“THE SUSTAINABLE SOLUTION FOR DREDGING”.

MID 8 SEPT 2014

BY CARLO CONTESSI

WÄRTSILÄ

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1. Why looking for (fuel) alternatives

2. Dual Fuel sustainable on Dredgers
    1. Dual Fuel Design, Operation and Maintenance
    2. Dredgers applications typical aspects
    3. Wärtsilä dual fuel engine developments

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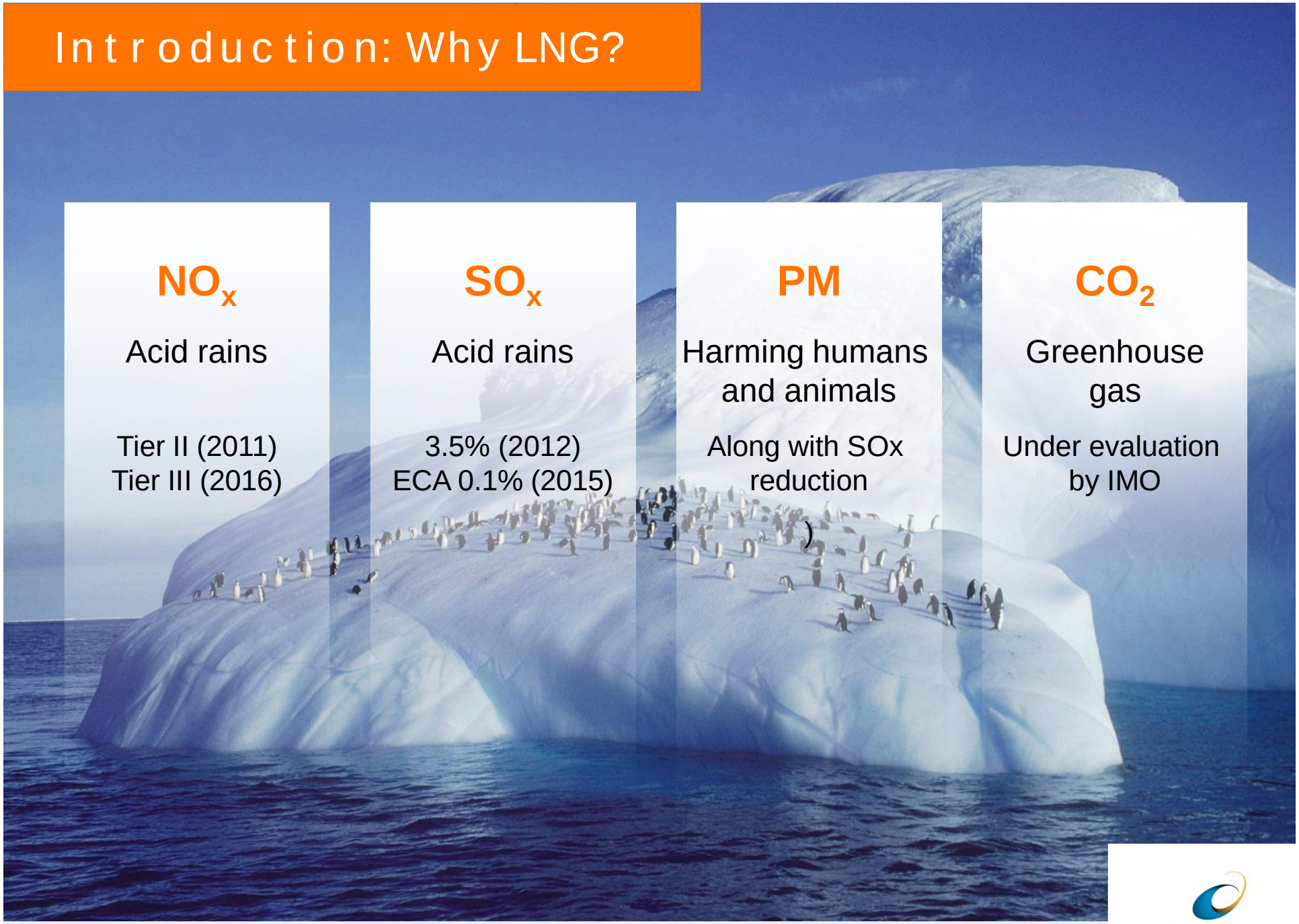
Introduction: Why LNG?



NO_x	SO_x	PM	CO_2
Acid rains	Acid rains	Harming humans and animals	Greenhouse gas
Tier II (2011) Tier III (2016)	3.5% (2012) ECA 0.1% (2015)	Along with SOx reduction)	Under evaluation by IMO

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Current and potential emission control areas

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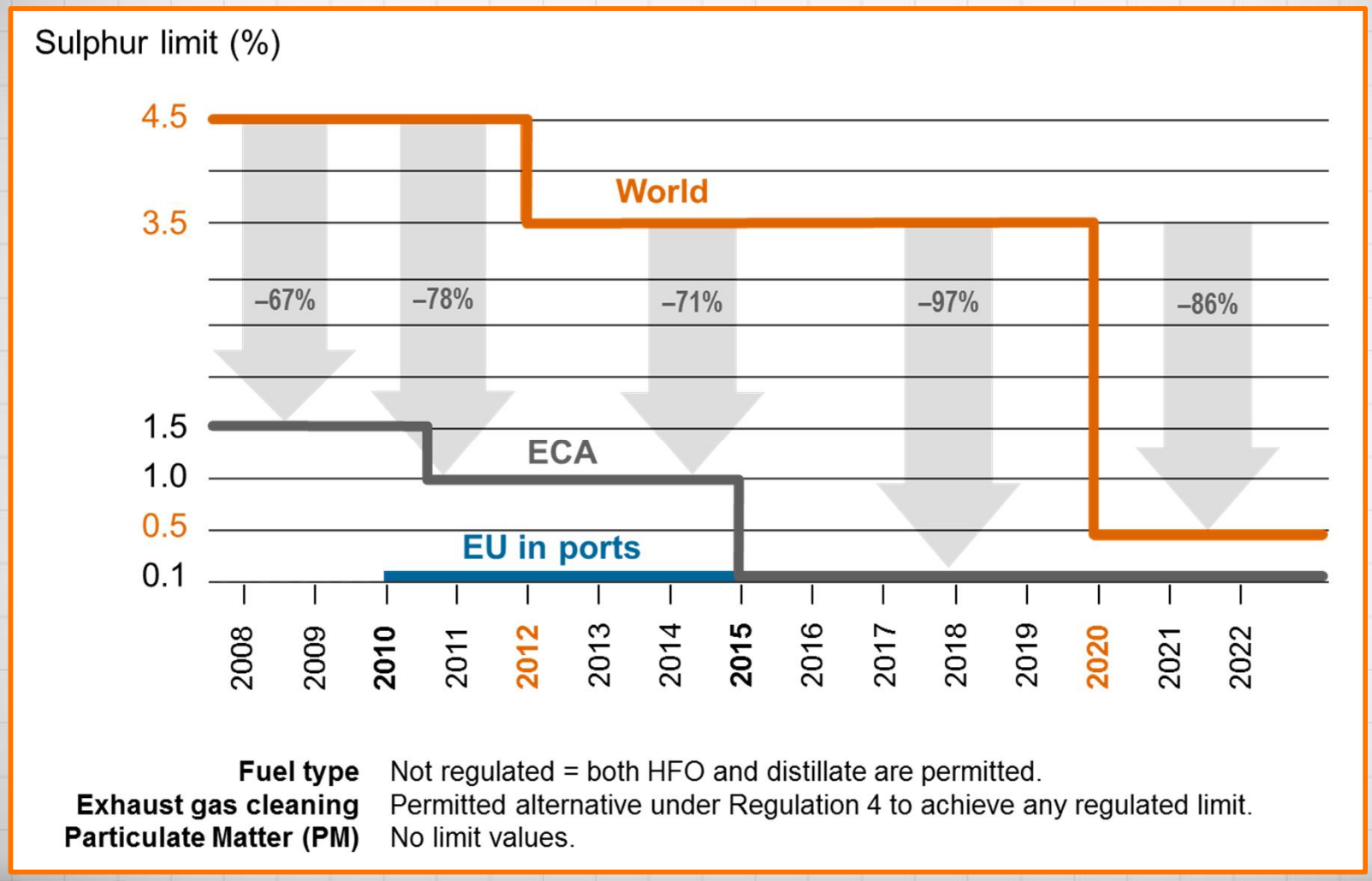
Introduction: Why LNG?



Fuel type	Not regulated = both HFO and distillate are permitted.
Exhaust gas cleaning	Permitted alternative under Regulation 4 to achieve any regulated limit.
Particulate Matter (PM)	No limit values.

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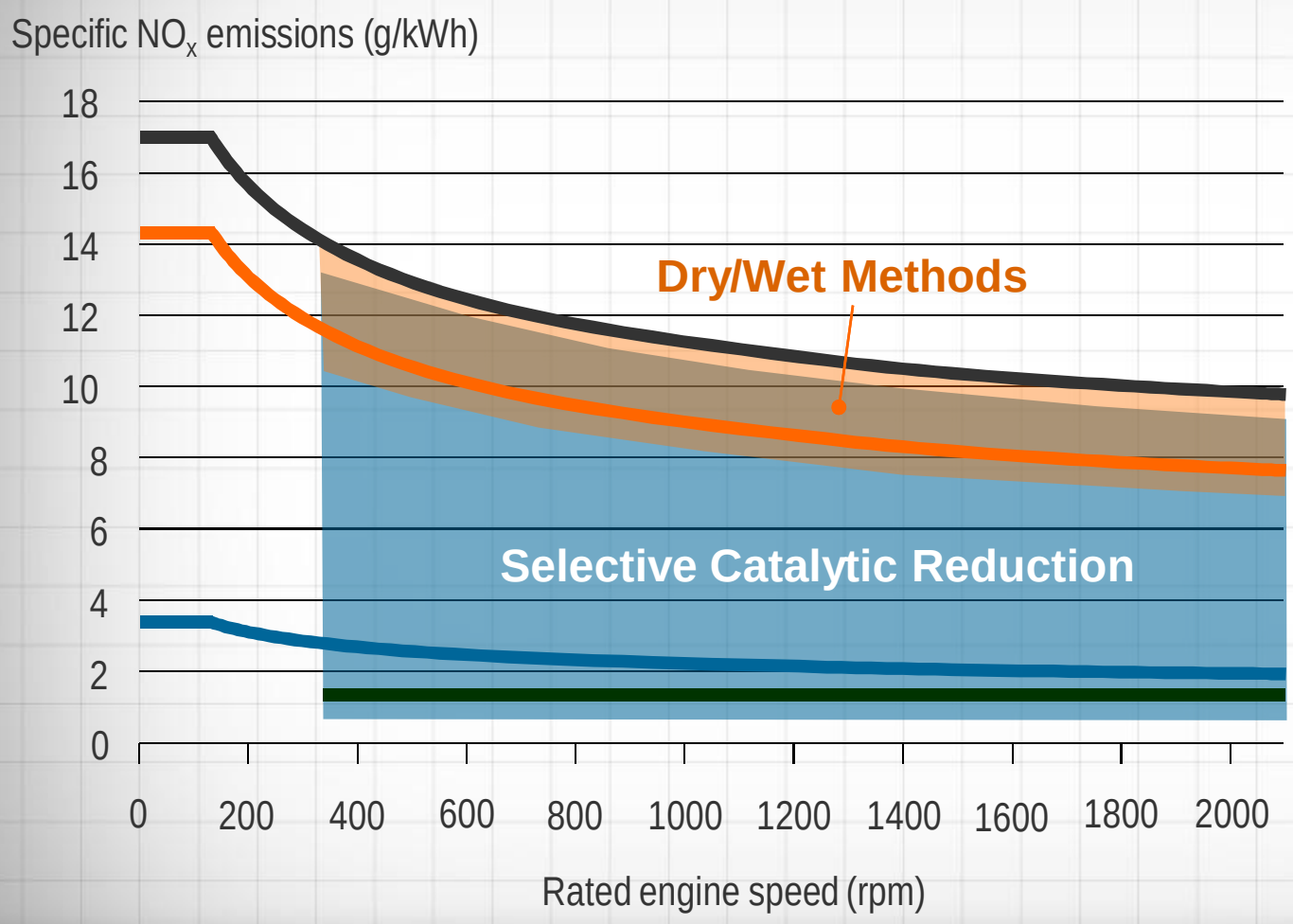
Introduction: Why LNG?



Tier I (present)

Ships built 2000 onwards
Engines > 130 kW

Retrofit: Ships built 1990 – 2000
Engines > 90 litres/cylinder and > 5000 kW

Tier II (global 2011)

Ships built 2011 onwards
Engines > 130 kW

Tier III (ECAs 2016)

Ships in designated areas, 2016 onwards
Engines > 130 kW

Wärtsilä dual-fuel technology

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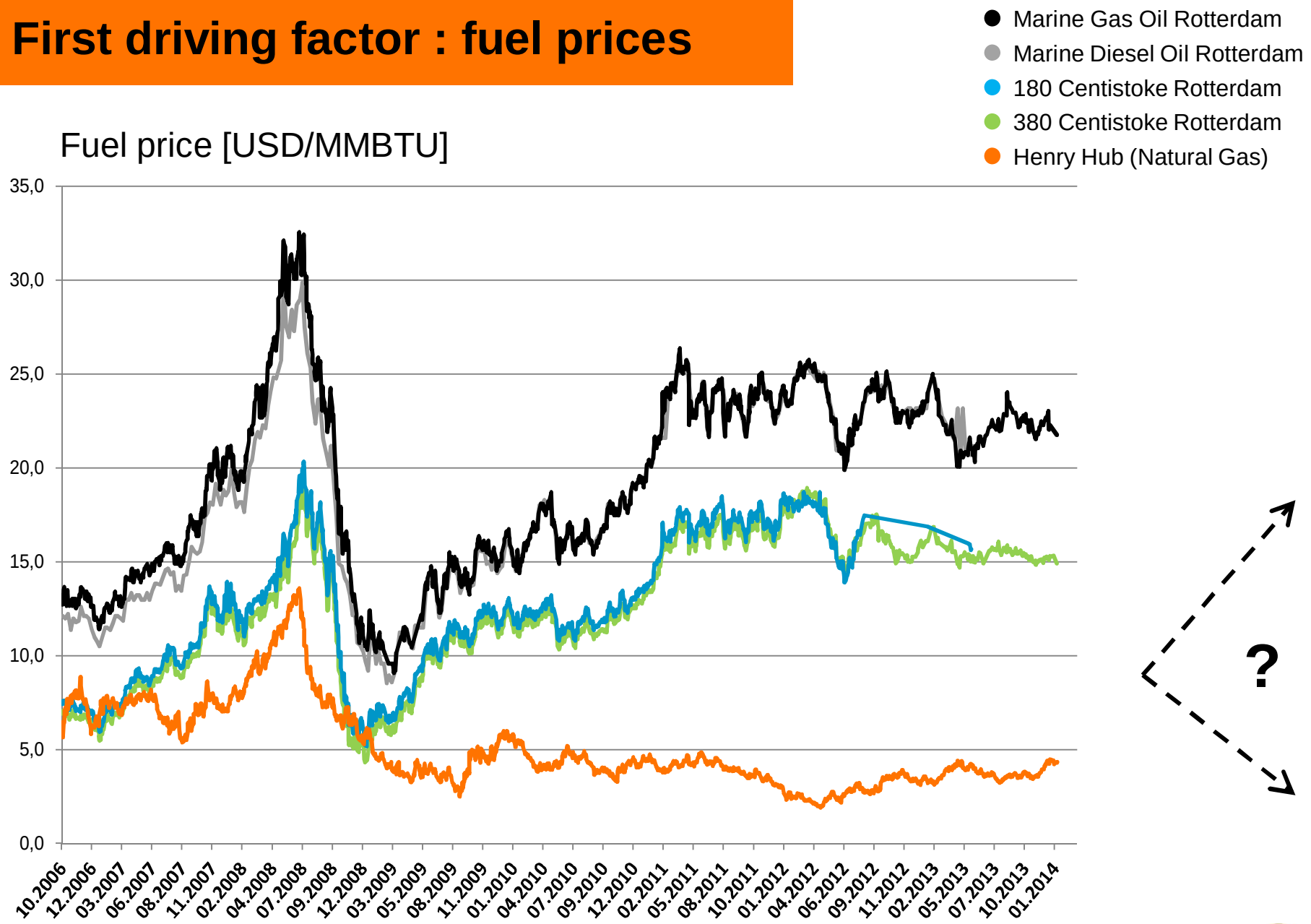
First driving factor : fuel prices



Source: bunkerworld.com; LNG OneWorld.com

Solutions to fulfil the limitations

... running on **HFO/MDO**

HFO/MDO
(S > 0,1%)

SCR
(NOx reducer)

SCRUBBER
(SOx reducer)

... running on **MGO**

MGO
(S < 0,1%)

SCR
(NOx reducer)

... running on **LNG**

DF-LNG

IMO TIER III
SOx compliant
EPA compliant

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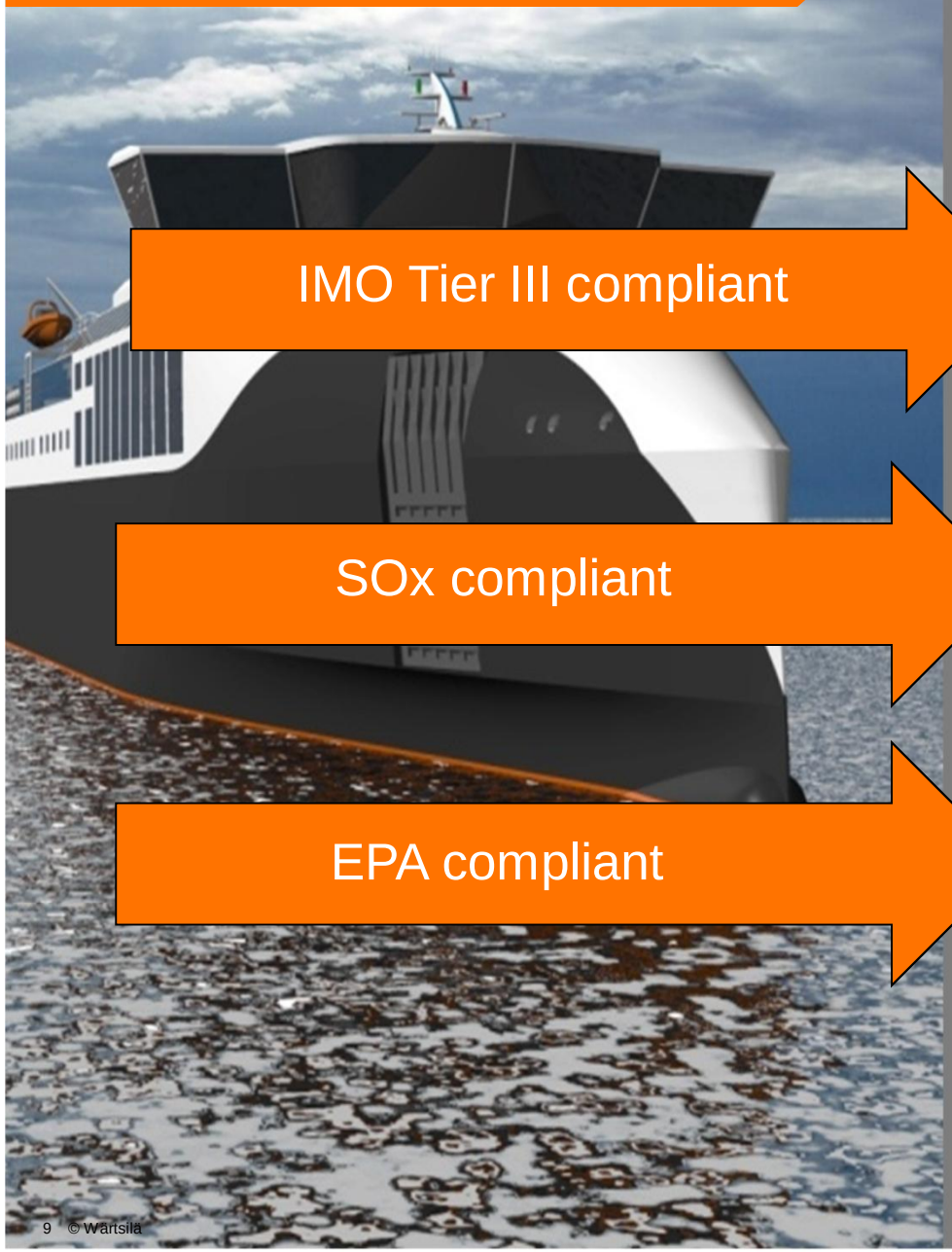
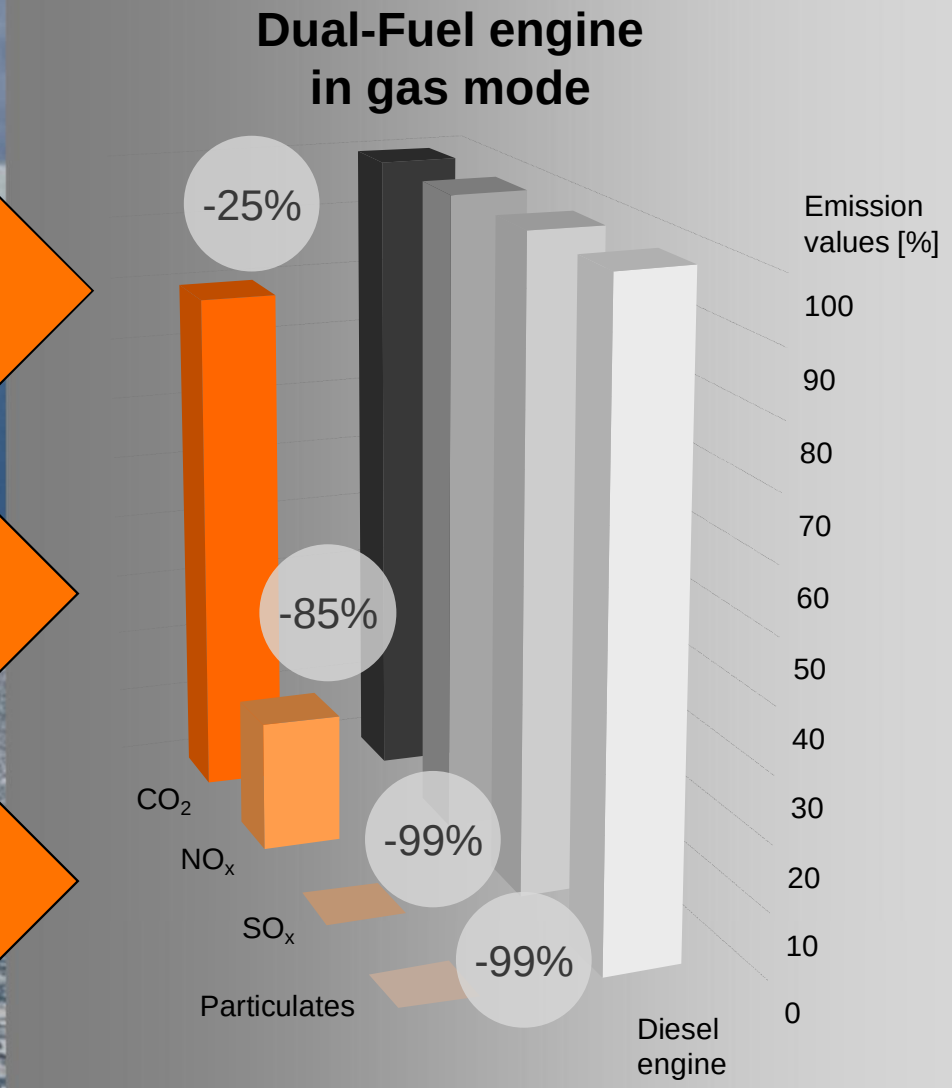
LNG ship - Emissions



IMO Tier III compliant

SOx compliant

EPA compliant



2. Dual Fuel sustainable on Dredgers

1. **Dual Fuel Design, Operation and Maintenance**
2. Dredgers applications typical aspects
3. Wärtsilä dual fuel engine developments

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LNG: DesIGn, RULES and Requirements

ISO- Bunkering guidelines

Different studies

DNV - GAS FUELLED ENGINE INSTALLATIONS

IMO – Resolution MSC.285(86) – Interim Guidelines on Safety for Natural Gas-Fuelled Engine Installations in Ships

IMO – IGF Code

LRS - Provisional Rules for the Classification of Methane Gas Fuelled Ships

IMO – IGC Code

GL - Guidelines on gas as a ship fuel
ABS - Guide for Propulsion and Auxiliary Systems for Gas Fueled Ships
BV - Safety Rules for Gas -Fuelled Engine Installations in Ships

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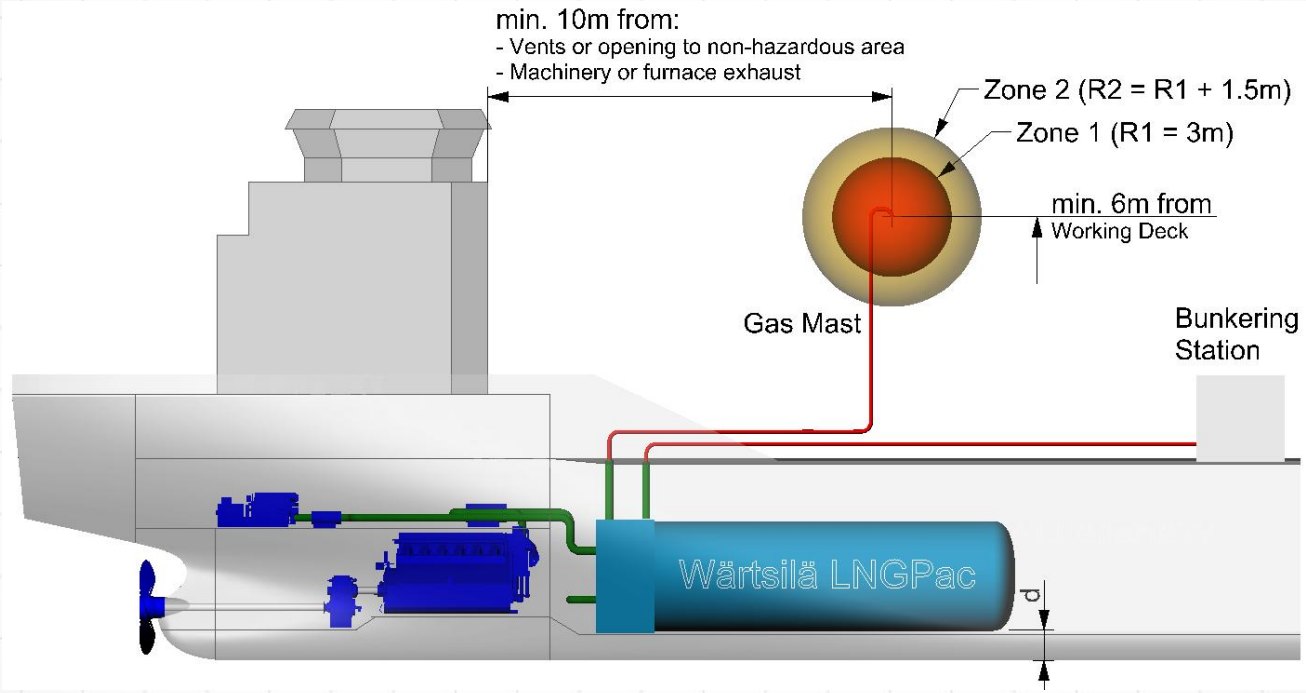
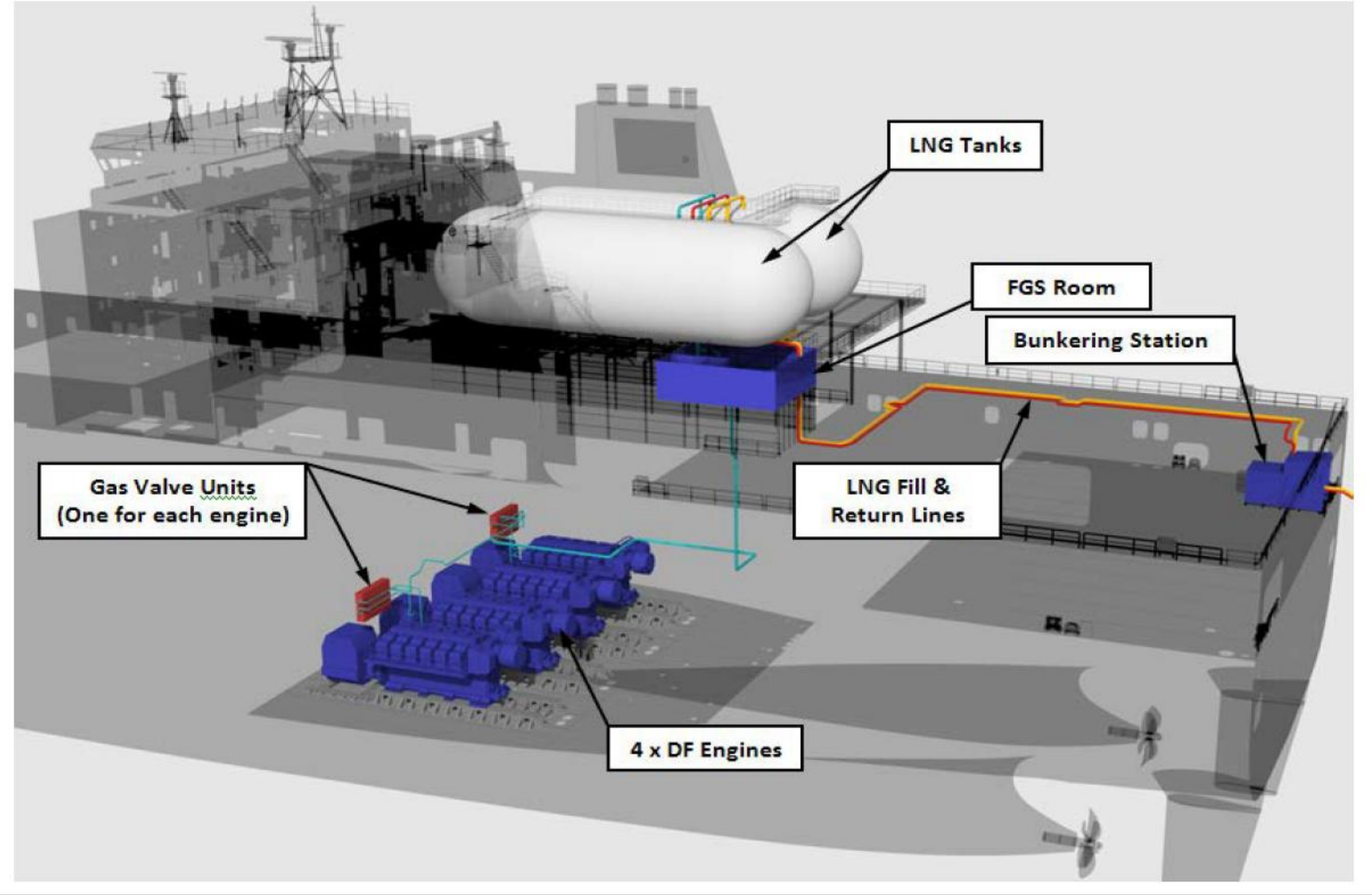
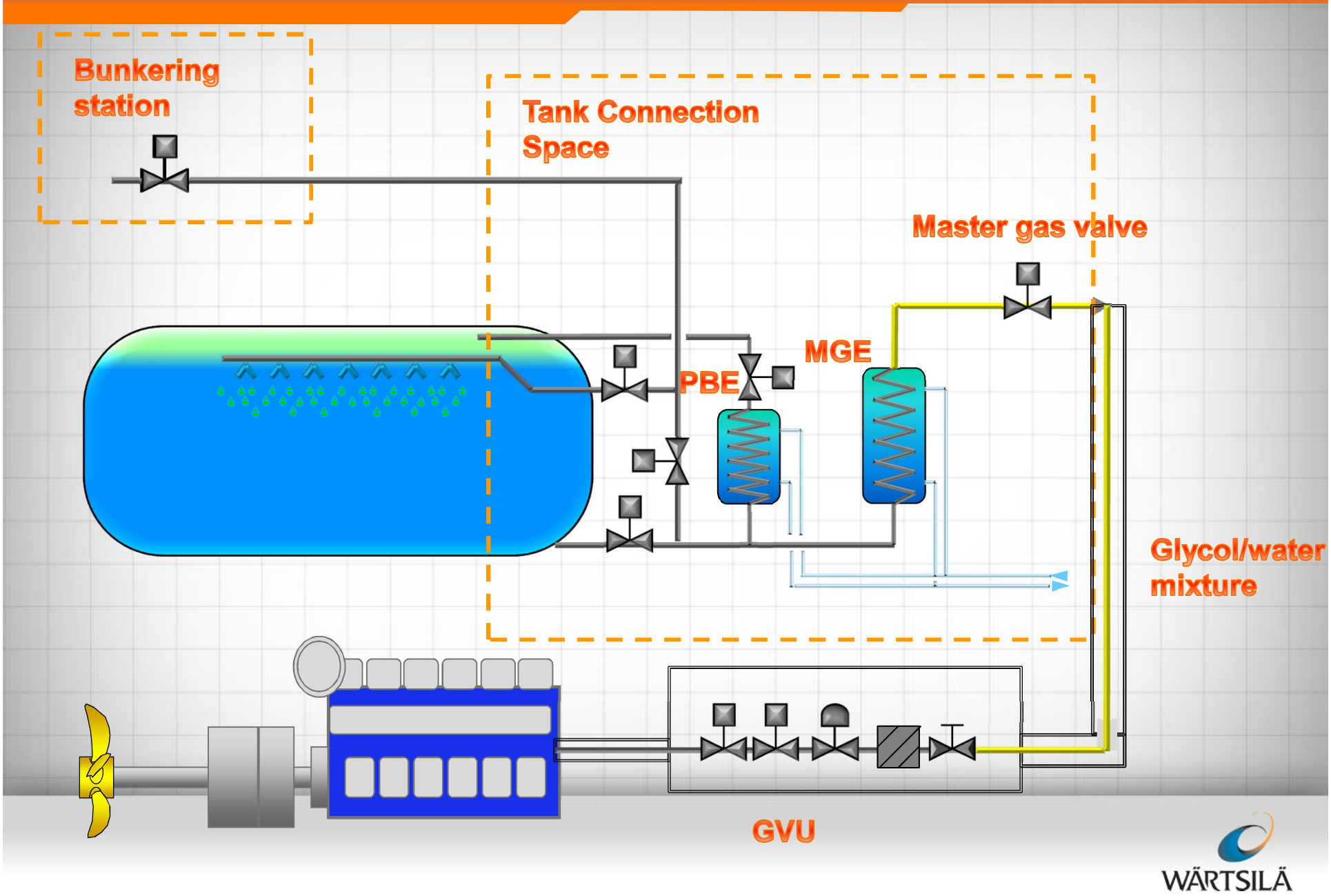
HAZARDOUS ZONES



Bunkering


LNG Tanks
FGS Room
Bunkering Station
Gas Valve Units
(One for each engine)
LNG Fill &
Return Lines
4 x DF Engines

LNGPac™ Simplified P&ID – Vacuum - PBE



Bunkering

- Truck to ship ~40 m3/h
- Stationary tank to ship ~ 500 m3/h
- Ship to ship ~150-200 m3/h

Bunkering from truck to ship

- Bunkering of Viking Grace in Stockholm

Dual Fuel Operation and Maintenance

Quote from Eidesvik:

"LNG and natural gas system proven very reliable.

Scavenging air channel after 14 000 hours operation

Maintenance interval is now set to 25 000 hours"

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Wärtsilä added values on Dredgers

1. Dual Fuel Design, Operation and Maintenance
2. **Dredgers applications typical aspects**
3. Wärtsilä dual fuel engine developments
   - W20DF
   - W34DF
   - W46DF

4-stroke DF Portfolio & Application types

WÄRTSILÄ 20DF

0.5 -1.8 MW

- LNG Feeder
- Jack-up
- Tugs
- Small cargo vessels
- Barges
- Small ferries
- Aux. engines with W34DF & W50DF

WÄRTSILÄ 34DF

3,0 – 10,0 MW

- Small LNG / CNG vessel
- Small cargo vessels
- Supply vessel
- Offshore application & Production
- Aux. engines with W50DF

WÄRTSILÄ 50DF

5.8- 17.5 MW

- LNG Carriers
- Cruise ships
- RO-RO/PAX
- Ferries
- Large Offshore Units

WÄRTSILÄ 46DF

6.2 -18.3 MW

- LNG Carriers
- Cruise ships
- RO-RO/PAX
- Ferries
- Large Offshore Units

0 5 10 15 20

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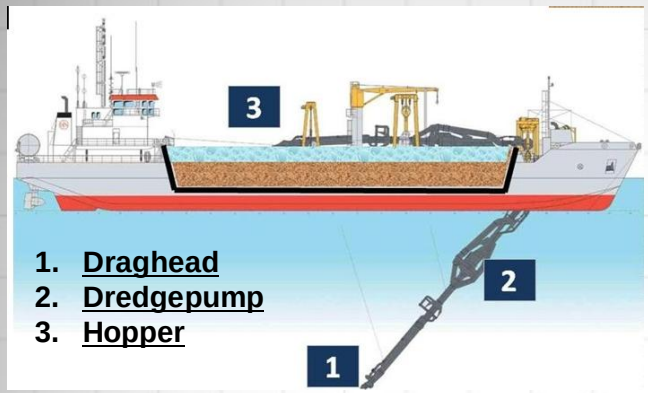
Trailing Suction Hopper Dredger (TSHD)



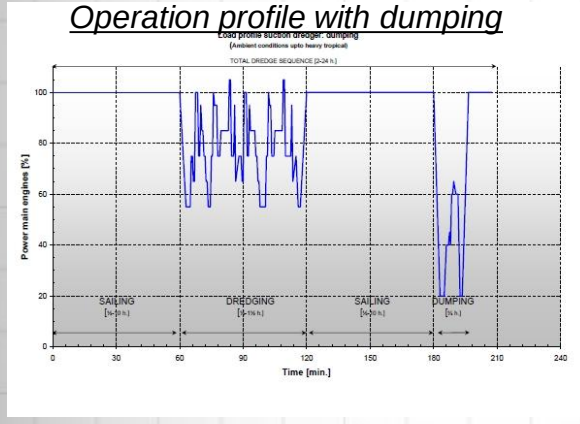
Main Features:

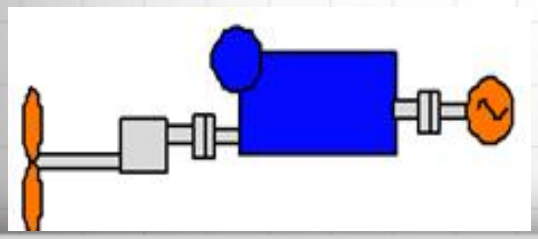
• Self-propelled dredger used to maintain or deepen channels and fairways or constructions of artificial islands

Typical operation profile:

Phase	% in Rhs
Sailing to the dredging location	30
Dredging phase	30
Sailing to the discharge point	30
Dumping/shore discharging	10

Operation profile with dumping





Requirements

- Engine direct drive
- Engine costant torque

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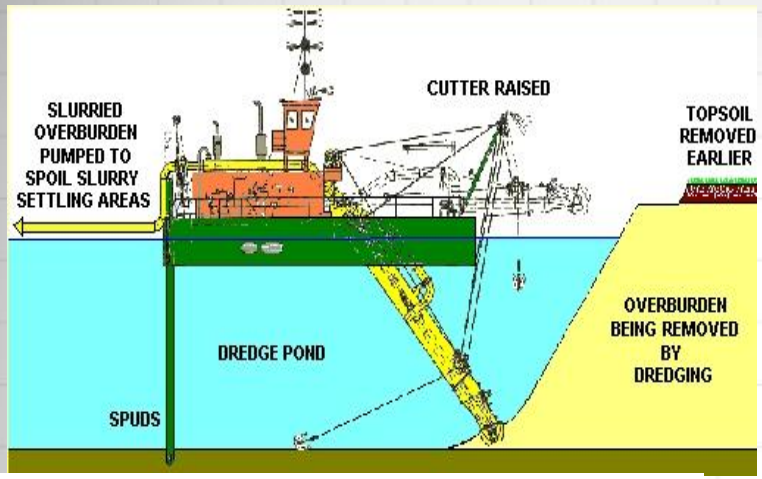
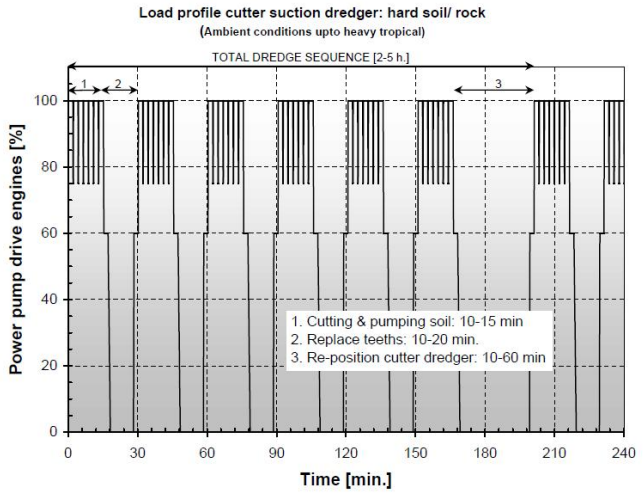
Cutting Suction Dredger





Main Features:

• Stationary dredger equipped with a cutter head, which excavates the soil before it is sucked up by the flow of dredge pump.

Typical operation profile:

Phase	% in Rhs
Cutting and pumping soft or hard soil: Consumers full load	80
Transient	10
Pump and boardnet	5
Boardnet	5

Requirements → Fast and frequent load variations (instant load)

Wärtsilä added values on Dredgers

1. Dual Fuel Design, Operation and Maintenance
2. Dredgers applications typical aspects
3. **Wärtsilä dual fuel engine developments**
   - **W20DF**
   - **W34DF**
   - **W46DF**

Wärtsilä 20DF

NEW RELEASE!

Main data:	176kW	185kW
Cylinder bore	200 mm	200 mm
Piston stroke	280 mm	280 mm
Cylinder output	146/176 kW/cyl	160/185 kW
Engine speed	1000/1200 rpm	1000/1200 rpm
Mean effective pressure	20.0 bar	22 bar
Methane number	> 80*	> 80*
Regulation	IMO Tier II & Tier III	
Cylinder configurations	6L, 8L, and 9L	

* MN70 version in planning phase

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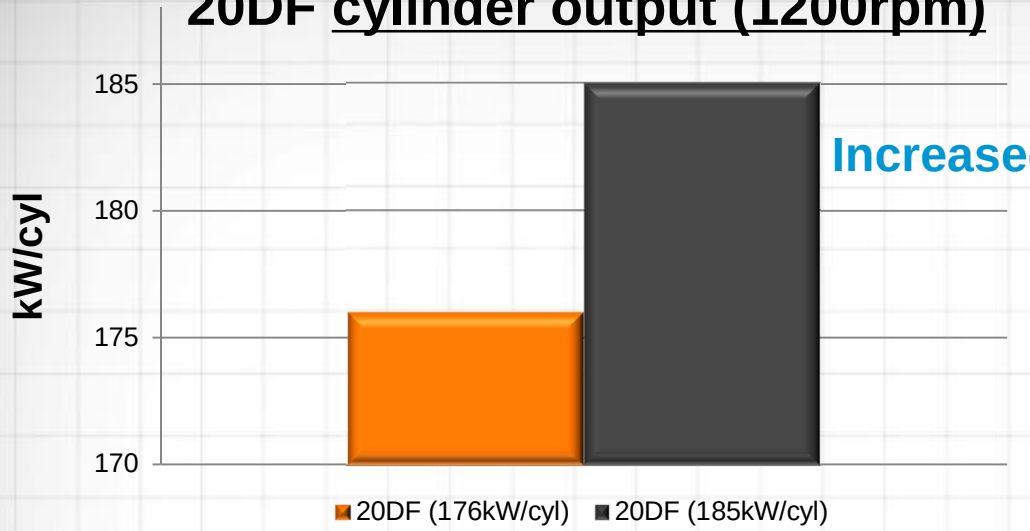
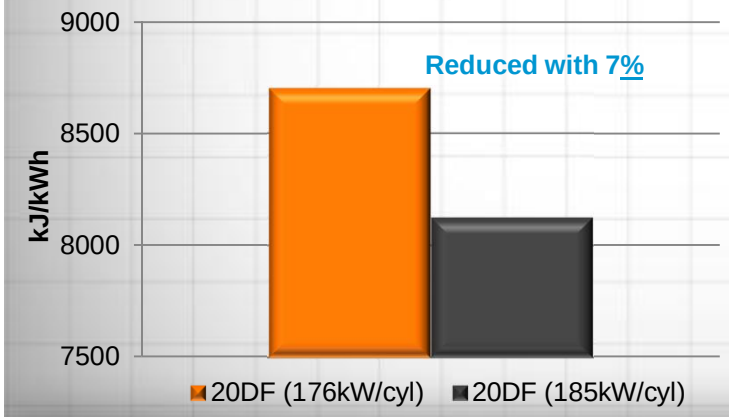
What's new : updated 20DF

20DF cylinder output (1200rpm)

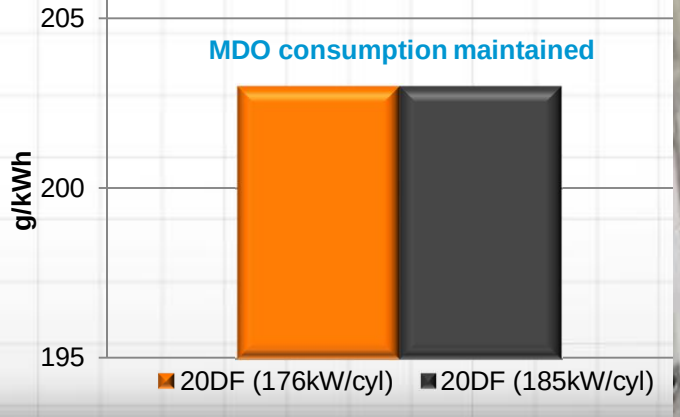


Increased with 5%

20DF energy consumption (gas mode)



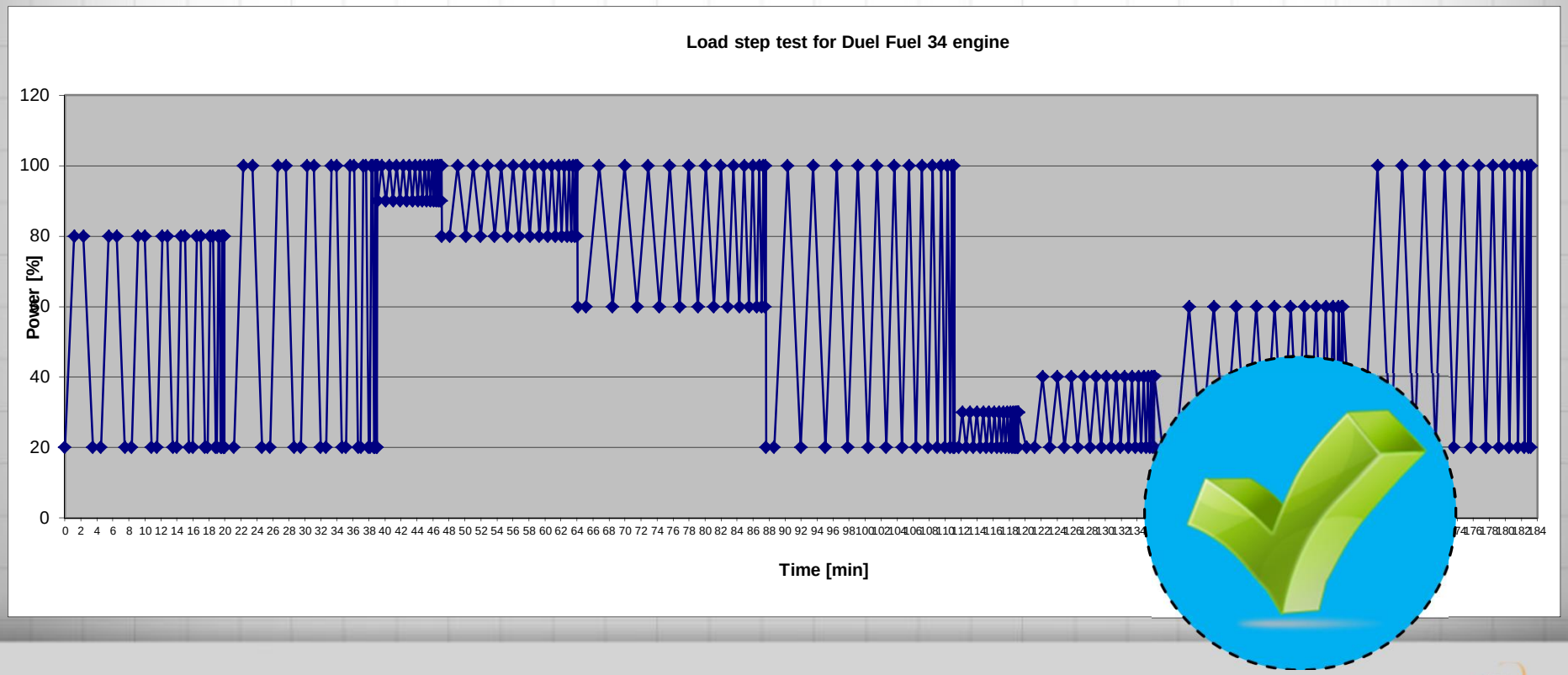
20DF fuel consumption (MDO)



Test Results

WÄRTSILÄ 34DF

34DF/W20DF load step variation successfully tested for **dredger application** test program in close cooperation with **Royal IHC**



Wärtsilä 34DF

NEW RELEASE!

Main data:	450kW	500kW
Cylinder bore	340 mm	340 mm
Piston stroke	400 mm	400 mm
Cylinder output	435/450 kW/cyl	485/500kW
Engine speed	720/750 rpm	720/750rpm
Mean effective pressure	20.0/19.8 bar	22 bar
Methane number	> 70	>80*
Regulation	IMO Tier II & Tier III	
Cylinder configurations	6L, 9L, 12V and 16V	

Test conditions

- Wärtsilä laboratory
- ISO conditions
- Gas MN >80
- MDO pilot fuel
- Standard reciver temperature
- **Generator drive**

* MN70 version in planning phase

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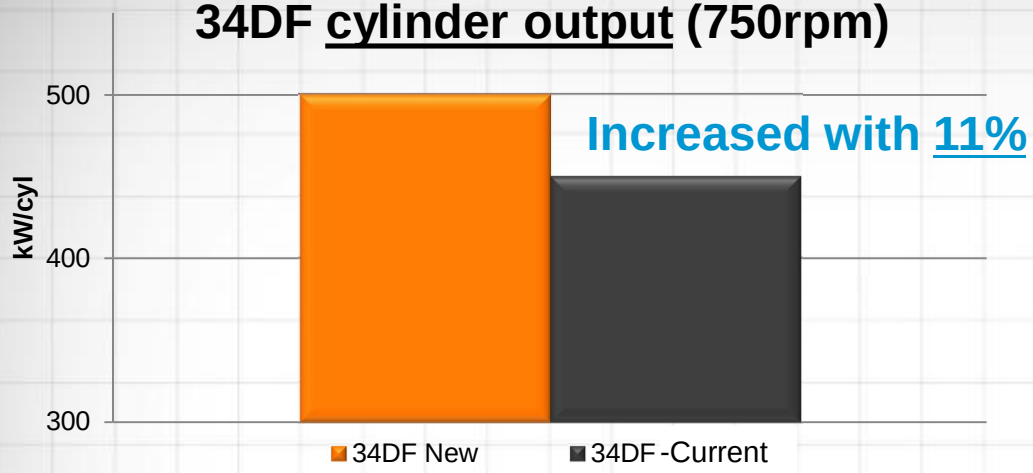
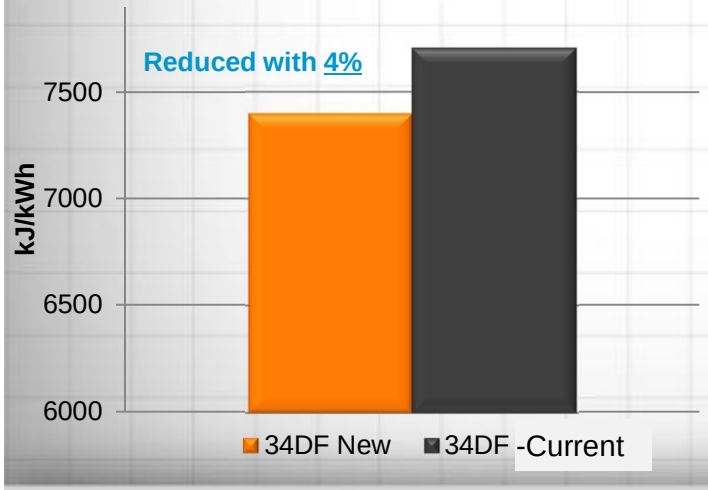
What's new : updated 34DF

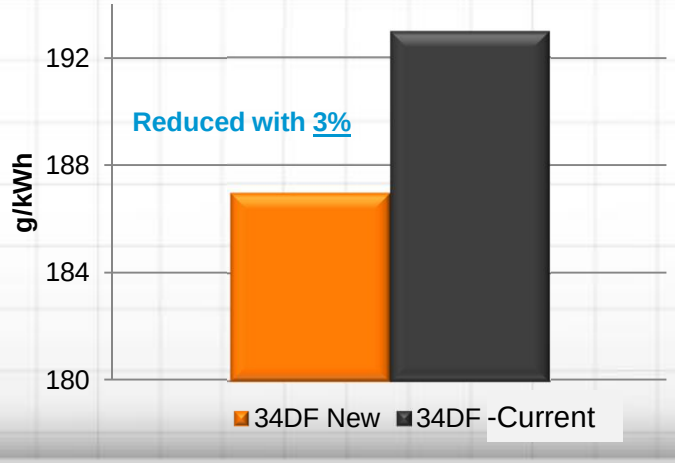
34DF cylinder output (750rpm)



34DF energy consumption (gas mode)



34DF fuel consumption (MDO)



W46DF - main features

- **Approx: 1150kW/Cyl**
- **Lowest fuel consumption in the market.**

✓ **The most powerful marine gas engine in the market**

✓ **Available for retrofit W46F to DF**

✓**600 rpm**

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W46DF installation's benefits

Assumed 17.4 MW power installed (2 x 12V38C ME - Hopper dredger)

W38C (725 kW/cyl)	W46DF (1145 kW/cyl)
600 rpm	600 rpm
24 cylinders	16 cylinders
2 * W12V38C	2 * W8L46DF
SFOC Diesel @ 100% load = 185 g/kWh	SFOC Diesel @ 100% load = 182 g/kWh
SFOC Diesel @ 100% load = 7899 kJ/kWh	SFOC Diesel @ 100% load = 7771 g/kWh
	BSEC Gas @ 100% load = 7075 kJ/kWh

W46DF MAIN BENEFITS:

✓ - 3 g/kWh @ 100 % load SFOC vs W38C -> **less fuel cost (DIESEL)**
✓ - 8 cylinders installed in the engine room -> **less maintenance**
✓ same rpm (600)
✓ + 58 % kW/cyl installed vs W38C
✓+ 11 % more efficient in GAS mode vs W38C in Diesel mode

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Wärtsilä Worldwide Dredgers reference

More than

641 MW

installed

More than

155 engines

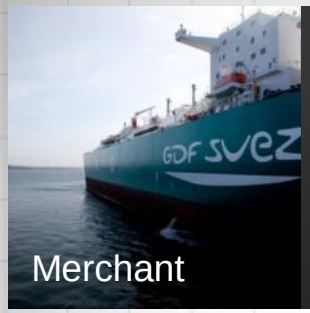
installed

More than

390 dredgers

in operation

Dual-fuel application references



Merchant

LNGC
- 141 vessels
- 567 engines

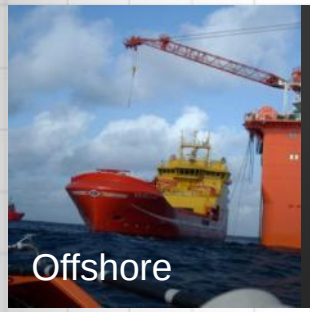
Multigas Carrier
- 5 vessels
- 20 engines

Conversion
- 1 Chem. Tanker
- 2 engines

Ro-Ro
- 2 vessels
- 8 engines

Navy

Coastal Patrol
- DF-propulsion
- DF main and auxiliary engines



Offshore

OSV's
- 31 vessels
- 96 engines

Production
- 2 platform
- 9 FPSO's etc.
- 1 FSO
- 40 engines

Others

TUG
- 2 vessel
- 2 engines each
- Mechanical drive

Guide Ship
- 1 vessel /engine

IWW
- 2 vessel
- 3 engines

Cruise & Ferry

LNG Cruise ferry
- 1 vessels
- 4 engines
- Complete gas train

LNG ferries
- 4 ferries
- 18 engines

Conversion
- 1 ferry
- 2 engines

Power Plants

DF Power Plant
- 67 installations
- 354 engines
- Output 4600 MW
- Online since1997

→ 6 segments → >1,000 engines → 10,000,000 running hours

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Dutch Recent References

Built	**2000**
Overall lenght	**177 meter**
Width	**11,45 meter**
Draft	**2,56 meter**
Tonnage	**5300 tonnes**
Capacity (4 layers)	**348 TEU**
Engines	**2x 900 kW**

Yard: Shipyard Constr. H-Foxhol
Owner: Chemgas Shipping
Delivery: 2014/2015
Amount of vessels: 2

Wärtsilä scope of supply:

- **1*W8L20DF main engine (8L20DF, 1’408kW)**
- **Shaft, S&B**
- **CPP, HR Nozzle**

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Wärtsilä DF Sustainability proven

Excellent experience:

- Load taking capability
- Intrinsic redundancy – no interruption of operations
- Safety and fuel flexibility
- Application as:
  - mechanical drive, (CPP,FPP, Pump)
  - single main engine,
  - OSV DP requirements.
  - Etc..

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Thank You!