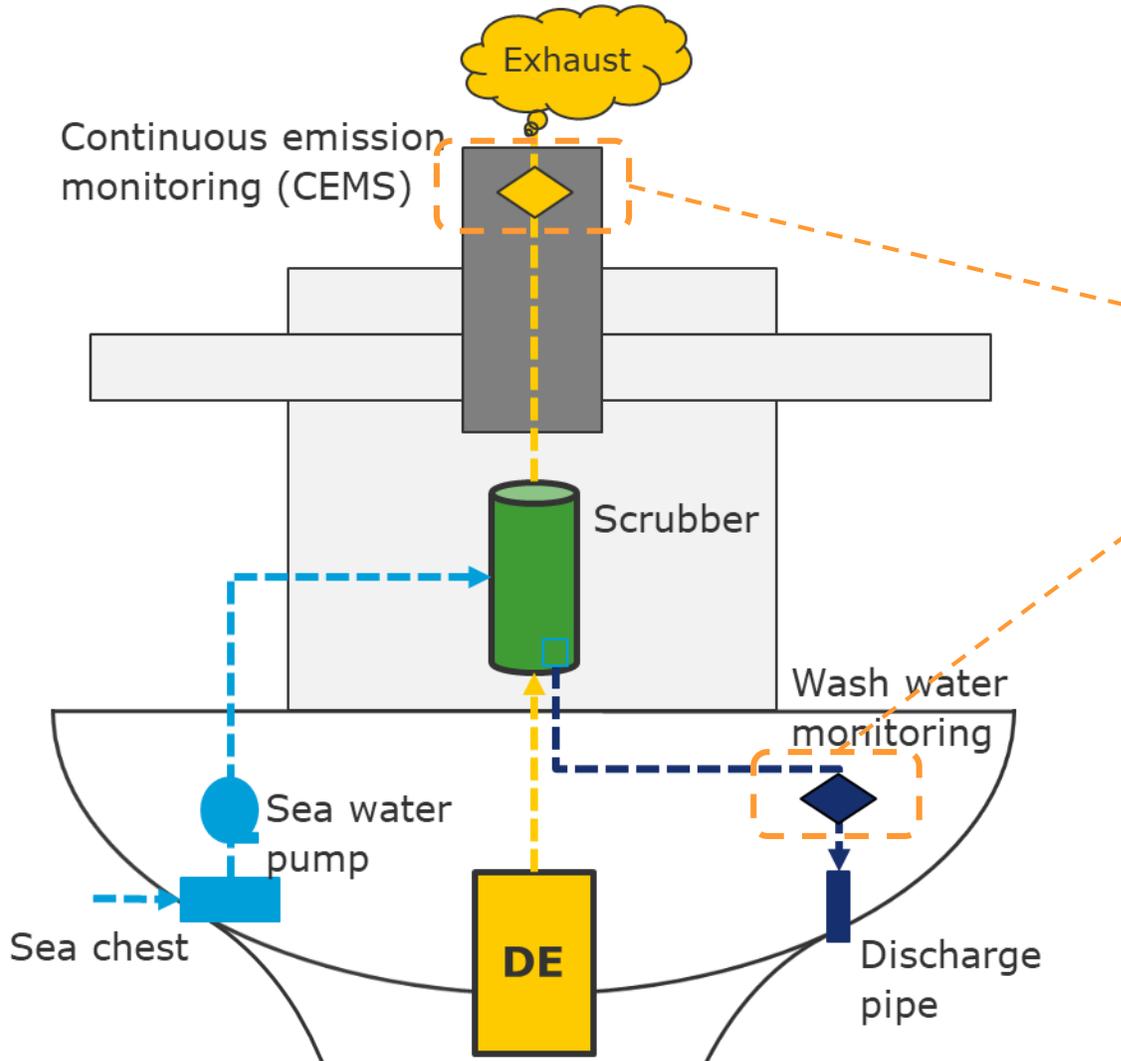
By-pass valves and sealing air fans (multi-inlet)

- Failure of by-pass valves or sealing air fans can result in non-compliant air emissions
- The interlock functionality of by-pass valves are critical to ensure that the valves are in correct position when starting DE's
- It is recommended to install redundant sealing air fans

Automation system

- A robust automation system is key to ensure reliable operation of scrubber systems
- The automation systems incorporate a range of shut-down alarms, and poor automation systems can impact the availability

Monitoring equipment calibration and maintenance



Analyzer reliability

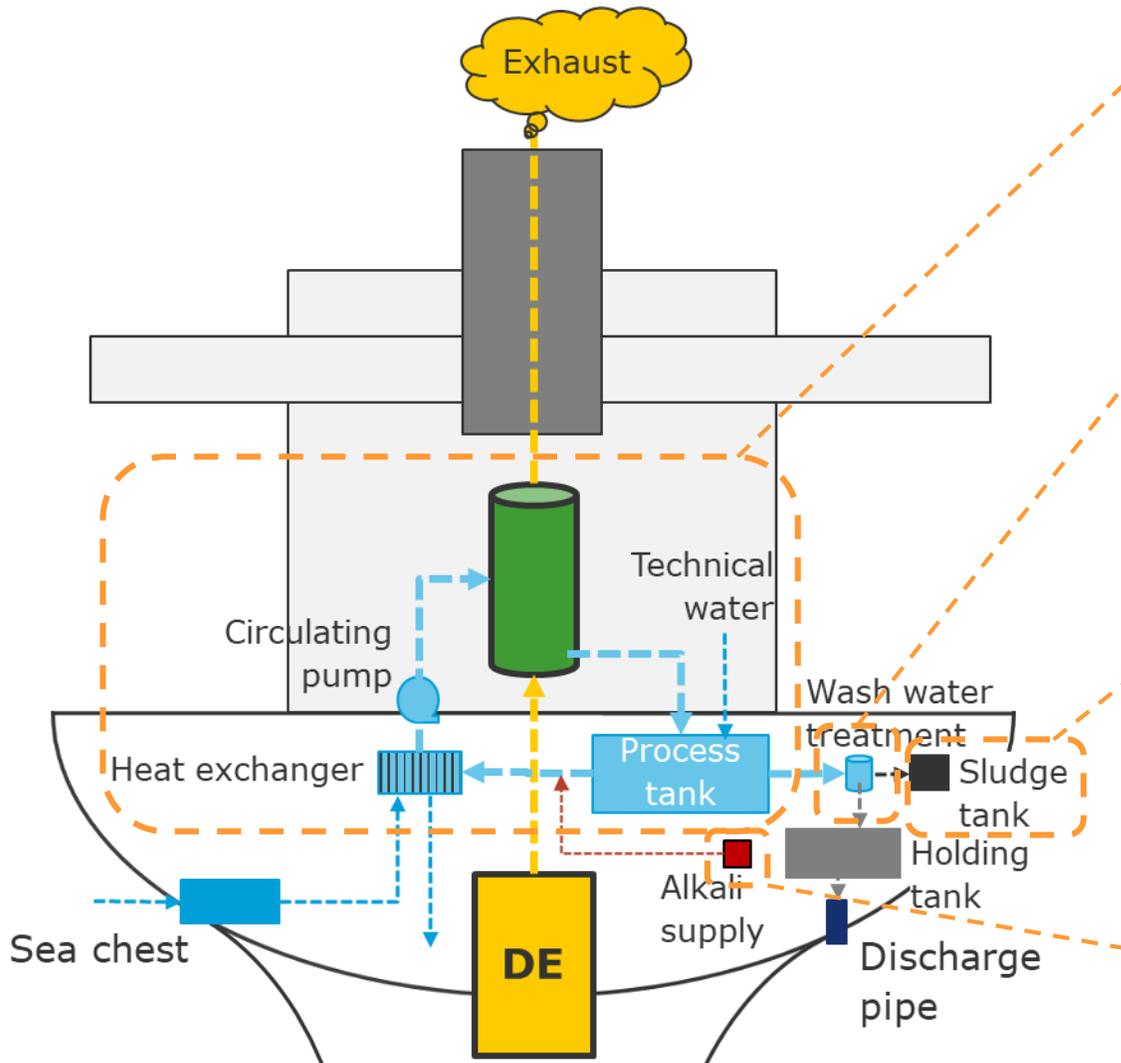
- Reliable monitoring equipment is key since they are the basis to show compliance of the system
- The analyzers requires proper maintenance to function correctly
- Crew training is important to minimize downtime of analyzers

Calibration and maintenance

- Calibration methods and interval vary between manufactures, general intervals can be summarized as:

Sensors	Onboard calibration	Factory calibration / maintenance
CEMS	~ 1 month	~ 1 year
Turbidity	~ 3 month	~ 2 year
PAH	~ 6 month	~ 2 year
pH	~ 2 - 3 month	

Closed / hybrid systems



Process reliability

- Hybrid / closed loop systems are significantly more complex
- Robust automation system and good installation quality of sensors are required to minimize downtime from "false alarms"

Wash water treatment

- Various types of wash water treatment systems are available; centrifugal, chemical and membrane types
- Performance vary significantly and thorough technology assessment is recommended

Sludge storage and discharge

- Sludge from treatment units are hazardous waste and must be treated accordingly
- Major ports have facilities / companies for accepting sludge

Alkali bunkering and handling

- Common alkalis are caustic soda (NaOH) and magnesium hydroxide
- NaOH has very strict requirements, and it will be reclassified in the IBC code to toxic from 2020

How is your ship prepared for installation?

Allocation of
space

Weight
increase

Structural
modifications

System
modifications

Fire Safety

Integration
with existing
ship systems



Installing one scrubber in 1,5 year is easy, installing e.g. 32 in 1,5 year is difficult

Example

32 ships, 4 sister series



A relatively small scrubber retrofit project may require close follow up of 11 stakeholders and management of 392 individual project processes

Stakeholder mapping: 11

Sister series	Ships	Technology suppliers	Design house	Class	Yard
Series A	8	Scrubber 1	Design House 1	Class 1	Yard 1 and 2
Series B	8	Scrubber 2	Design House 2	Class 2	Yard 2 and 3
Series C	8	Scrubber 1	Design House 1	Class 1	Yard 1 and 3
Series D	8	Scrubber 2	Design House 2	Class 3	Yard 1 and 4
Sum	32	2	2	3	4

Project processes: 392

Technical specifications	4			
Basic design		4		
Plan approval		32	32	
Detailed design				32
Construction drawings				32
Planning and purchasing	32			32
Logistic	32			32
Installation				32
Commissioning	32		32	32
Sum	100	36	64	192

Key processes in a scrubber retrofit program

Key processes:

- Establish business case
- Complete technical feasibility study
- Evaluate & select supplier(s)

Contract(s) signed

Key processes:

- Align installation plan with dry-docking schedule
- Change order management
- Process tracking, monitoring and reporting
- Risk management
- Update SMS and PMS
- Establish inspection, test plan & sign off protocols

Program finished



Basic design

Key processes:

- Define clear scope
- Identify operational impacts
- Identify differences between sister ships
- Verify backpressure, stability, pH compliance

Detailed design

Key processes:

- Ensure design quality sufficient to support procurement & planning
- Develop installation (sequencing) strategy
- Follow up class approval process and drawing status



Planning & procurement

Key processes:

- Develop installation plan
- Monitor purchasing and logistic plan
- Manage owner supply

Ready for dry-dock retrofit



Installation

Key processes:

- Forecast & progress reports available to PM
- On-site quality control

Commissioning

Key processes:

- Complete MARPOL & performance test
- Make ship operationally ready

Installation complete

Operationally ready

Introduction

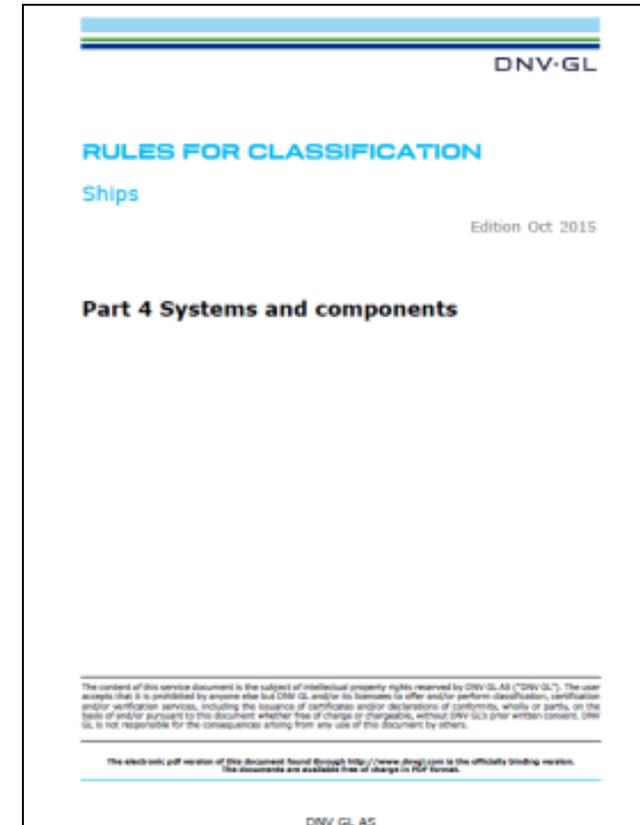
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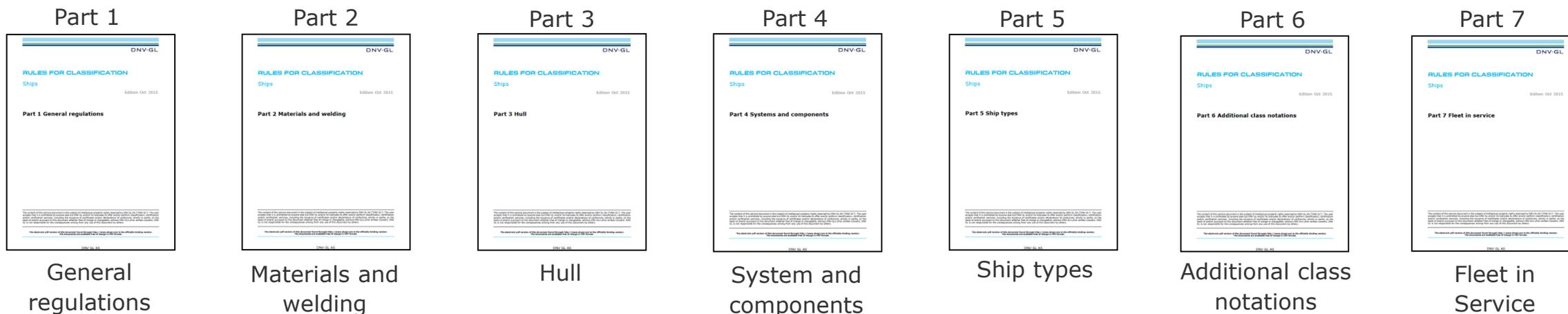
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How DNV GL can support

Summary and Q & A



DNV GL classification – Supporting the low sulphur future



■ DNV GL classification process

- Contact your local DNV GL contact – as for normal conversion
- Responsible DNV GL Approval Center will handle approval and kick off
 - Remember to start in *due time* before your docking
- DNV GL local dedicated surveyor will follow up installation
 - Please inform us *as soon* as you know your retrofit location

■ Emission Reduction (ER) notation for Scrubber - **Published July 2018**



Class involvement in scrubber installations



- Statutory verification of documents for EGCS acc. to MARPOL Annex VI, Reg.4 & 14 as detailed in MEPC.259(68) scheme B,

Marpol Verification Surveys onboard after installation and commissioning.

- Following up work towards the Flag State:

- IMO notification (GISIS database) requests.
- USCG notification (by the Flag State) requests for ships operating in US waters.
- IAPP endorsement for the completed EGCS installation.



- MED certification of EGCS for ships flying EU flags acc. to Directive 2014/90/EU on marine equipment and Regulation (EU) 2017/306, item MED/2.10.

DNV GL
INTERNATIONAL AIR POLLUTION PREVENTION CERTIFICATE
DNV GL 36 No: 20372
Date of issue: 2015-02-26

Issued under the provisions of the Protocol of 1997 as amended by resolution MEPC.176(58) in 2008, to amend the International Convention for the Prevention of Pollution from Ships, 1973, as modified by the Protocol of 1978 related thereto (hereinafter referred to as "the Convention") under the authority of the Government of

NORWAY

Particulars of Ship
Name of Ship:
Distinctive Number or Letters:
Port of Registry:
Gross Tonnage:
IMO Number:

This is to certify:
1. That the ship has been surveyed and
2. That the survey shows compliance with the applicable provisions of the Convention.

Remarks/Recommendations:
This Certificate is valid until VI of the Convention.
Completion date of survey on
Issued at **Havik, Norway**

Form code: IAPP 1219
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2.3 Sulphur Oxides (SO_x) and particulate matter (Regulation 14)
2.3.1 When the ship operates outside of an Emission Control Area specified in regulation 14.3, the ship uses:
2.3.1.1 fuel oil with a sulphur content as documented by bunker delivery notes that does not exceed the limit value of:

- 4.50% m/m (not applicable on or after 1 January 2012); or
- 3.50% m/m (not applicable on or after 1 January 2020); or
- 0.50% m/m, and/or

2.3.1.2 an equivalent arrangement approved in accordance with regulation 4.1 as listed in 2.5 that is at least as effective in terms of SO_x emission reductions as compared to using a fuel oil with a sulphur content limit value of:

- 4.50% m/m (not applicable on or after 1 January 2012); or
- 3.50% m/m (not applicable on or after 1 January 2020); or
- 0.50% m/m

2.3.2 When the ship operates inside an Emission Control Area specified in regulation 14.3, the ship uses:
2.3.2.1 fuel oil with a sulphur content as documented by bunker delivery notes that does not exceed the limit value of:

- 1.00% m/m (not applicable on or after 1 January 2015); or
- 0.10% m/m, and/or

2.3.2.2 an equivalent arrangement approved in accordance with regulation 4.1 as listed in 2.5 that is at least as effective in terms of SO_x emission reductions as compared to using a fuel oil with a sulphur content limit value of:

- 1.00% m/m (not applicable on or after 1 January 2015); or
- 0.10% m/m

2.4 Volatile organic compounds (VOCs) (Regulation 15)
2.4.1 The tanker has a vapour collection system installed and approved in accordance with IMO MSC/Circ.585 (1).
2.4.2.1 For a tanker carrying crude oil, there is an approved VOC Management Plan
2.4.2.2 VOC Management Plan approval reference: -

2.5 Shipboard incineration (Regulation 16)
2.5.1 The ship has an incinerator:
2.5.1.1 installed on or after 1 January 2000 which complies with resolution MEPC.76(40) as amended

2.5.1.2 installed before 1 January 2000 which
2.5.1.2.1 complies with resolution MEPC.59(33)

2.5.1.2.2 complies with resolution MEPC.76(40)

2.5.1.2.3 does not comply with resolution MEPC.59(33) or resolution MEPC.76(40)

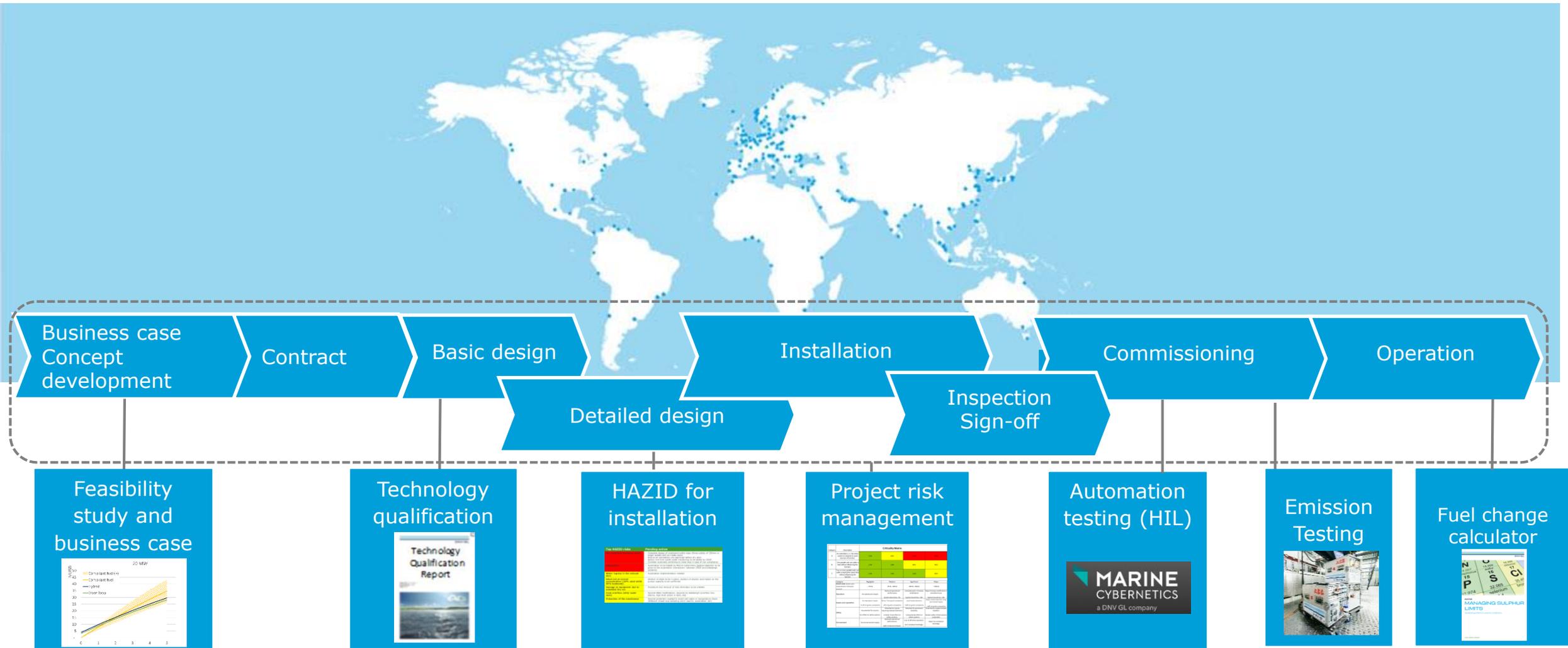
2.6 Equivalents (Regulation 4)
The ship has been allowed to use the following fitting, material, appliance or apparatus to be fitted in a system or equipment required by this Annex:

System or equipment	Equivalent used	Approval reference
Wärtsilä Moss AS, 148M1 SC200	EGCS (open-loop wet scrubber systems)	MED-G-1997
S.N.SP/01512.81 and 144M3 SC400		
S.N.SP/01512.82		

4 Ships with DNV GL Class notation KCS-1 or KCS-2 (in compliance with IACS CSR 48 Part 38) comply with IMO MSC/Circ.585.

Form code: IAPP 1219
Revision: 2015-01
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DNV GL Maritime Advisory – Supporting the low sulphur future



Introduction

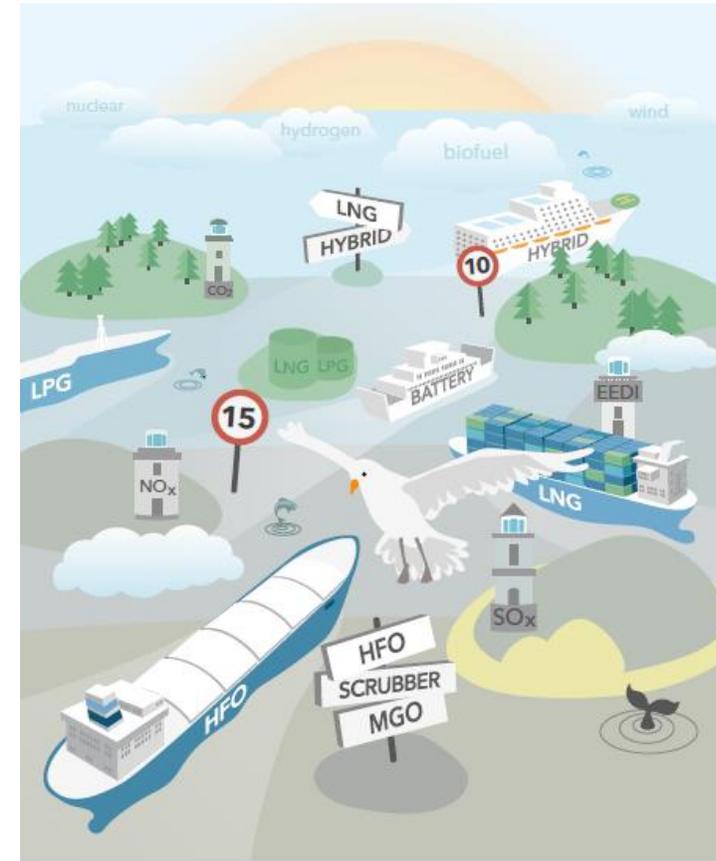
Business case

Scrubber system design principles

Safety, reliability and operation

How DNV GL can support

Summary and Q & A



Demystifying the scrubber myths

Are they reliable?

- First of all – **They are working**
- Experience is made and design has improved
- Scrubbers are technical feasible solution while good **system design** and **material selection** is critical to **minimize downtime**



None of my competitors are installing..?!?

- First installations were mainly due to **SECA** implementation in **2015** – Cruise and Ro-Ro/ferries
- **Drastic shift** in segments that now install
- There will be **capacity constraints** throughout the value chain
- Scrubbers can **significantly** mitigate the cost impact from the 2020 Sulphur Cap and the **decision if to invest** should be made yesterday

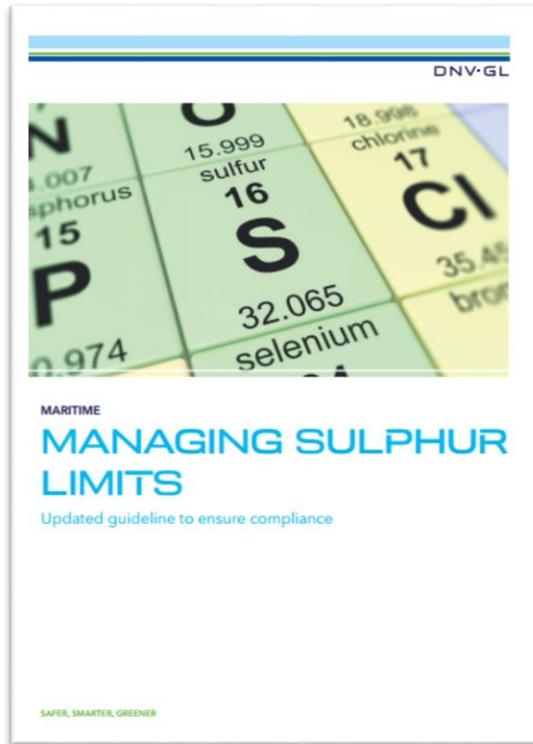
The long term solution for compliance?

Who knows – maybe not...

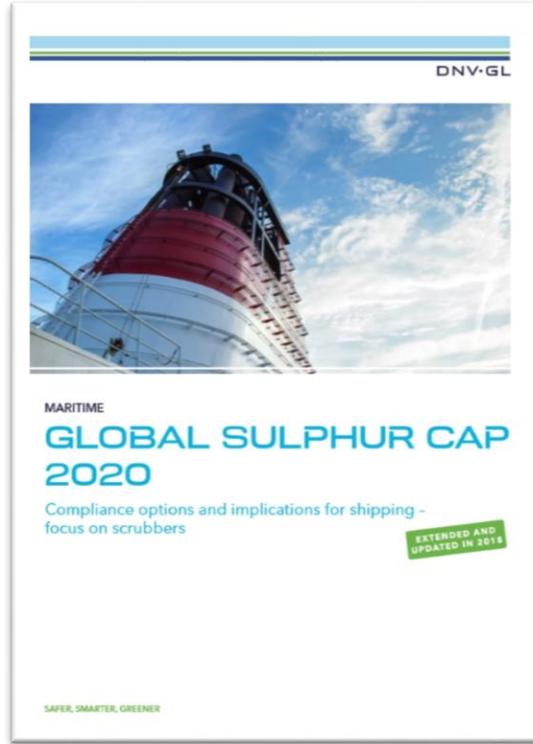
There are many uncertainties for the future.

However, it might very well be a **cost saving** and **safe solution** as the fuel market transitions into a “new fuel normal” situation.

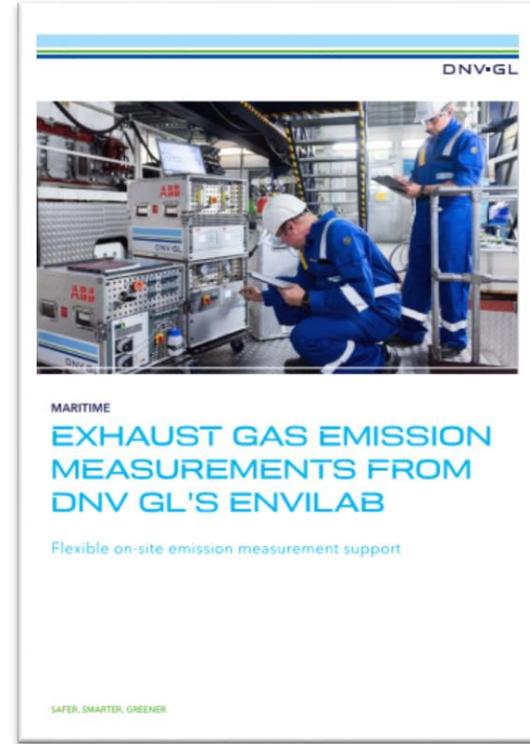
Find more information in our DNV GL brochures



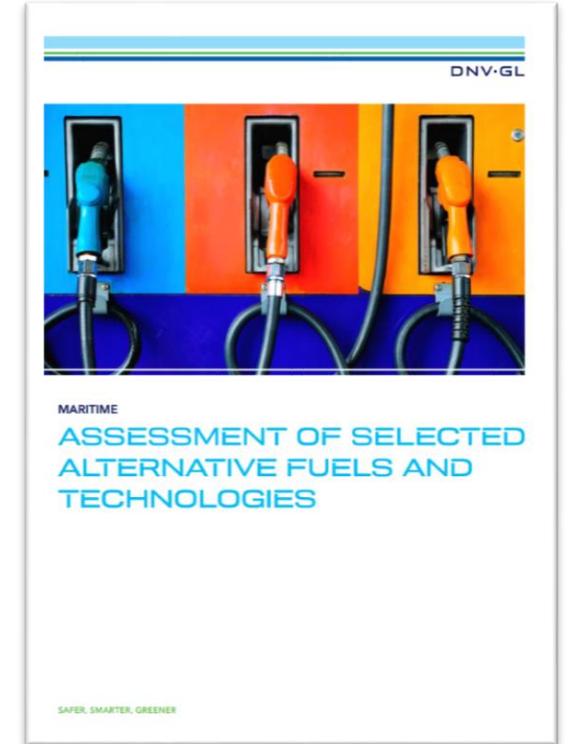
www.dnvgl.com/maritime/publications/sulphur-limits.html



www.dnvgl.com/maritime/publications/global-sulphur-cap-2020.html



www.dnvgl.com/services/exhaust-gas-emission-measurements-65835



www.dnvgl.com/maritime/publications/alternative-fuel-assessment-download.html

DNV GL offering the broader view on sulphur compliance

Stine Mundal
Project Manager Approval

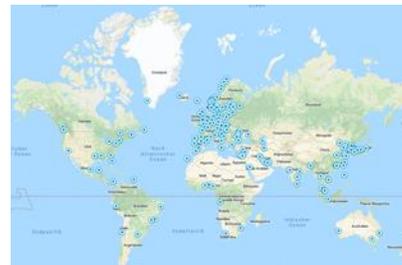


Dag Sandal
Principal Consultant



www.dnvgl.com

For more information, get in touch with your local DNV GL office



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