

WORKSHOP ON MODERNISATION OF **DANUBE** VESSEL FLEET

WÄRTSILÄ PORTFOLIO

Wärtsilä Ship Design – 18th April 2018

Krzysztof Czerski – GM Project Development
& Naval Architecture



• **Introduction of Wärtsilä**

- Increasing public awareness of environmental issues
- 6L20DF engines
- Fuel Gas Supply System.
- LNG Cargo Handling Systems.
- Wärtsilä Ship Design & LNG Inland Water Tankers
- Exhaust Gases Cleaning Systems

THIS IS WÄRTSILÄ

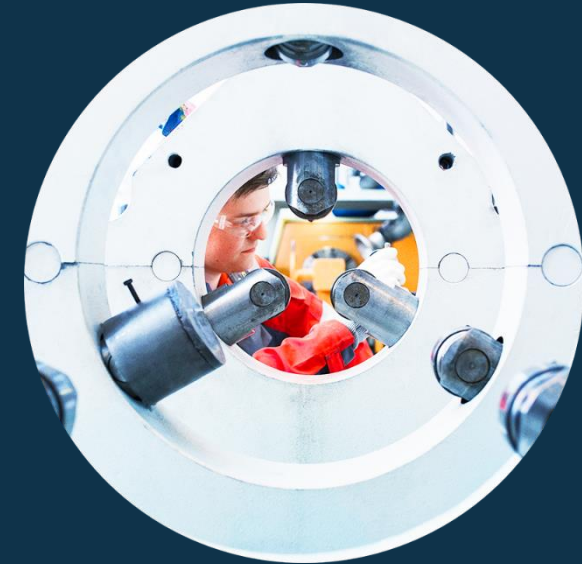
Our business **area**



Energy solutions



Marine solutions



Services

GLOBAL PRESENCE

Global strategic footprint to meet customers' demands

Close to the customer anywhere

Leading experts in LNG as cargo and as fuel

Approximately 18,000 professionals

In over 200 locations

In more than 70 countries



A Comprehensive product portfolio



SERVICES

We create lifecycle services with our customers, enhancing their businesses – whenever, wherever



A broad range of expertise and services



**LIFECYCLE SOLUTIONS INCL.
WÄRTSILÄ GENIUS SERVICES**



SERVICE PROJECTS



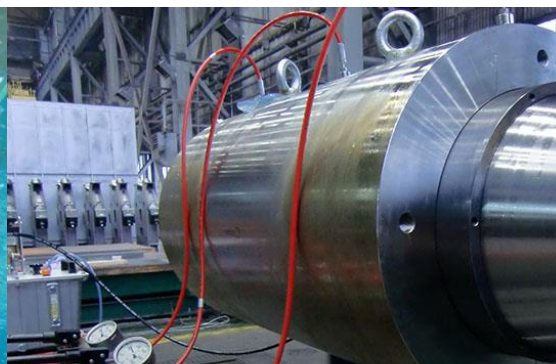
ENGINE SERVICES



TURBOCHARGER SERVICES



PROPULSION SERVICES



**SEALS & BEARINGS
SERVICES**



**HYDRO & INDUSTRIAL
SERVICES**



TRAINING SERVICES

ENERGY SOLUTIONS

We are a leading global systems integrator offering a broad range of environmentally sound solutions.

Our flexible and efficient solutions provide superior value to customers and enable a transition to a more sustainable and modern energy system.





**SOLAR PV AND ENGINE-SOLAR
HYBRID POWER PLANTS**

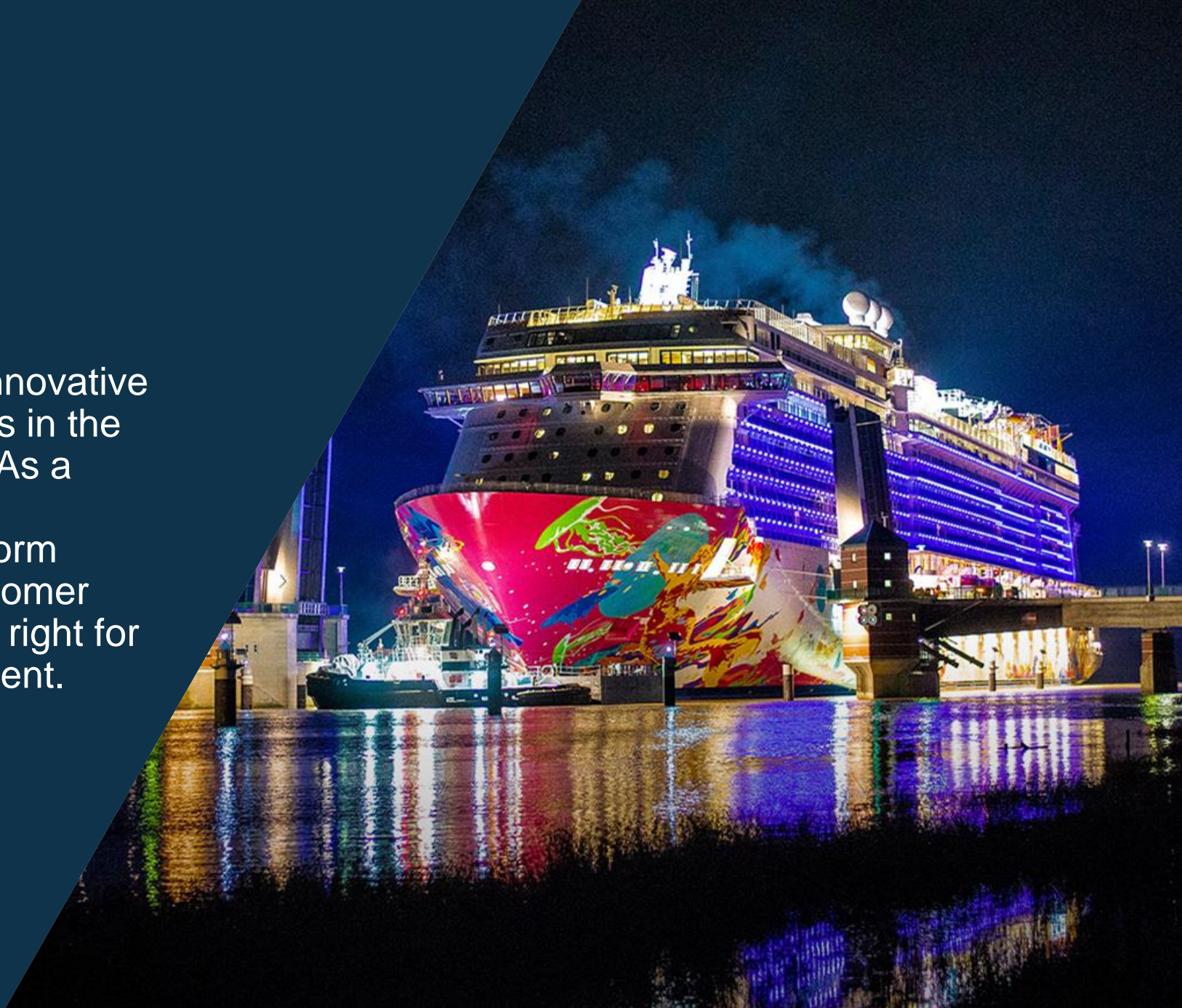
ENGINE POWER PLANTS

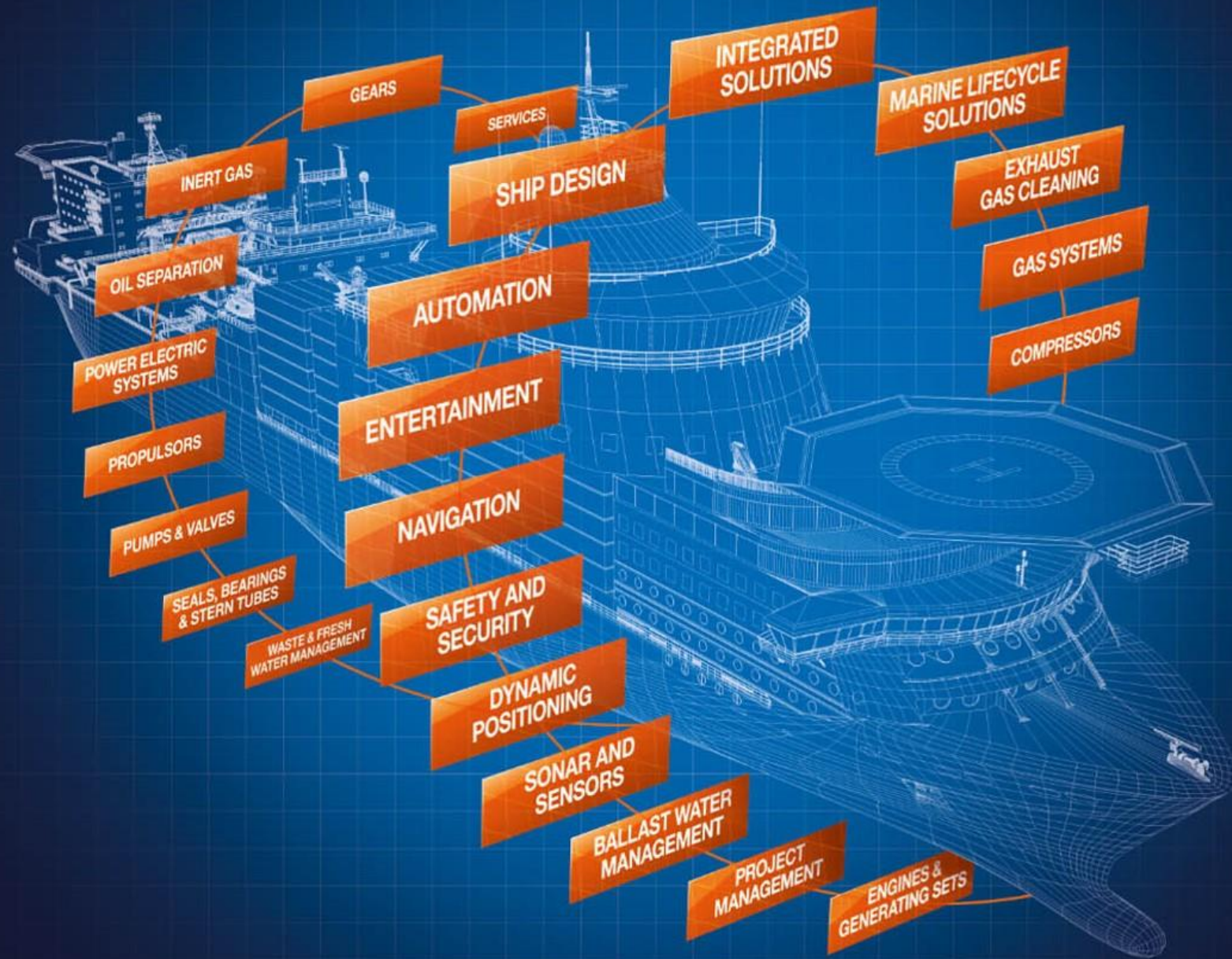
LNG INFRASTRUCTURE



MARINE SOLUTIONS

We are the leading provider of innovative products and integrated solutions in the marine and oil & gas industries. As a leader in our fields, we need to continuously develop and transform ourselves to meet changing customer needs. We have a passion to do right for our customers and the environment.





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LOCAL



NO_x Acid rains
Tier II (2011)
Tier III (2016)

LOCAL



SO_x Acid rains
Sulphur content in fuel from
2015 worldwide

LOCAL



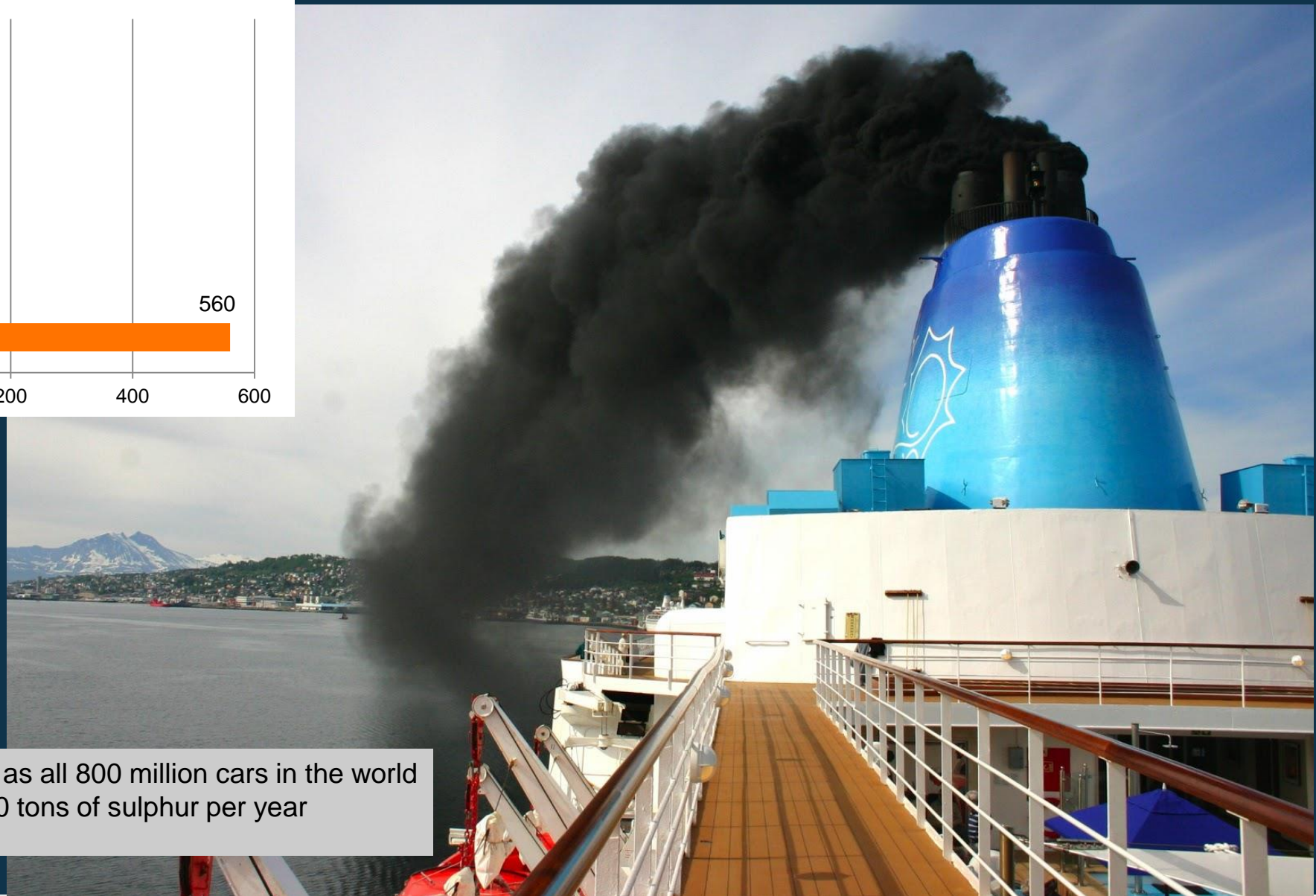
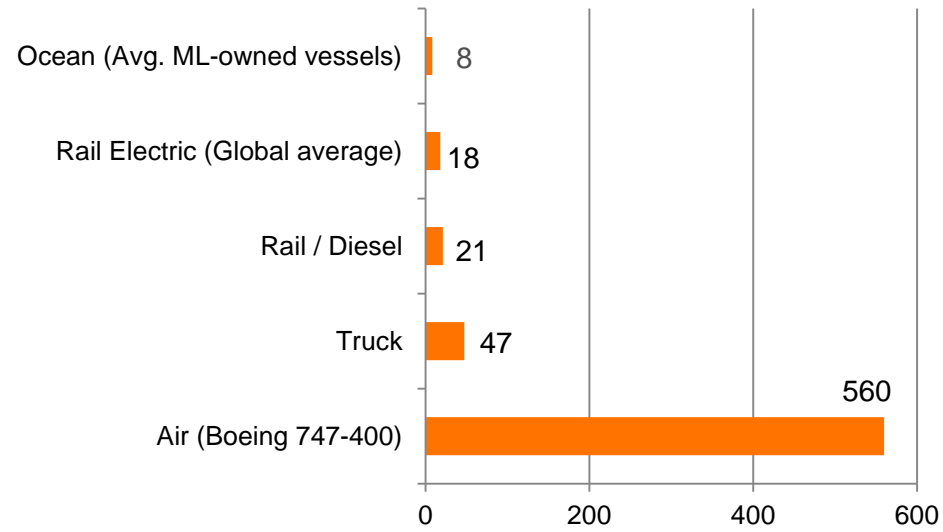
**Particulate
matter** Direct impact on humans
Locally regulated

GLOBAL



CO₂ Greenhouse effect
Energy Efficiency Design Index
(EEDI)

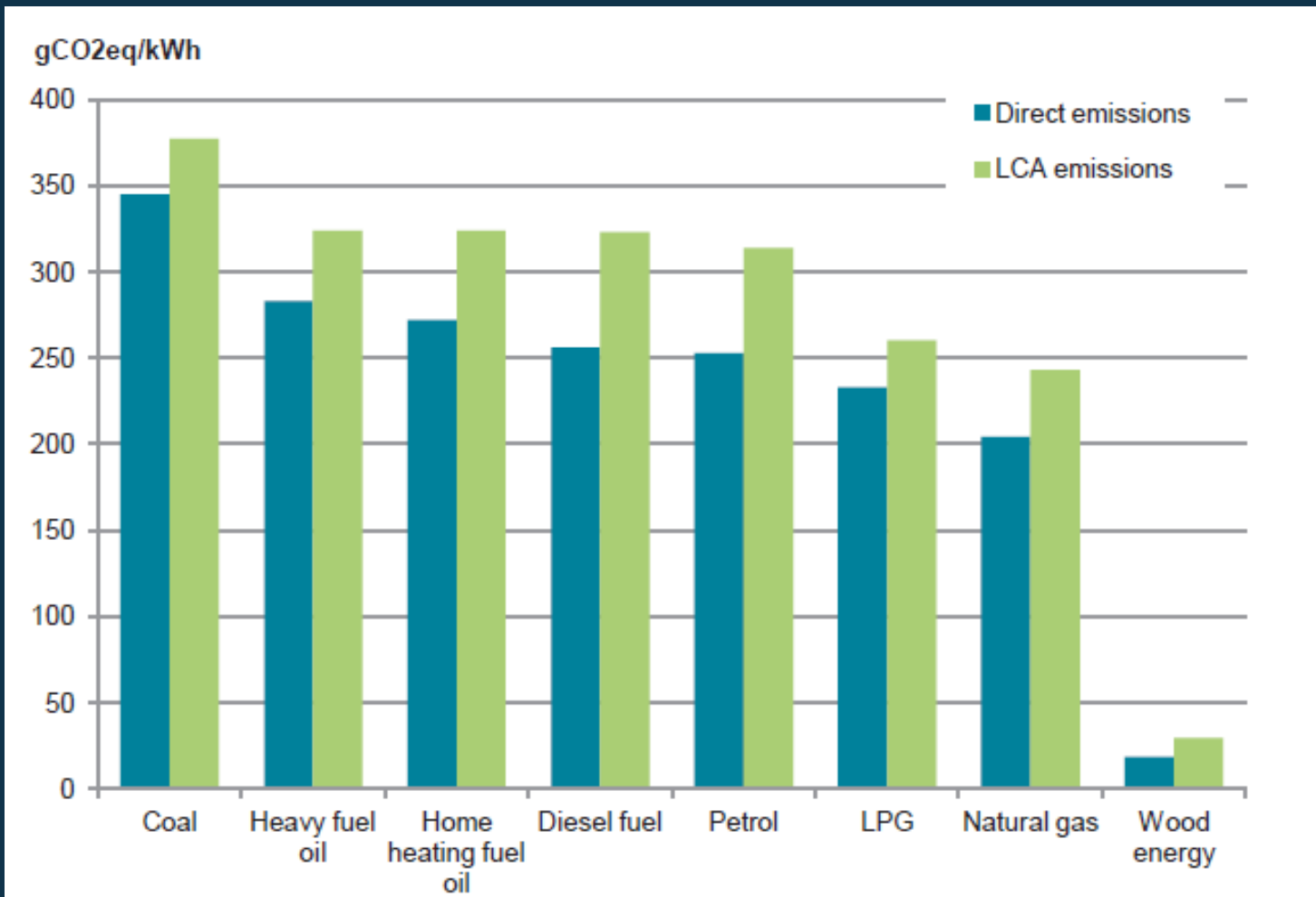
CO₂ in grams emitted per 1 ton of carried goods per 1 km



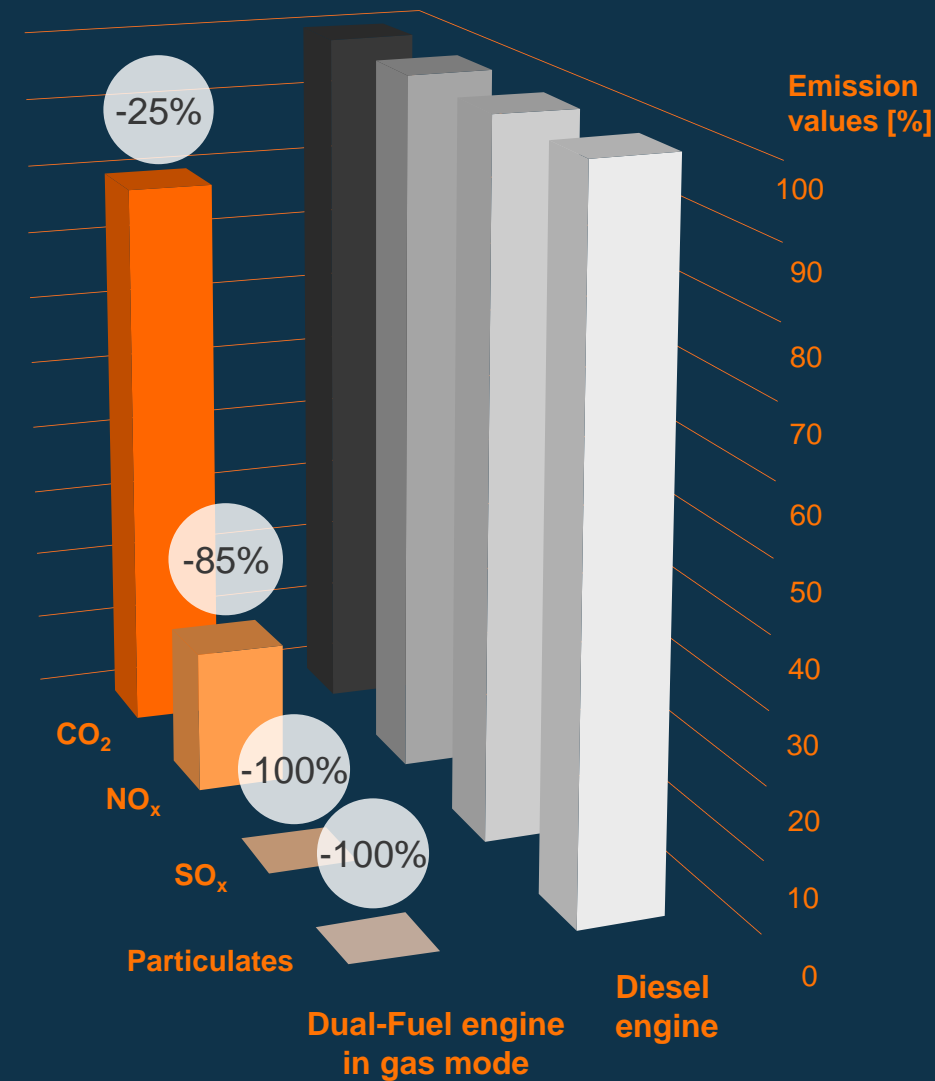
16 largest ships emit as much SO_x as all 800 million cars in the world
One ship can emit as much as 5000 tons of sulphur per year

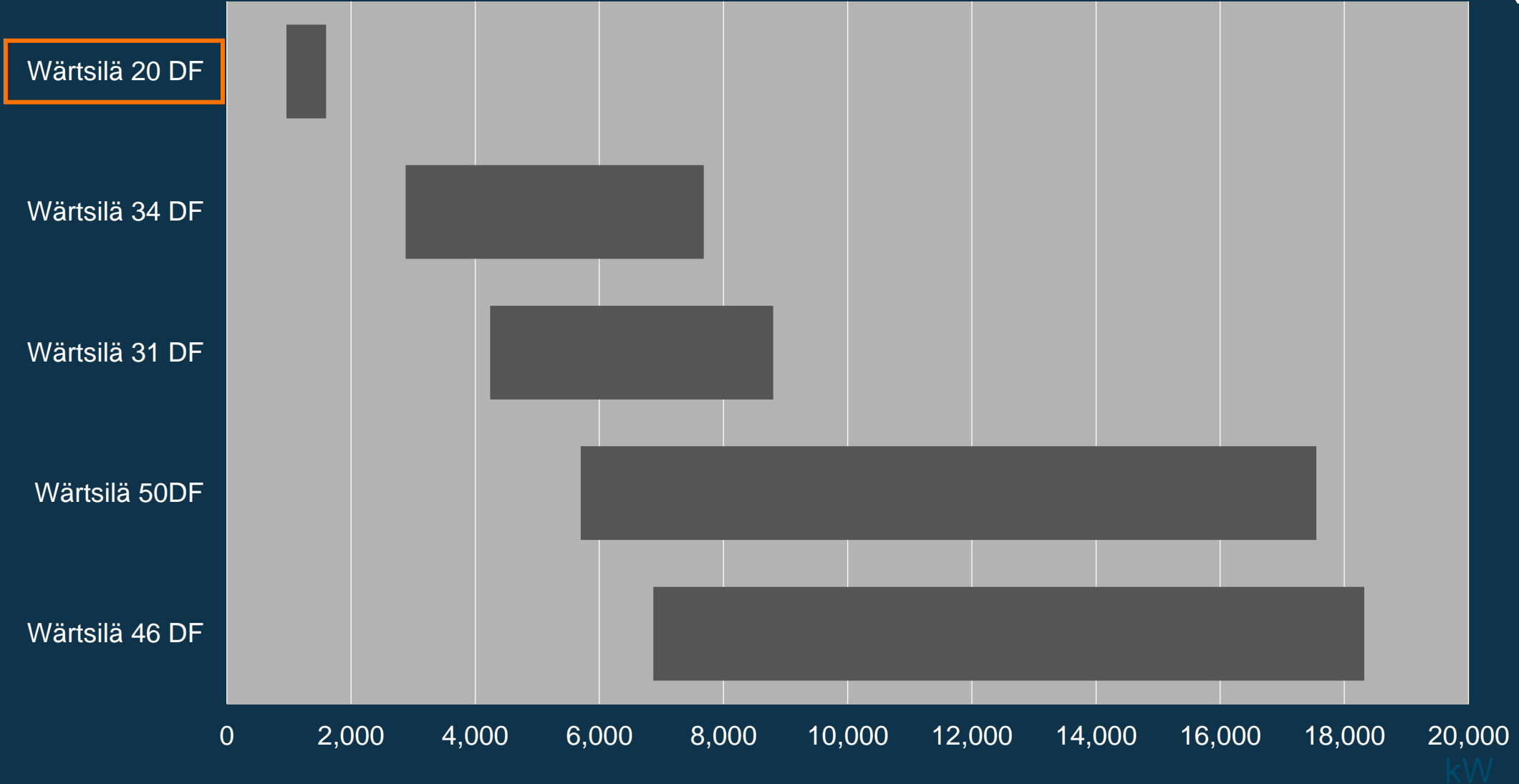
Source: The Guardian

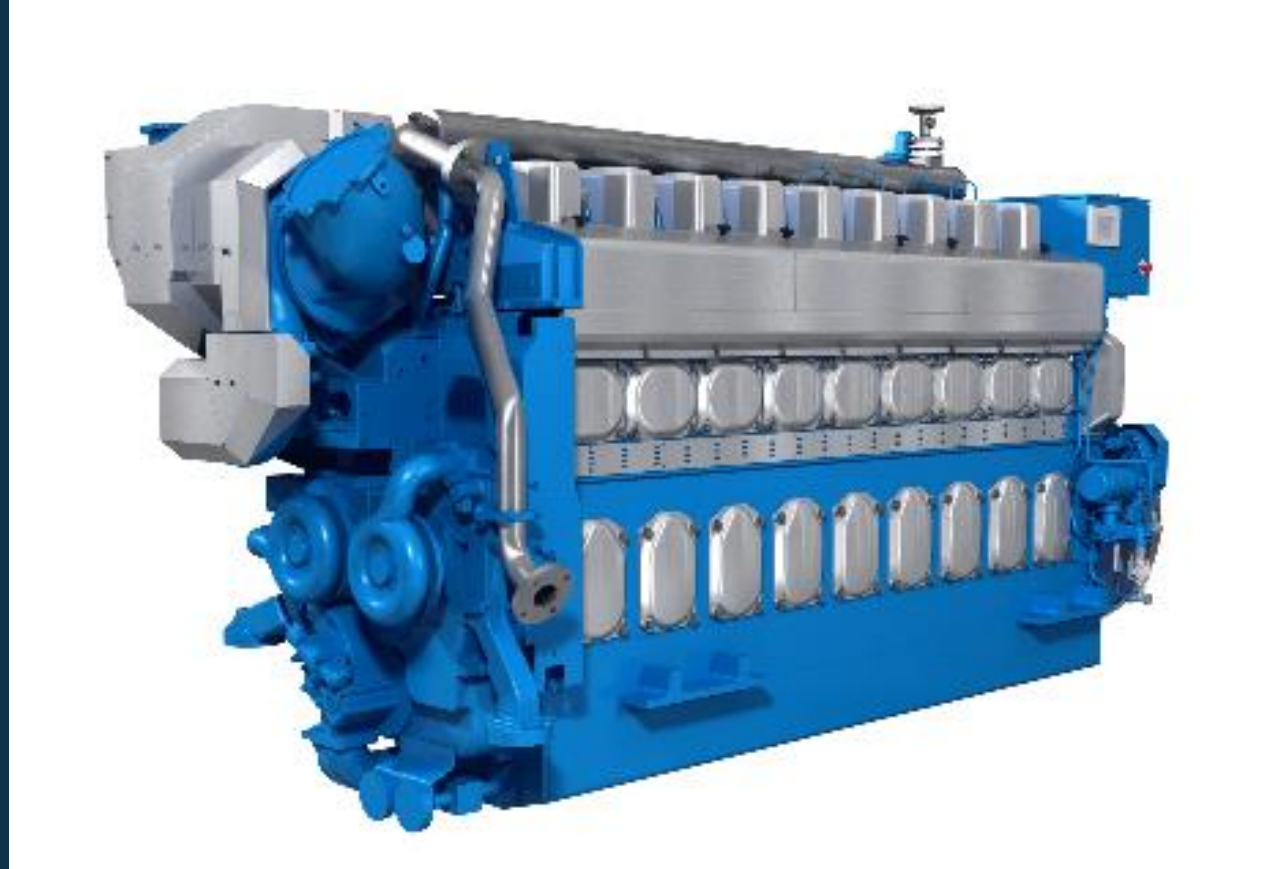
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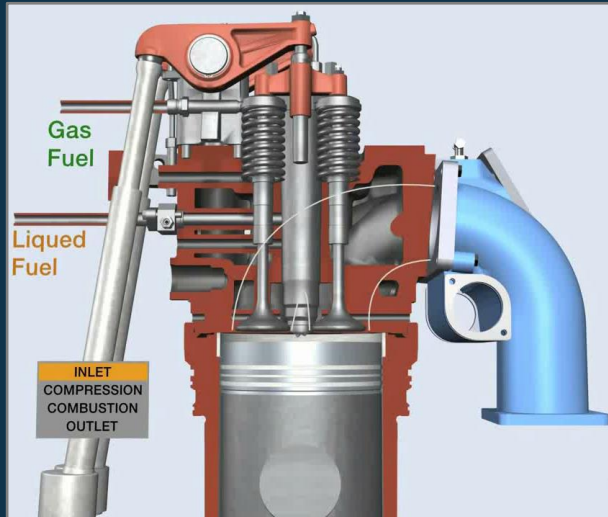
Source: ADEME (2015)





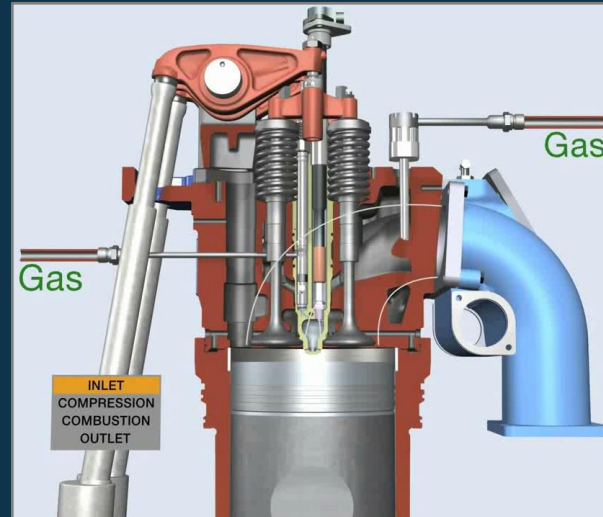


GAS DIESEL



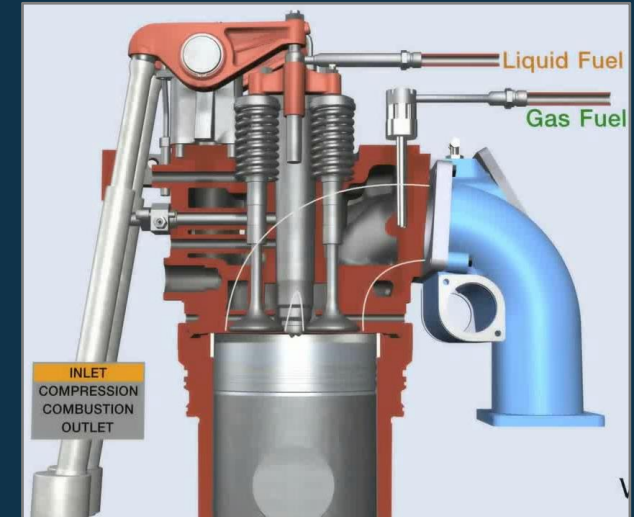
- ↓ Not IMO Tier III
- ↓ HP gas system
- ↑ Redundancy

SPARK GAS

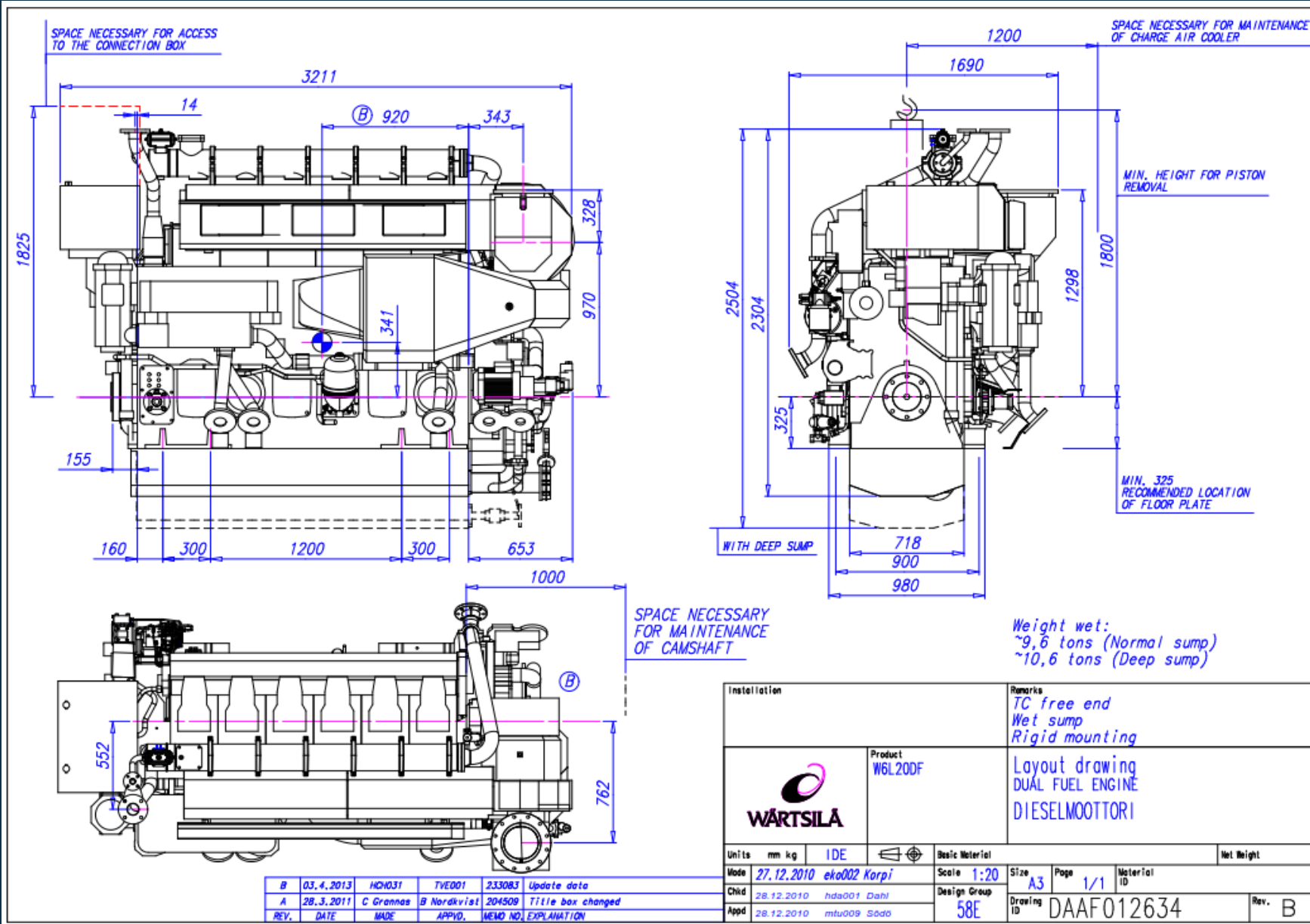


- ↑ IMO Tier III
- ↑ LP gas system
- ↓ No redundancy

DUAL FUEL

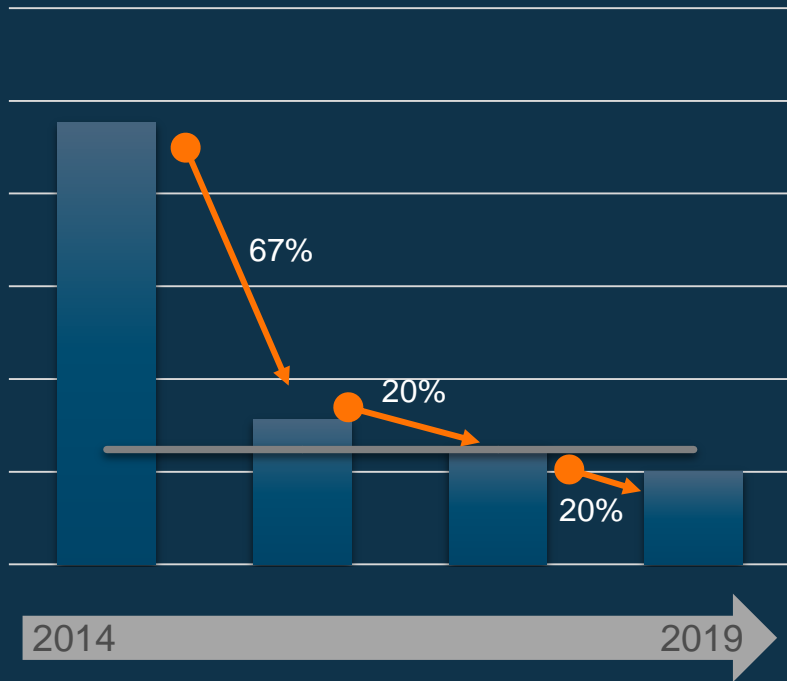


- ↑ IMO Tier III
- ↑ LP gas system
- ↑ Redundancy

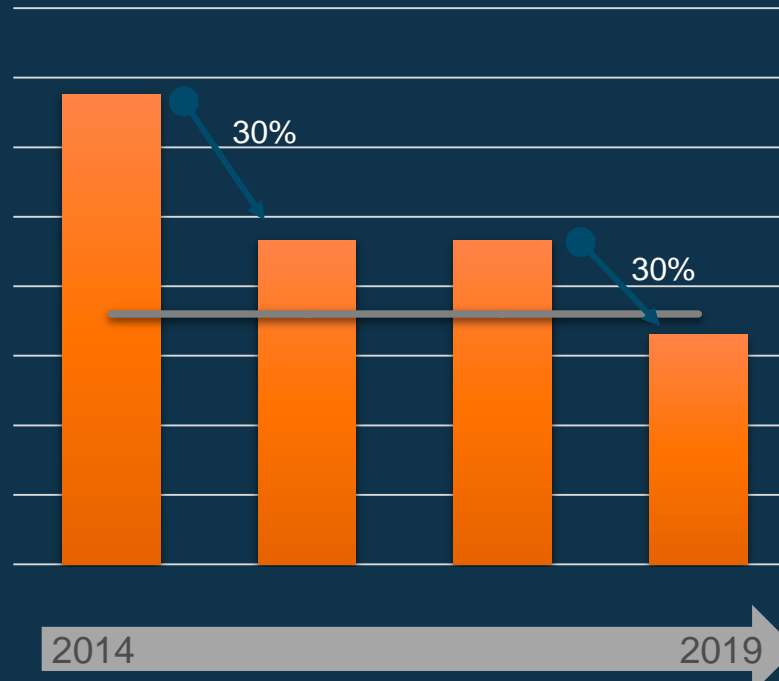


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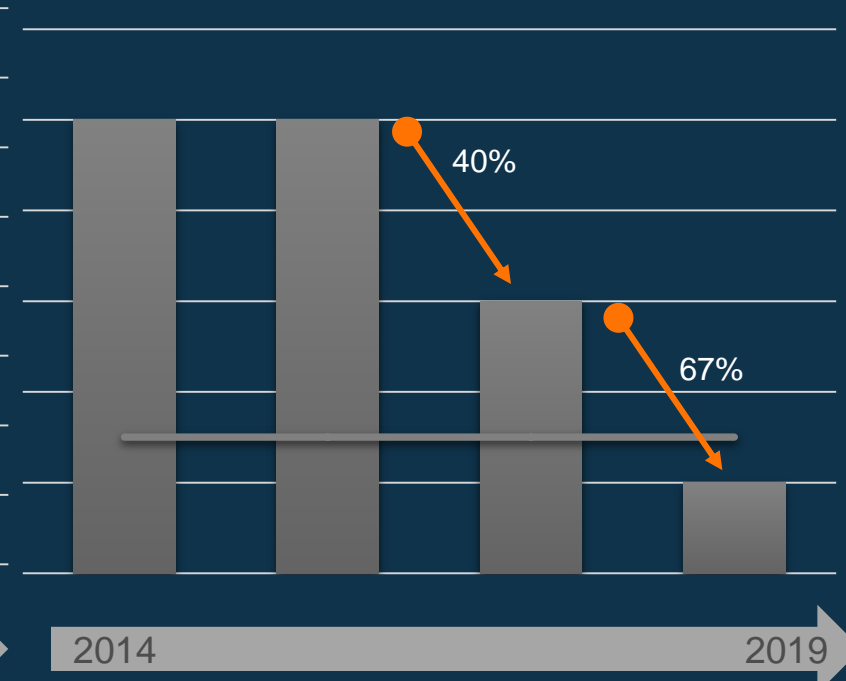
Methane emission



NOx emission



Particle Emission



=> Wärtsilä Dual Fuel Engines – NRMM STAGE V compliant (without after treatment)



LPG CARRIER

Owner: Chemgas Shipping BV

Yard: Chemgas Shipping BV

Capacity: 2620 CBM

Amount of vessels: 2

1 x W8L20DF (ME)



INLAND CARGO VESSEL (IWW)

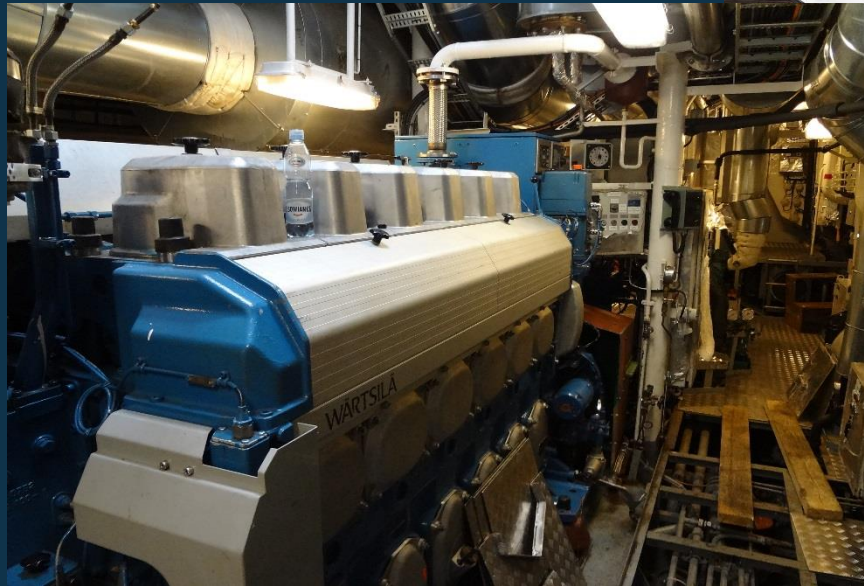
Owner: Combi International B.V.

Yard: Koedood Dieselservice B.V.

Capacity: 348 TEU

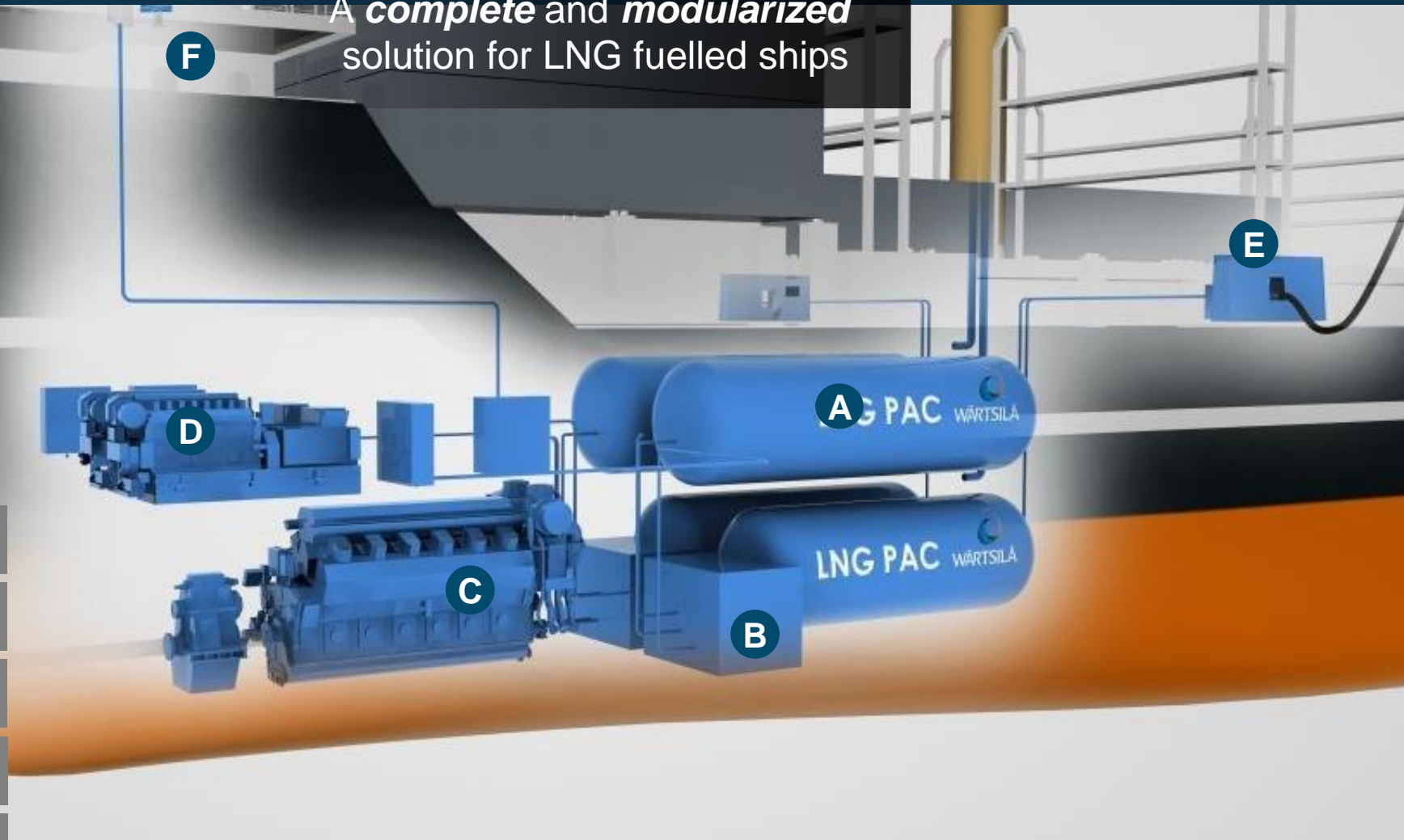
Amount of vessels: 1

2 x W6L20DF (ME) (LNG retrofit)



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A *complete* and *modularized* solution for LNG fuelled ships



A Storage tanks

B Evaporators

C Dual-Fuel Main engine

D Dual-Fuel Aux engines

E Bunkering station(s)

F Integrated control system

Total number of vessels equipped with Wärtsilä LNGPac™ *: 83

Total number of LNGPac™ *: 92

Total volume: 26180 m³

Number of vessels in operation: 27

Number of vessels confirmed and/or under construction: 56

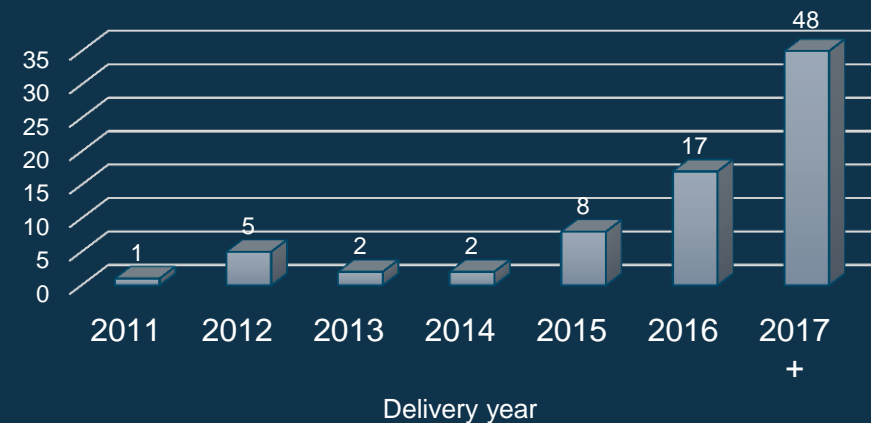
Owner country

Belgium	6
Canada	14
Germany	3
Norway	15
Sweden	7
UAE	1
USA	8
UK	17
Finland	1
Spain	3
Denmark	8

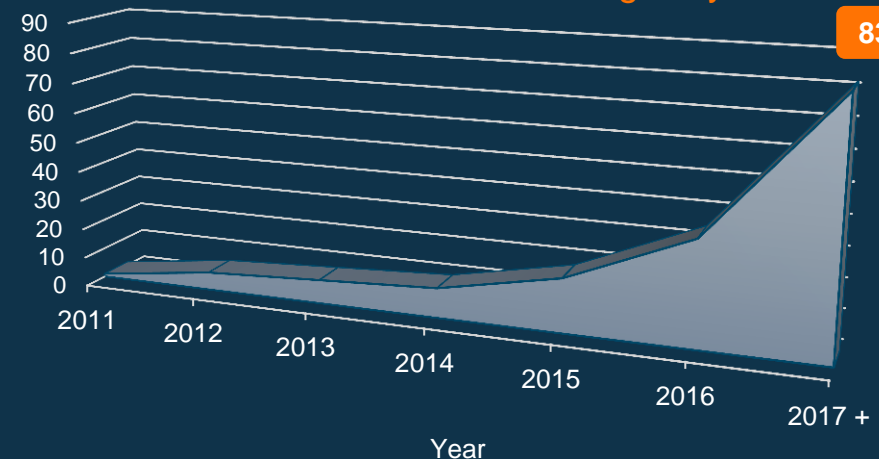
Application

Dredger	4
Fish Feeder	1
Offshore special	1
Passenger	1
Product Tanker	9
PSV	12
RoPax	22
RoRo	4
Tug	4
Special vessels	16
Windfarm	1
Multigas carrier	8

Distribution trend of LNG fuel gas vessels fitted with Wärtsilä LNG Fuel gas system



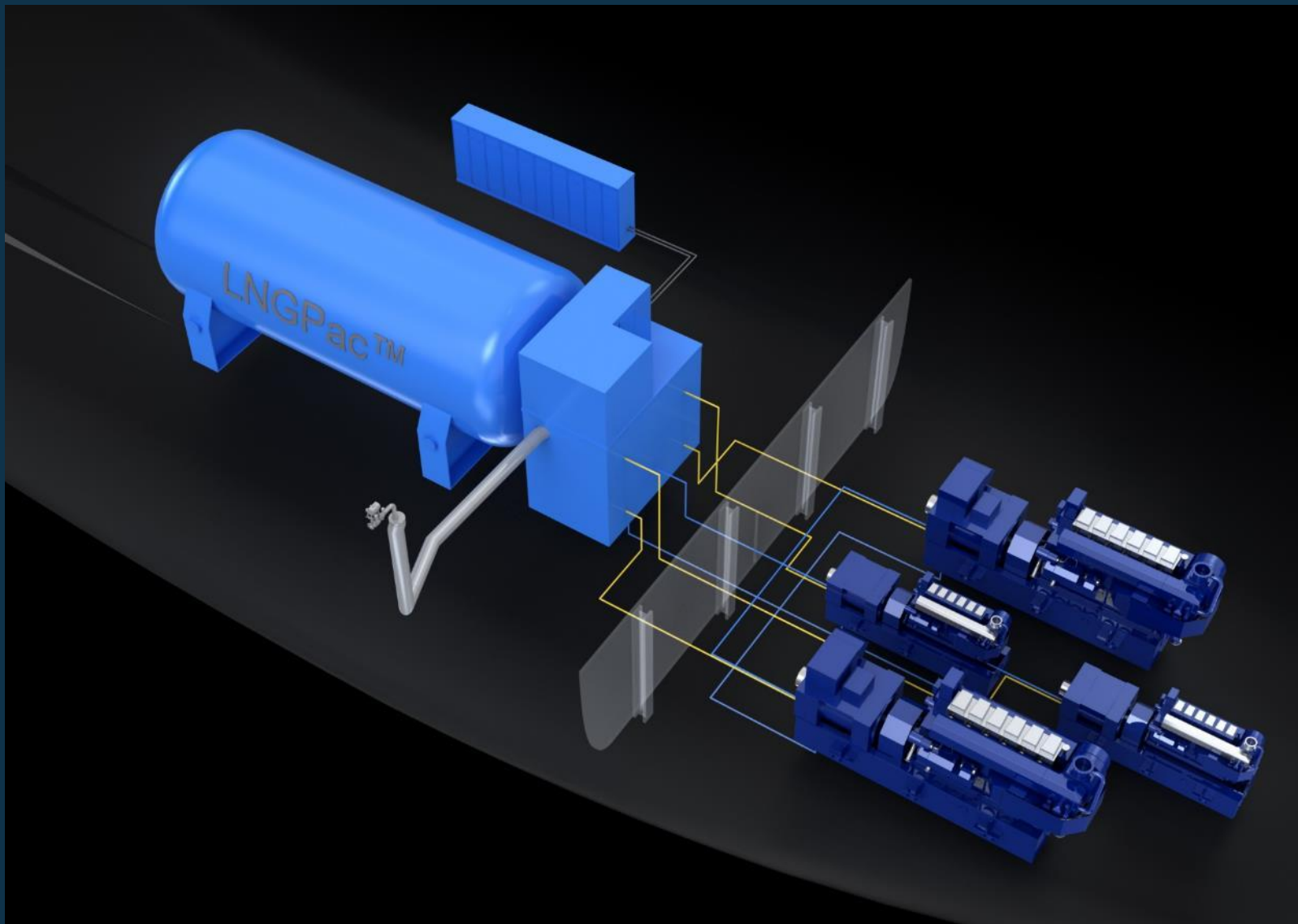
Cumulative distribution of LNG fuel gas vessels fitted with Wärtsilä LNG Fuel gas system



* Includes also LNG fuel gas tank deliveries of Hamworthy as cargo or tank handling system

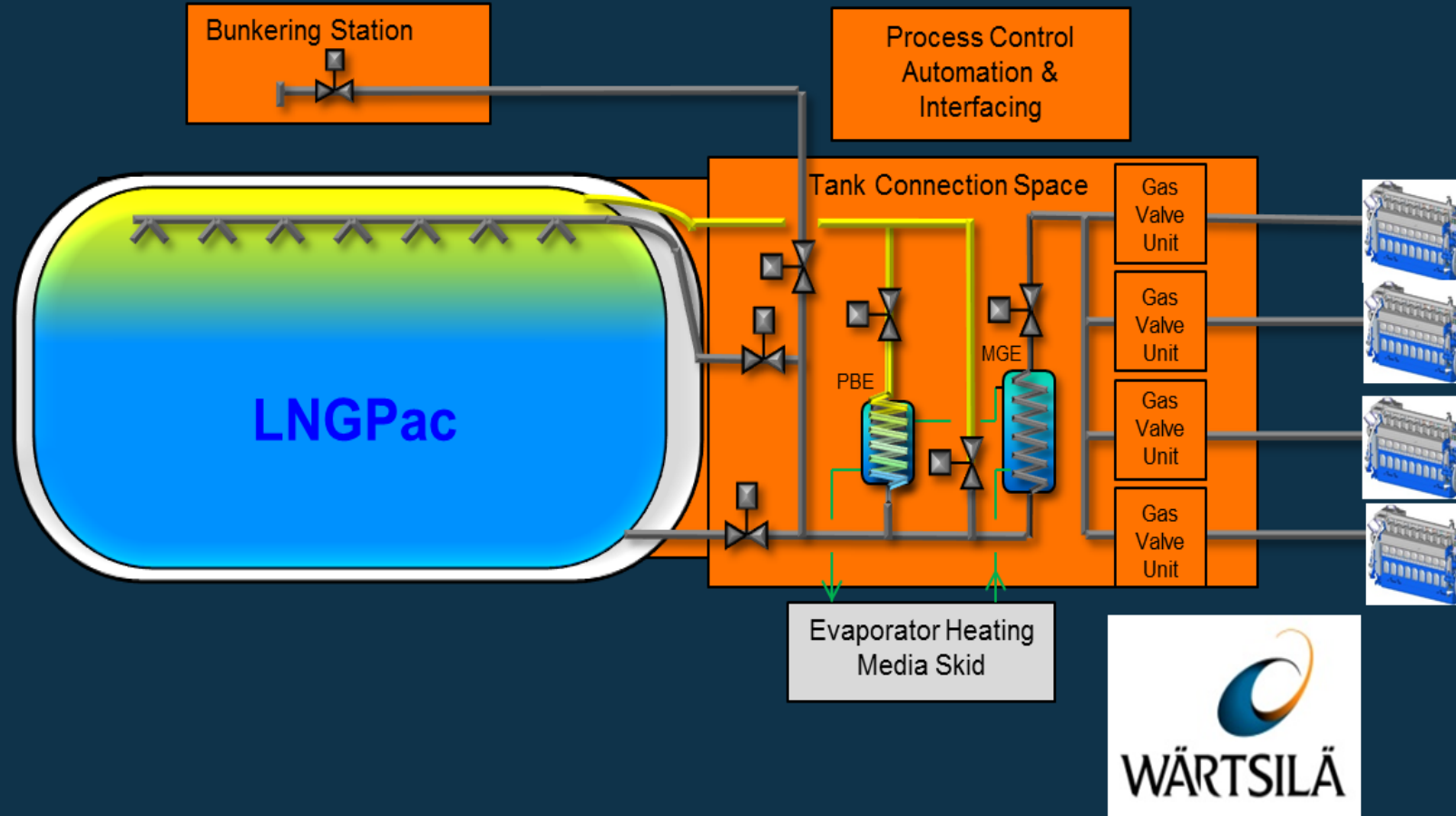
IMO C-type LNG-tank	Double-wall tank	Single-wall tank	
LNG Volume	25 – 300 cbm	300 – 5000 cbm	500 – 5000 cbm
Dmax (2 < L/D < 7)	6.5 m	10 m	10m
Design pressure	4 – 9 barg	4 – 7 barg	4 – 7 barg
Insulation	Vacuum	PUR	PUR
Tank type	Single lobe	Single/Bilobe	Multilobe
Positioning	Horizontal or Vertical, Top- or Below-deck		
Secondary barrier	Not required		
Bunkering capacity (DN 50-200)	40 – 1000 cbm/h		

50m³ to 250 m³

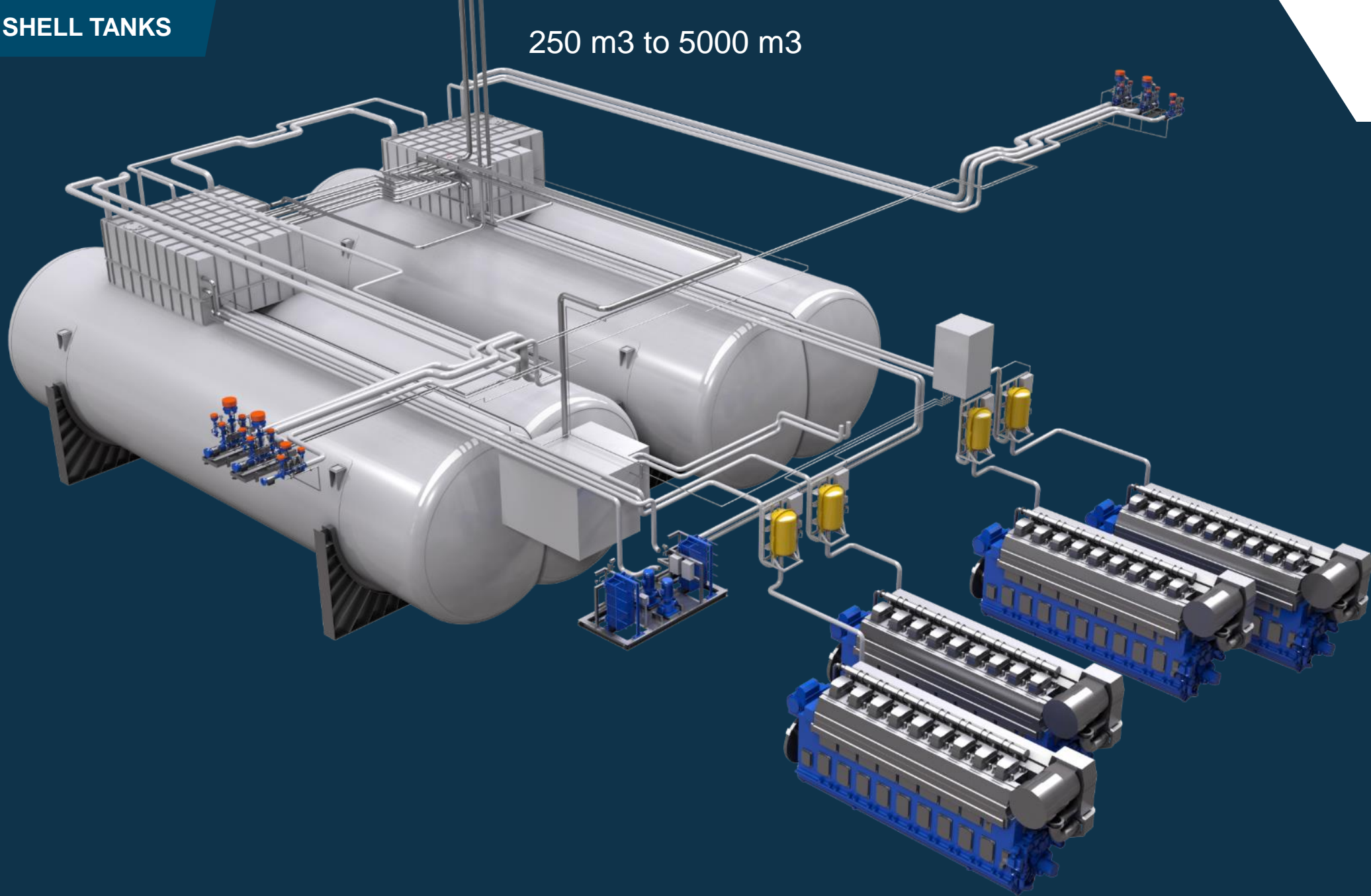


DOUBLE SHELL TANKS

50m³ to 250 m³

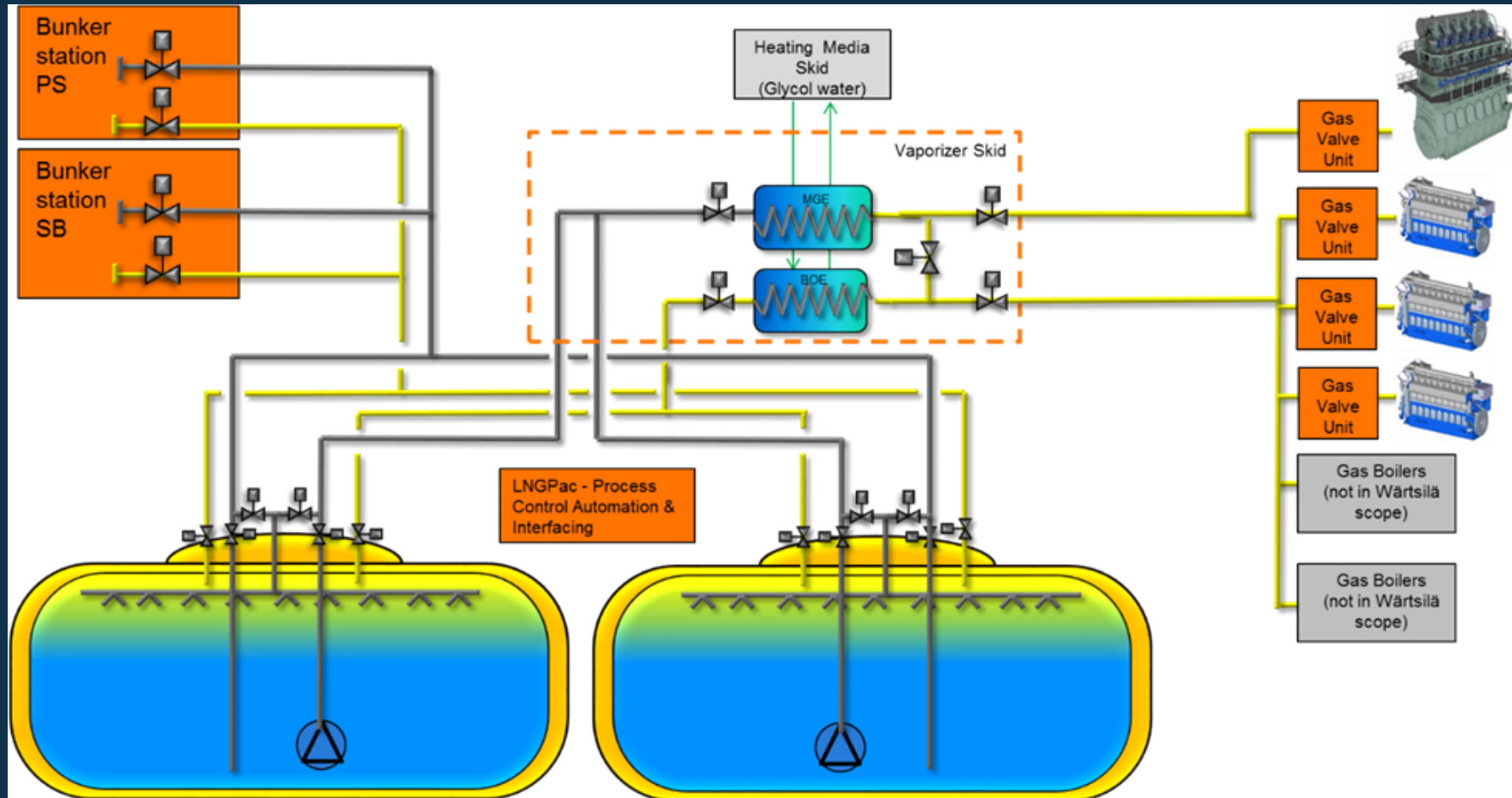


250 m3 to 5000 m3



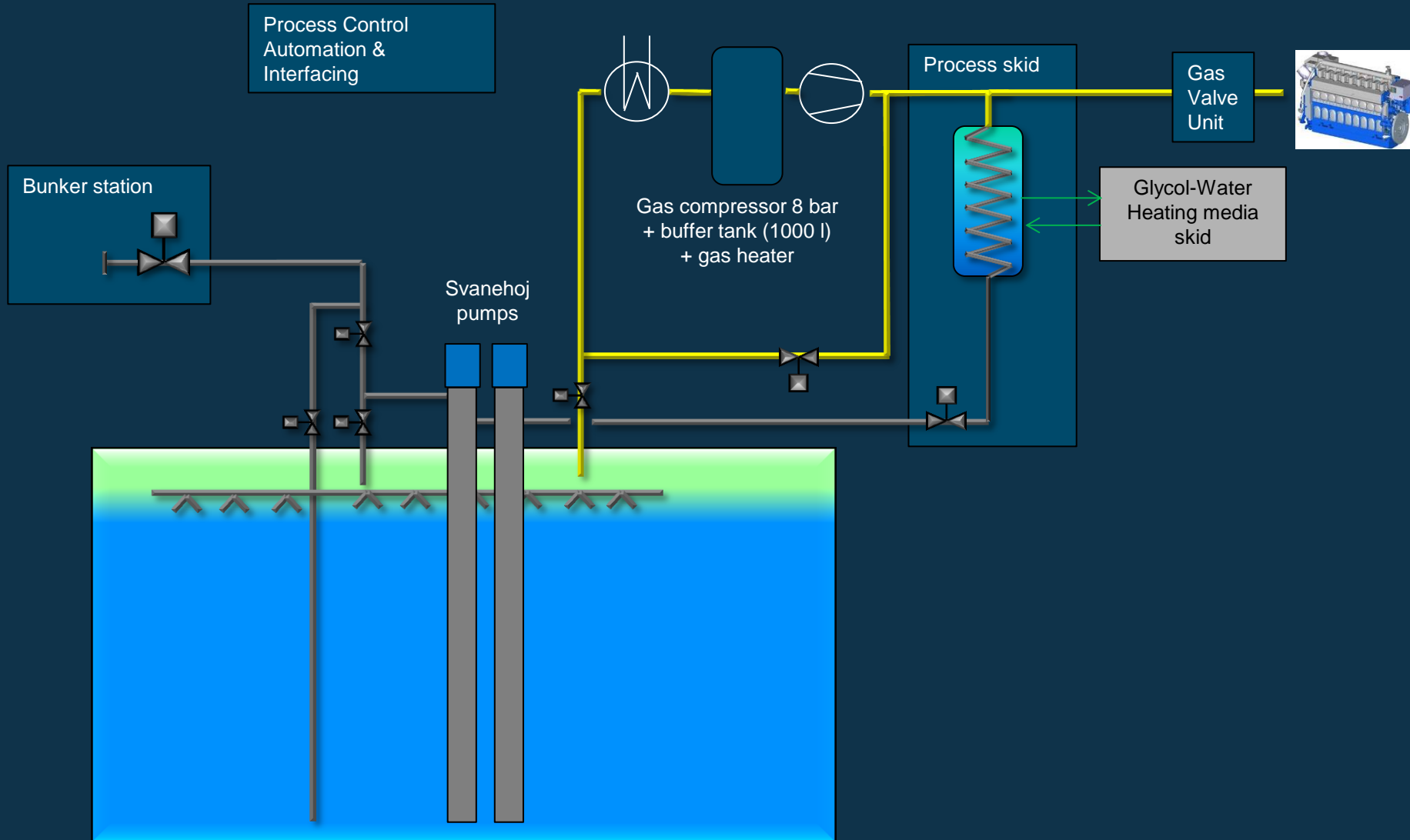
SINGLE SHELL TANKS

250 m³ to 1500 m³



PRISMATIC TANKS

3000 m3 and above





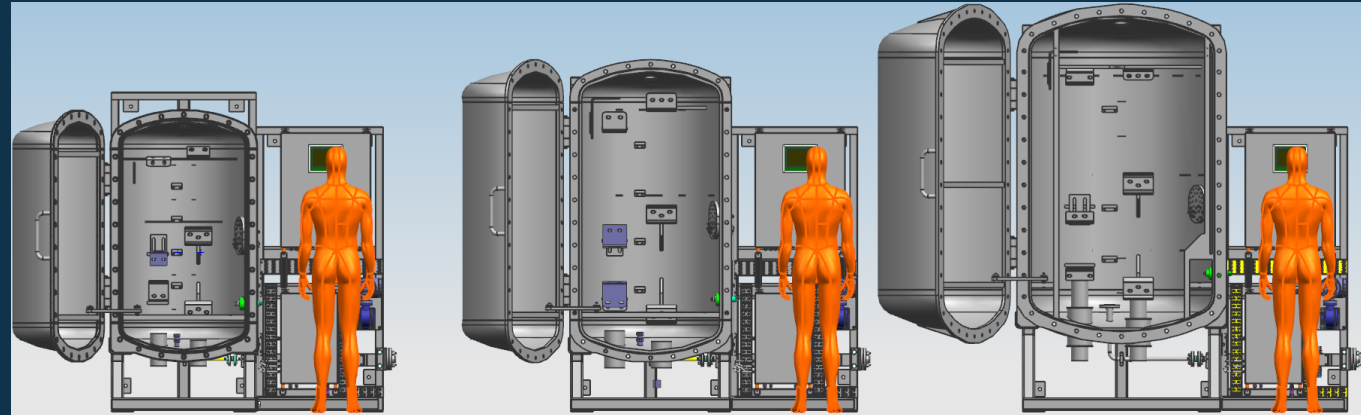
Wärtsilä Gas Valve Unit enables:
Efficient space utilisation
Fewer interfaces
Increased reliability

Unit sizes in Scale

Designs

GVU-ED

- Enclosed design
- Installation in safe area



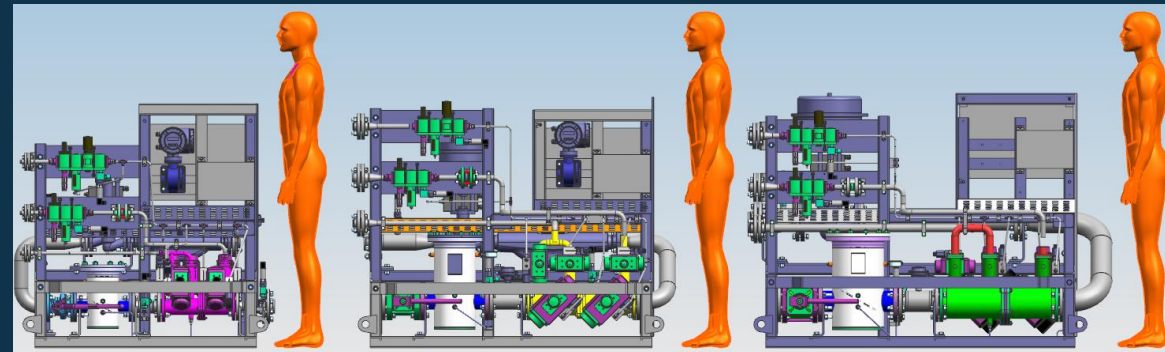
DN50

DN80

DN100

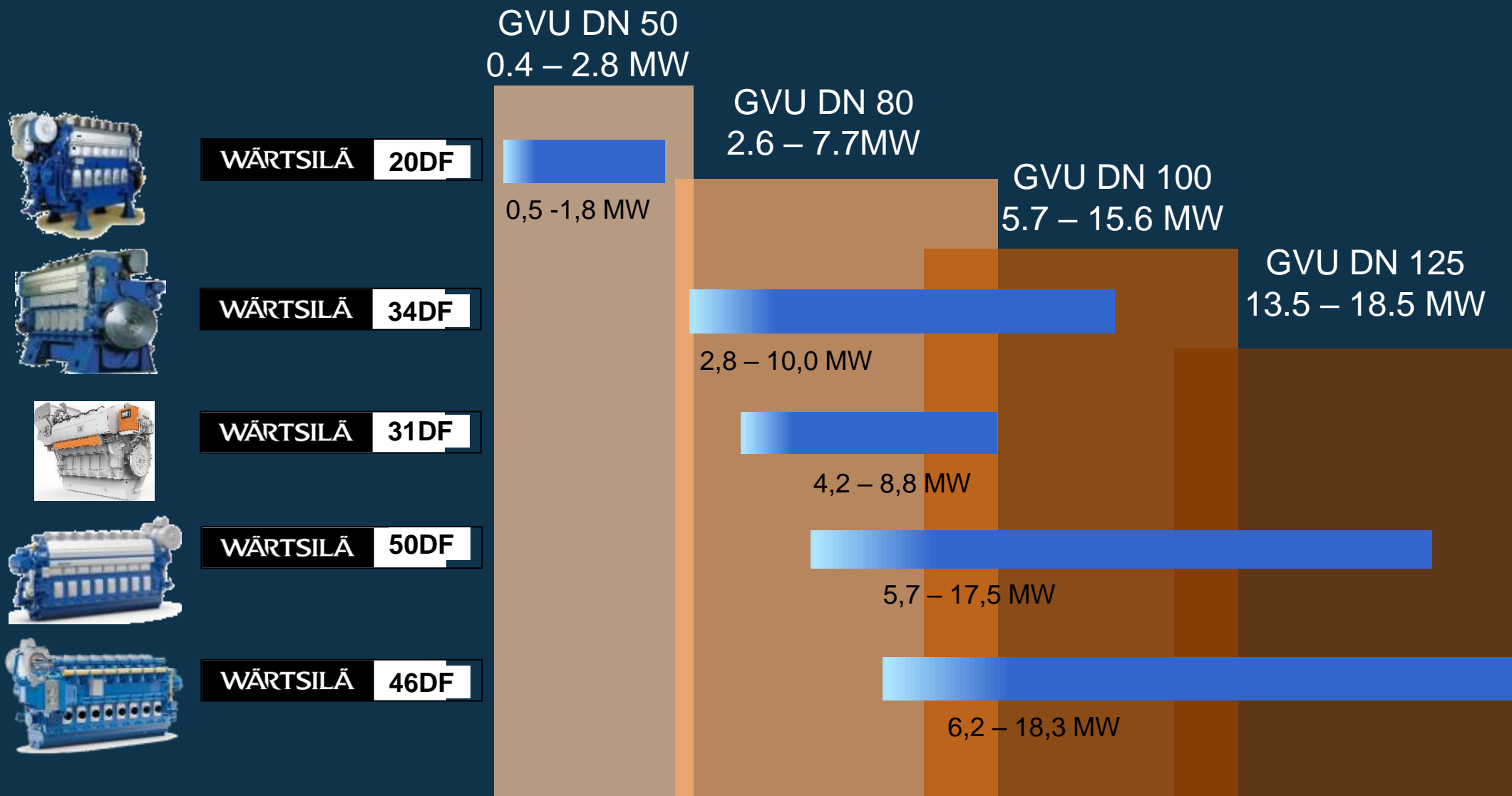
GVU-OD

- Open Design
- Installation in dedicated area (hazardous area zone 1)



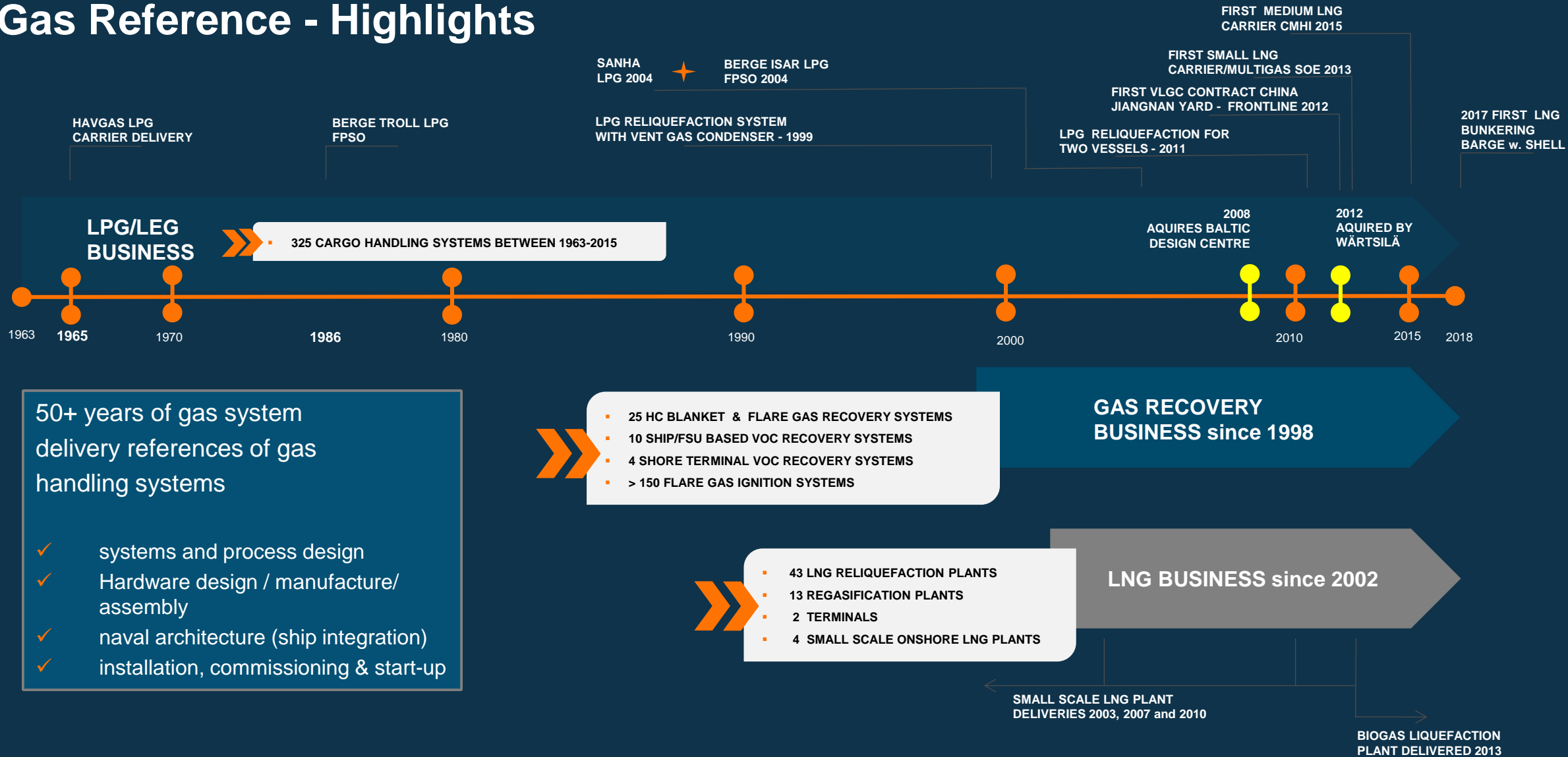
Both type of designs are available for

- 2-stroke engine applications
- 4-stroke engine applications



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Gas Reference - Highlights



50+ years of gas system delivery references of gas handling systems

- ✓ systems and process design
- ✓ Hardware design / manufacture/ assembly
- ✓ naval architecture (ship integration)
- ✓ installation, commissioning & start-up

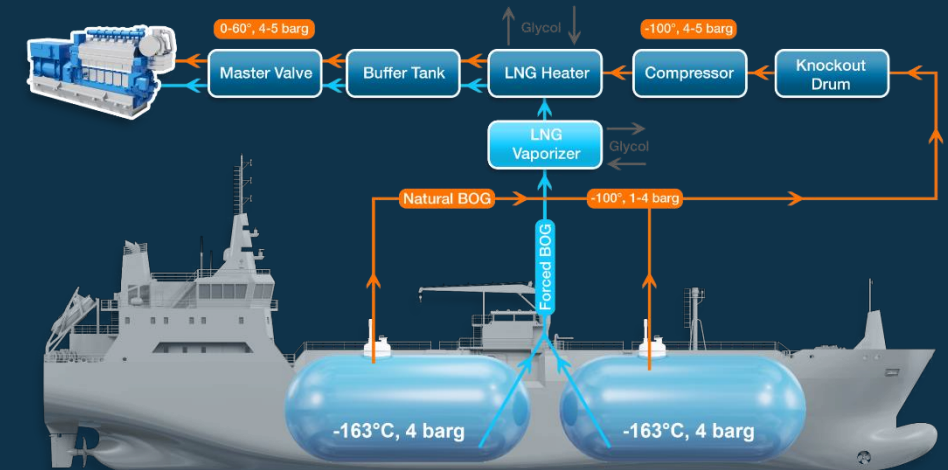
LNG will evaporate at -163°C , and will expand with increasing temperature. Expansion and boil-off gas needs to be handled by onboard systems

BOG Management Options

1. Pressure build-up; warm LNG and high pressure?
2. Fuel supply to engines; changing composition?
3. Reliquefaction; CAPEX,
4. Gas Combustion Unit; flexible, changing composition, uneconomical?

Considerations

- Required voyage time?
- LNG Quality?
- Supply requirement of LNG (temperature / pressure)?
- Loading limit requirements?
- Size / type / number of engines and fuel demand?
- Tank design pressure?
- Vapour management and vapour return?



Case study: 3k LNG Bunkering Barge for European Inland Water Ways

Owner	LNG Shipping (Victrol and CFT)	Cargo tanks	Cylindrical 4x750 CBM
Type	LNG Bunkering Barge	Cargo tanks insulation	Vacuum / perlite
Cargo	LNG	Tank pressure	4 barg
Financier	Shell	Loading limits	MARVS / Trading patterns
Ship Size	3 000 CBM	Boil-off rate (BOR)	0.2 %
Shipyard		BOG Management	Subcooling / pressure build-up
Scope of supply	<ul style="list-style-type: none"> Cargo Handling System Cargo Tanks LNG Metering system 	Loading rate	1000 m ³ /hr
Ship design	INEC	Bunkering rate	Up to 660 m ³ /hr
Class	BV	Nitrogen system	Membrane / shore
Ship dimensions (LxBxD)	110 x 15 x 11 m	Custody Transfer	Static + dynamic
Delivery	2018		





The design is a pressure tank allowing Boil-off Gas (BOG) handling by pressure build-up. Tanks are delivered with insulation.

Typical types of tanks:

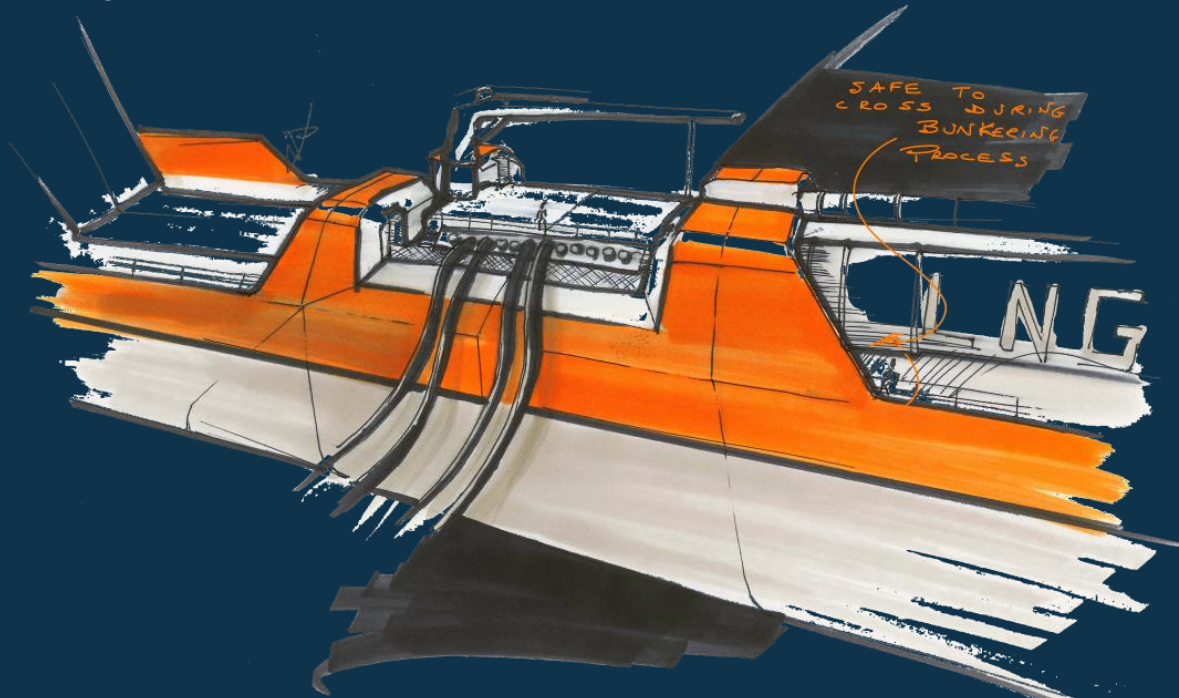
- C-Type Cylindrical for LNG carriers up to 15000m³
- C-Type Bilobe for LNG carriers up to 30 - 40000m³
- LNGPac solutions - LNG fuel tanks with integrated Tank Connection Space

<https://www.youtube.com/watch?v=0WbbfAIC-7I>

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Wärtsilä Ship Design develops your new **DESIGN CONCEPT** to meet market needs

- Increase crew comfort and safety
- Understanding customers needs and how to improve their business model
- Uses of new technologies
- Challenging status quo in the market perception of ship designs



VALUE CREATION

WSD59 3K

3,000m³ Coastal LNG Bunkering Vessel



CO₂



- Wärtsilä 6L20 DF main generators for **maximum fuel savings** and reduced environmental footprint



- **Optimized hull and propulsion design**

LNG



- Efficient cargo handling arrangement and reduced ballast water capacity



- Safe and crew friendly environments



- Responsibility centralised on a single supplier for equipment and design



- Smart maintenance and reduced operating costs

IWW LNG TANKERS

WSD50 1.8K



WSD50 3.6K



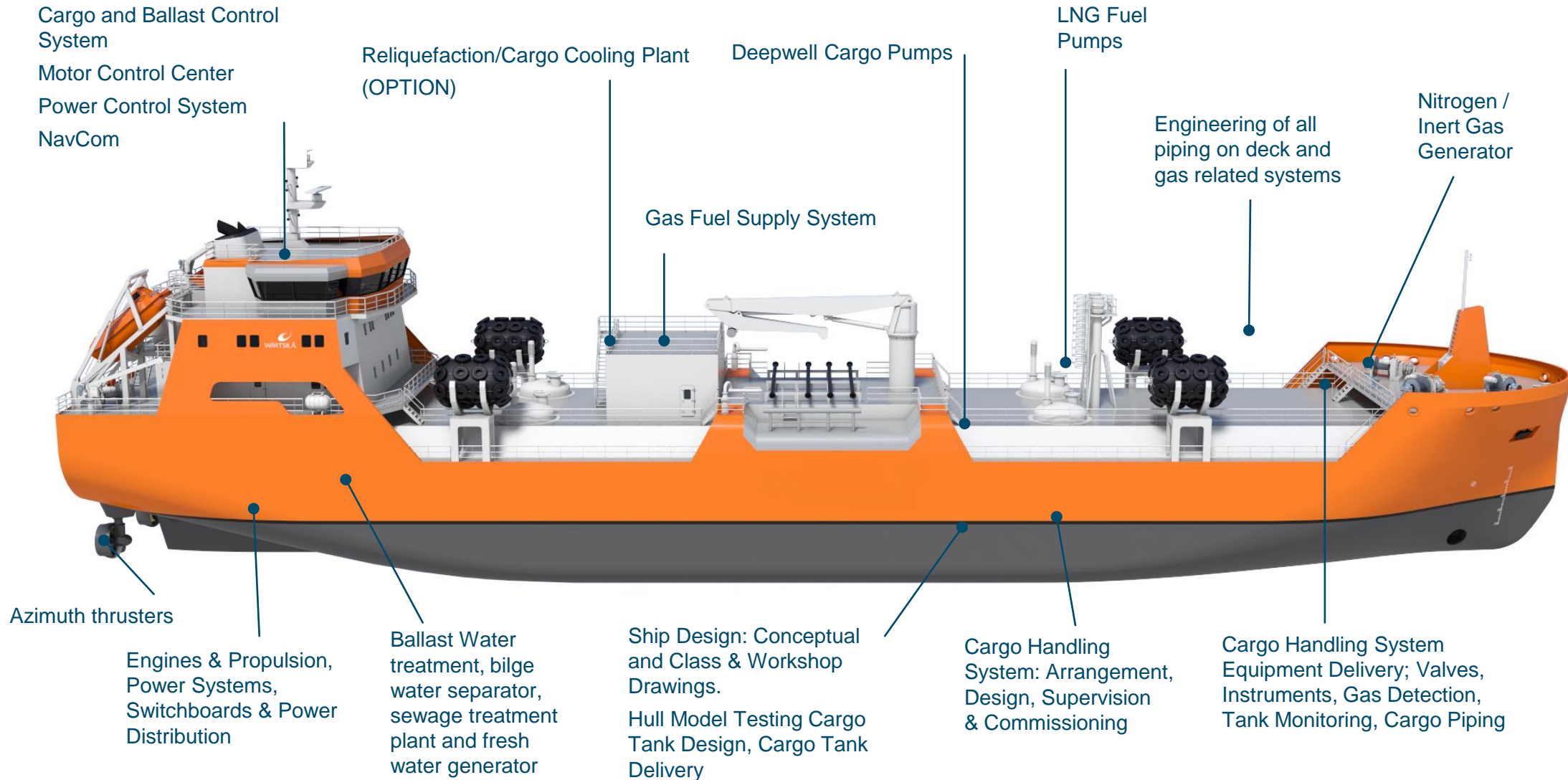
WSD50 4.8K



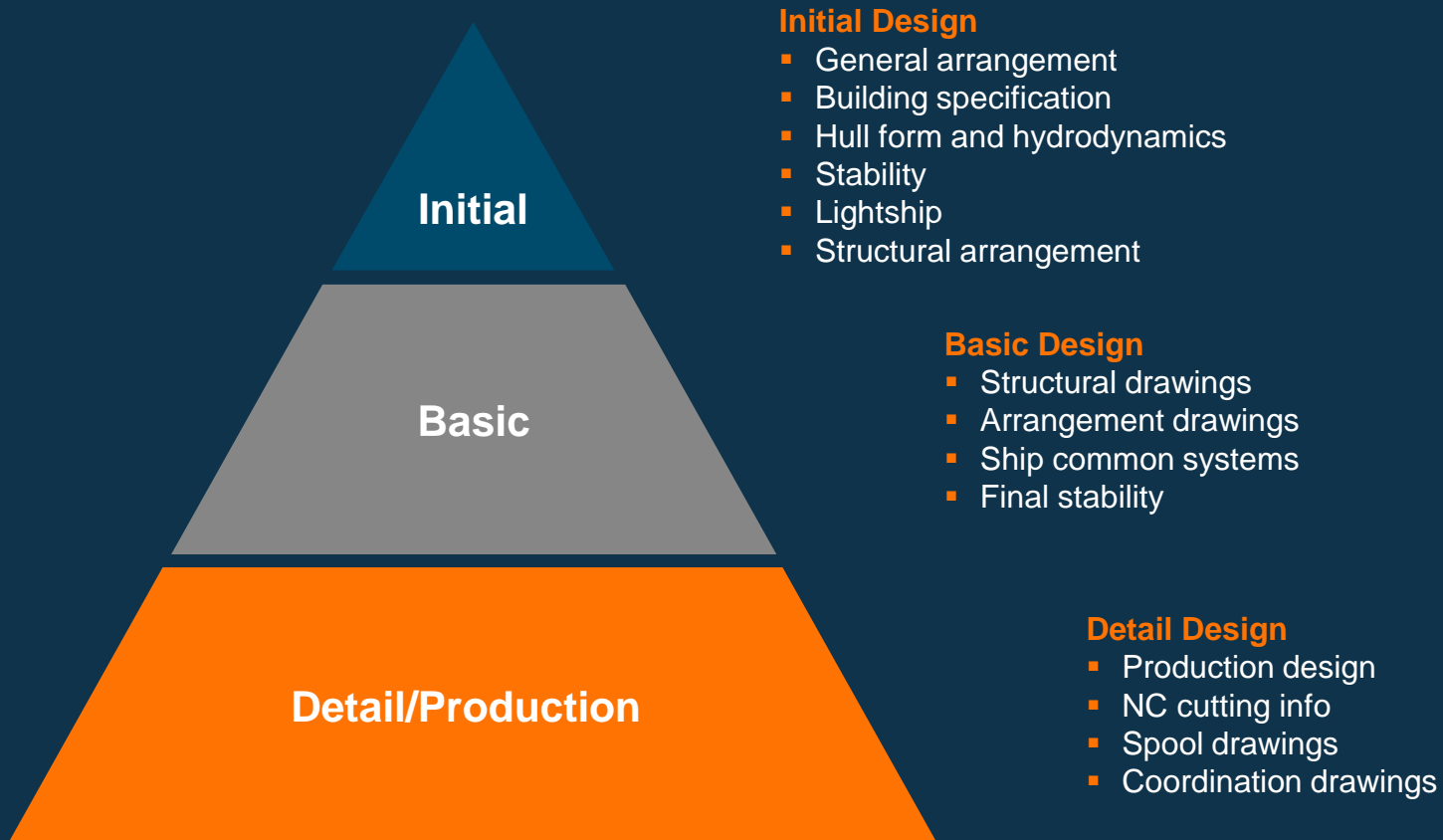


Main parameters

Length o.a., LOA	109.90 m	Draught Design, T_d	2.70 m
Length b.p., LBP	107.35 m	Deadweight @ T_d	1,050 t
Breadth, B	11.40 m	Main Engine 1x6L20DF	1,665 kW
Depth, D	5.66 m	Service speed @ T_d , 90% MCR, 15% SM, no restricted depth	20 km/h
Cargo capacity, 100% fill	1,850 m ³	Daily Consumption LNG	4,2 t



COMPLETE DESIGN SCOPE



Risk Management & efficiency



PRODUCT & ENGINEERING

- Less interface points
- E&A - fully integrated cargo handling & ship control
- Coordinated vessel and product development
- Wide range of BOG management solutions

PROJECT EXECUTION

- Avoid change order after contract
- Core competence of Gas Handling Systems within Wärtsilä Ship Design Team
- Wartsila as single project partner
- Save time by optimizing the engineering schedule

VESSEL OPERATIONS

- Streamlined digital operating system
- Userfriendly manual operations
- Fully automated engine management and cargo handling online performance reporting

We enable customer success by reducing risks related to time, cost and quality of construction through professional planning, communication and stakeholder management.

Over 50% of Wärtsilä business is run as projects

Over 3,000 projects under execution annually

Over 2,000 people involved in project management

Over 1,700 PMIS / PM Tool users

Over 300 certified project management professionals

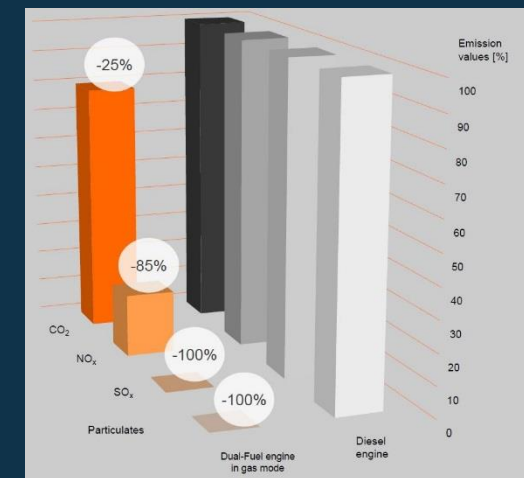
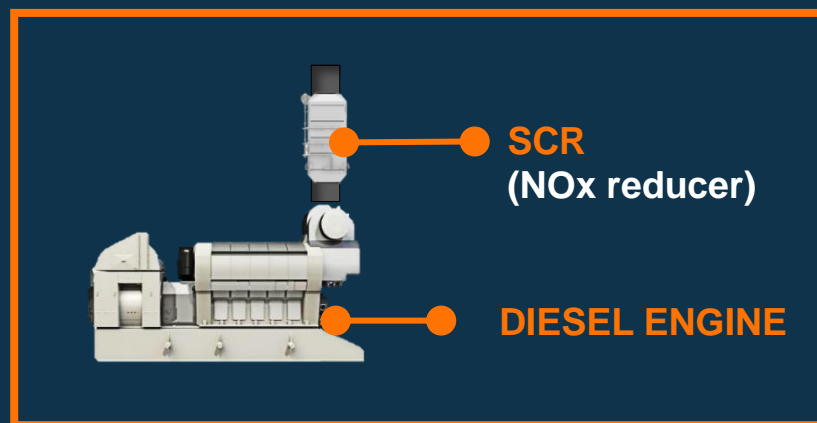
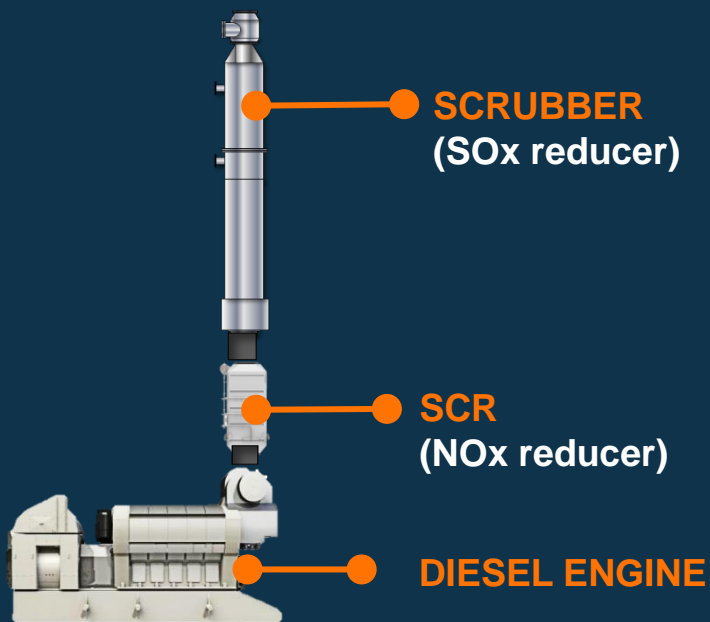
Operations in over 70 countries in 300 locations

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... running on **HFO/MDO**
(S > 0,1%)

... running on **MGO**
(S < 0,1%)

... running on **LNG**



IMO TIER III	No need for after treatment devices to be installed
SOx compliant	
EPA compliant	

- The Wärtsilä NO_x Reducer (NOR) is designed by Wärtsilä and is based on selective catalytic reduction (SCR) technology.
- The NOR is optimized and validated for Wärtsilä medium speed engine portfolio for marine applications in terms of reliability, flexibility and size. It is available for both newbuild and retrofits and is compatible for operation on both distillate and heavy fuel oils.

Injection and Mixing unit



Reactor



Soot blowing unit

Catalyst elements



Control unit



Pump unit



Air unit



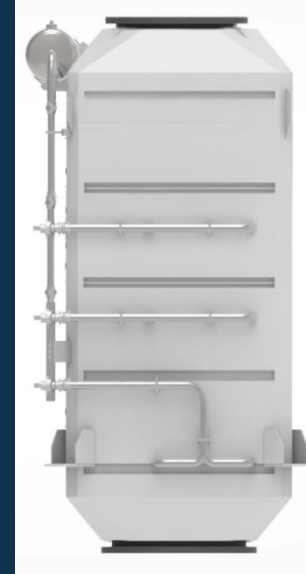
Dosing unit



Short and wide 2 layers vertical reactor



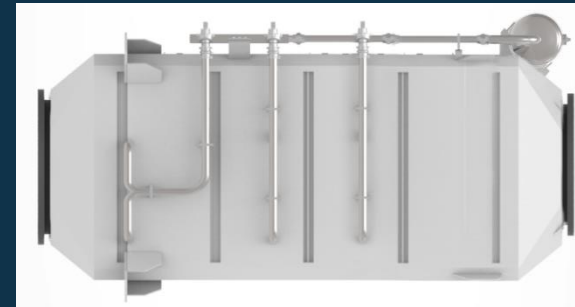
Long and narrow 3 layers vertical reactor



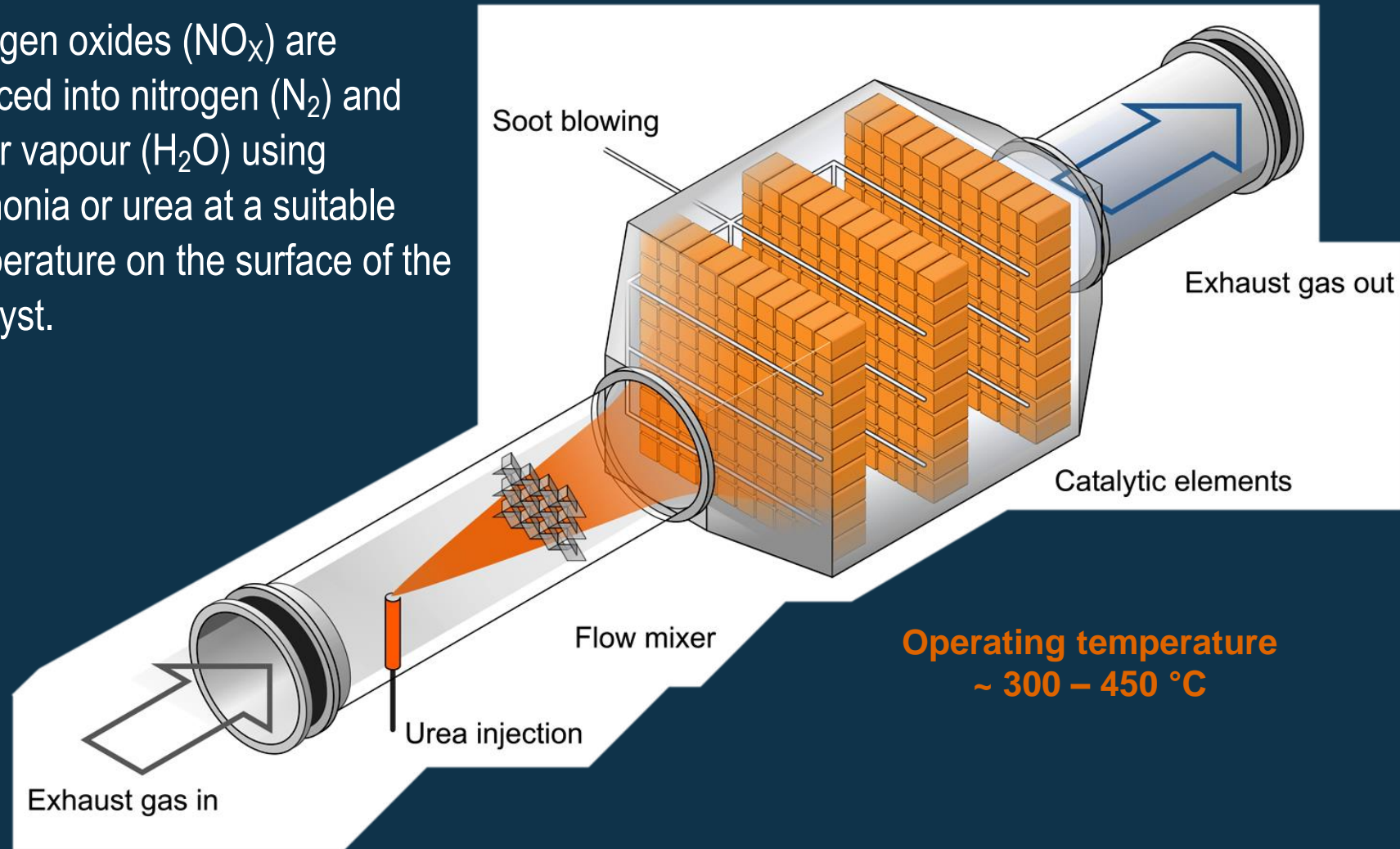
Short and wide 2 layers horizontal reactor

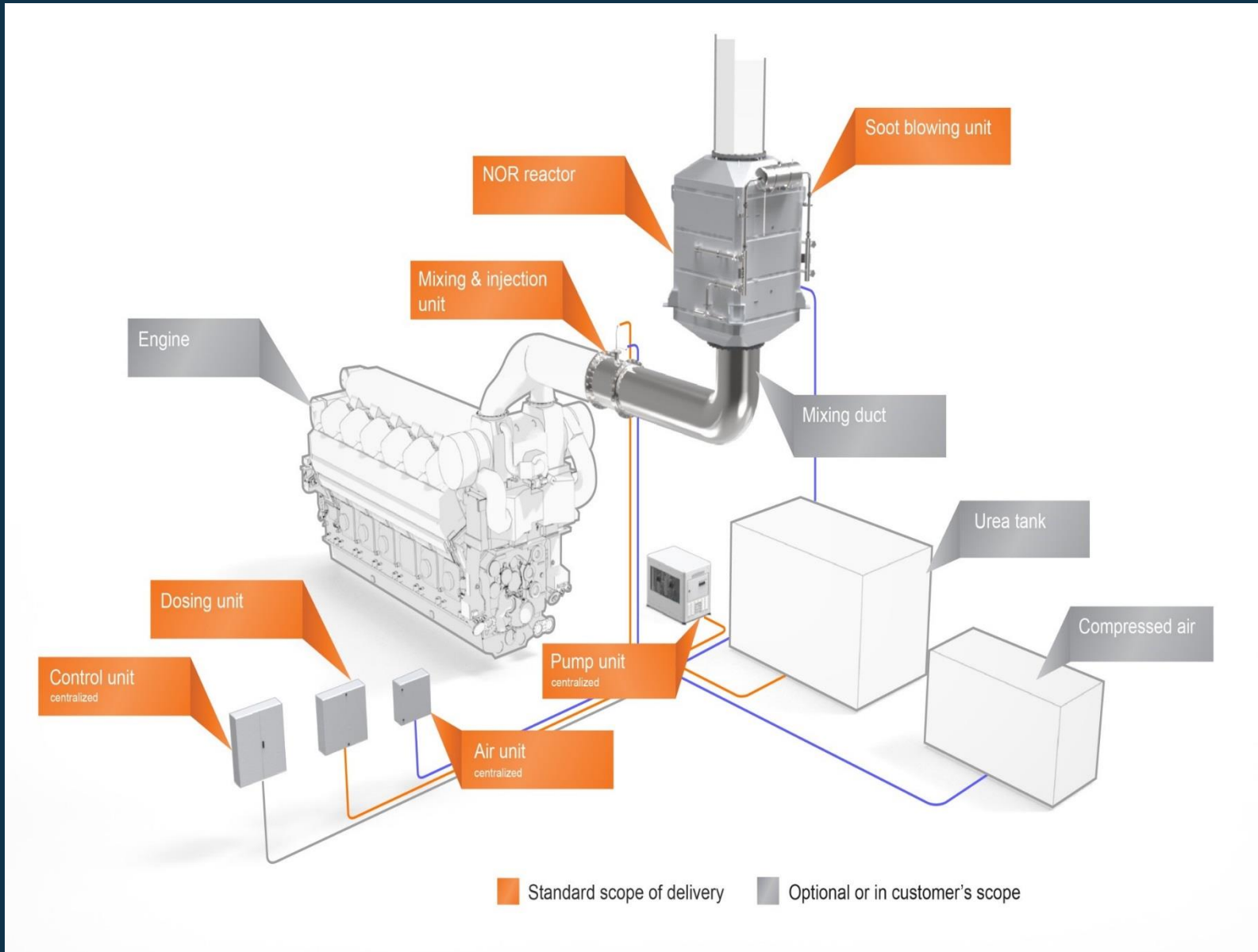


Long and narrow 3 layers horizontal reactor



Nitrogen oxides (NO_x) are reduced into nitrogen (N₂) and water vapour (H₂O) using ammonia or urea at a suitable temperature on the surface of the catalyst.



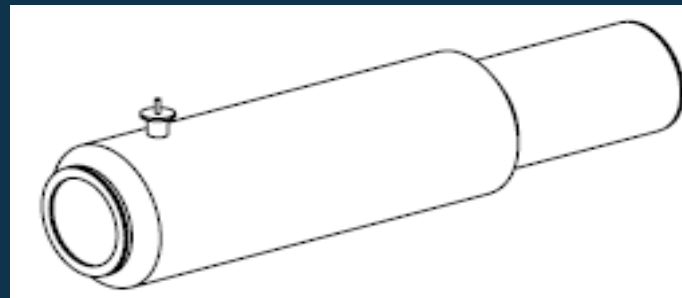


- ✓ Integrated SCR reactor with silencer
- ✓ Integrated mixing duct and silencer
 - Double pipe containing a reactive silencer element
 - tuned at the ignition frequency of an engine
- ✓ Benefits:
 - Utilizes the mixing duct length for sound attenuation
 - Optimize installation and save space

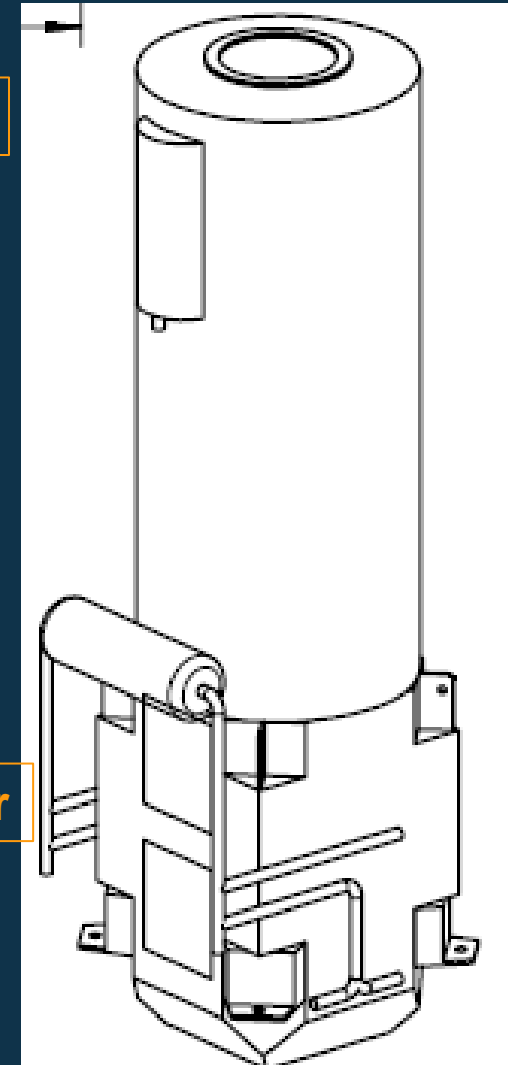
Integrated spark arrestor

Integrated silencer

SCR reactor



Mixing duct silencer



THANK YOU!

Krzysztof Czerski

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Naval Architecture*

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