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The use of LNG as fuel for propulsion on board merchant ships

Green Economy Committee Working Group

Confitarma - 20th January 2011 - Rome

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Content:

- Rolls-Royce Marine: an all-inclusive range of products
- Natural Gas and LNG
- Use of natural gas (LNG) as marine fuel
- Bergen gas engines - power range
- Rolls-Royce gas propulsion systems
- LNG supply chain for marine bunkering
- Some references



An all-inclusive range of products

Focus on environmental friendly solutions based on the widest range of products in the marine industry

Ship design and integrated ship systems



Diesel and gas engines systems



Gas turbines



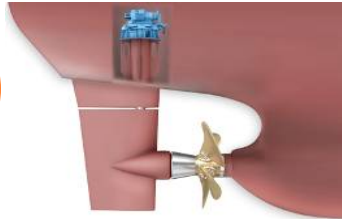
Automation and control - DP



Propulsion systems



Steering systems



Electrical podded propulsors



Azimuth thrusters



Tunnel thrusters



Waterjets



Stabilising systems

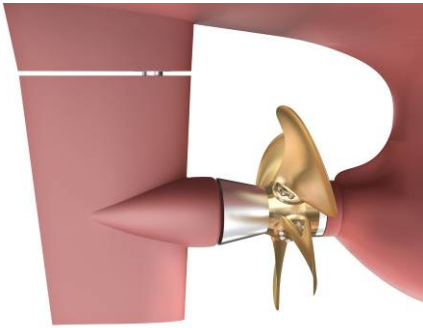


Winch systems

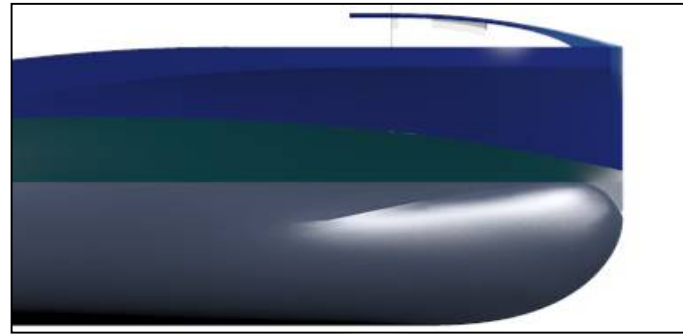


Increasing oil prices will drive new technologies

High efficiency propulsion and manoeuvring systems

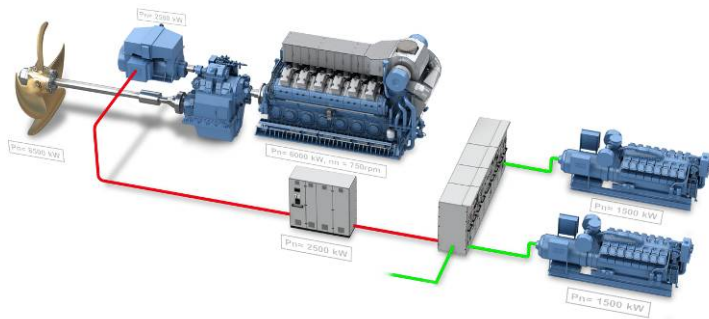


Advanced hull forms



Application for patent protection by Rolls-Royce

Hybrid propulsion



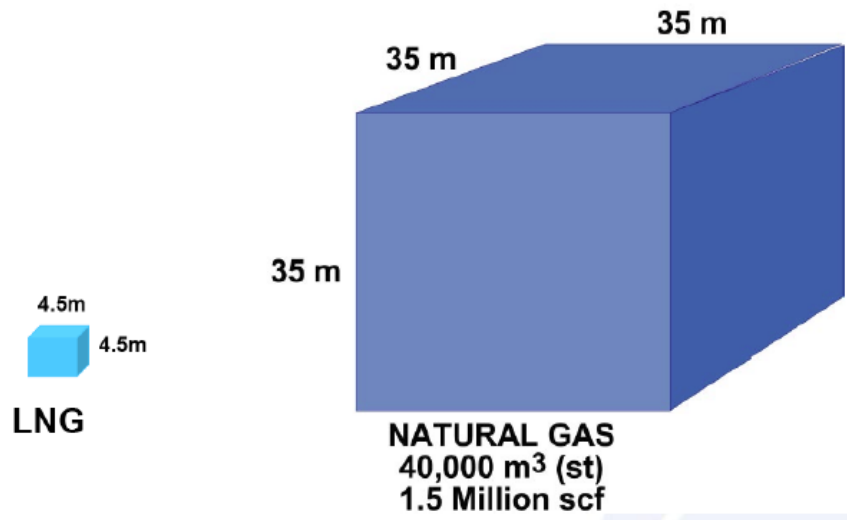
Gas powered propulsion



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Natural gas and LNG

- Natural gas is consisting primarily of methane, a typical composition is:
 - Methane 94%
 - Ethane 4.7%
 - Propane 0.8%
 - Butane 0.2%
 - Nitrogen 0.3%
- Natural gas burns more cleanly than all other fossil fuels:



1: 600

Natural gas (LNG) as a marine fuel

- **Emissions**

- Reduce harmful emissions of NO_x, SO_x, CO₂, Particles

- **Costs, operability and maintenance**

- Reduced maintenance, higher TBO
- Remove- or Reduce Ship owners taxes and other fees related to emissions
- Reduced LO consumption
- Reduced Fuel consumption, gas engine more efficient than diesel.
- All HFO installations deleted; Heating system with coils, purifiers, treatment units, service- and settling tanks.

- **Installation**

- A simpler propulsion set installation / refurbishment
- A simpler propulsion set operability and maintenance



Bergen Gas Engines generation

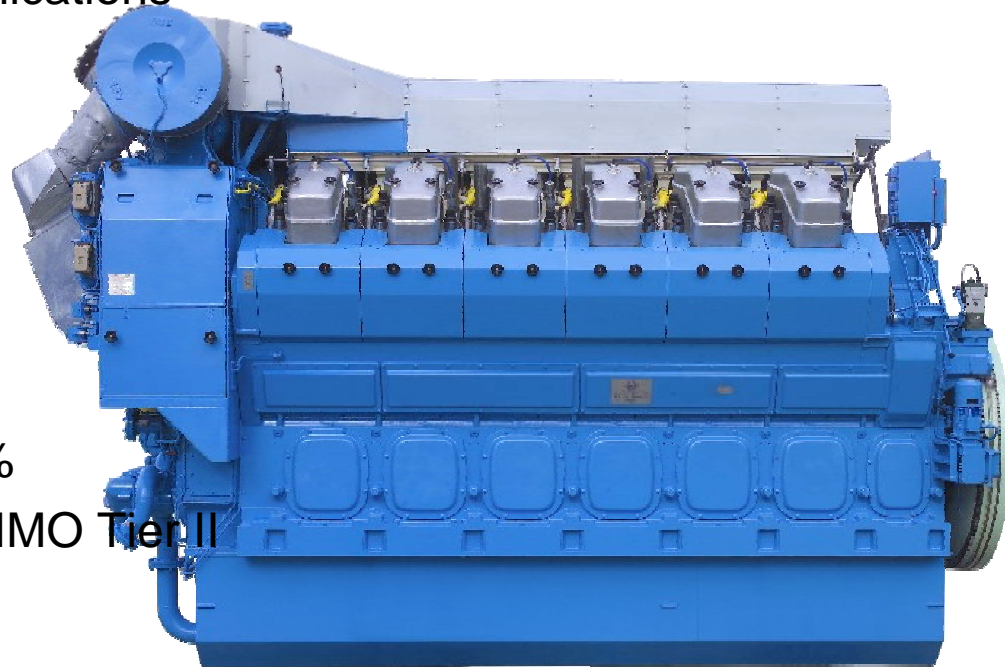
S.I. “Lean Burn” C26:33 & B32/35:40 Gas engines

Features:

- High efficiency, 48%
- Compact and powerful
- Approved by Class for marine applications
- Service friendly
- No oil contamination
- Super silent resilient mounting
- Available for both mechanical and electric driven applications

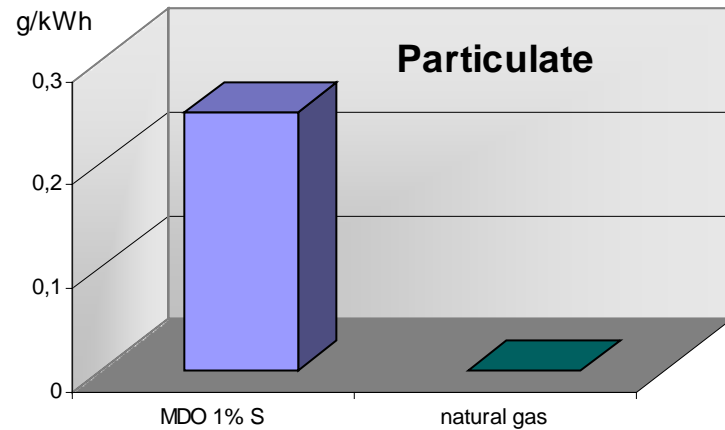
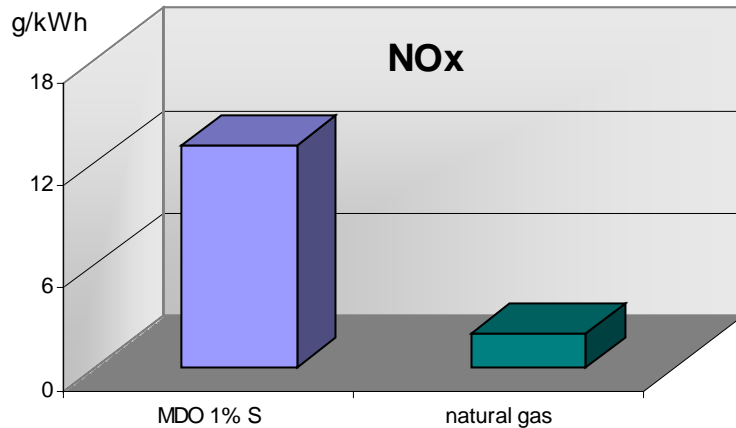
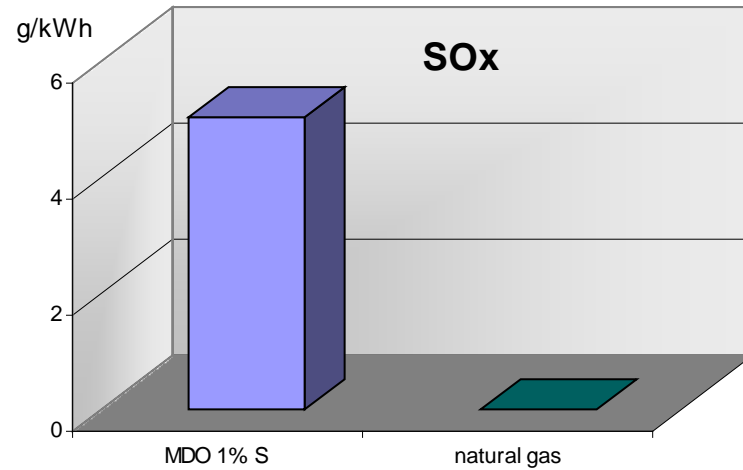
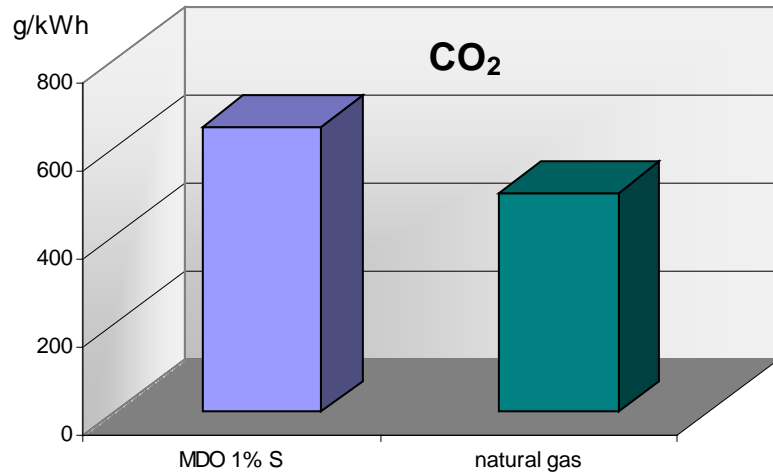
Emissions:

- CO₂ emission reduced net by 30%
- NO_x reduced by 86 % down from IMO Tier II level (meet IMO Tier III)
- PM emission reduced by 98%
- SO_x emissions resolved



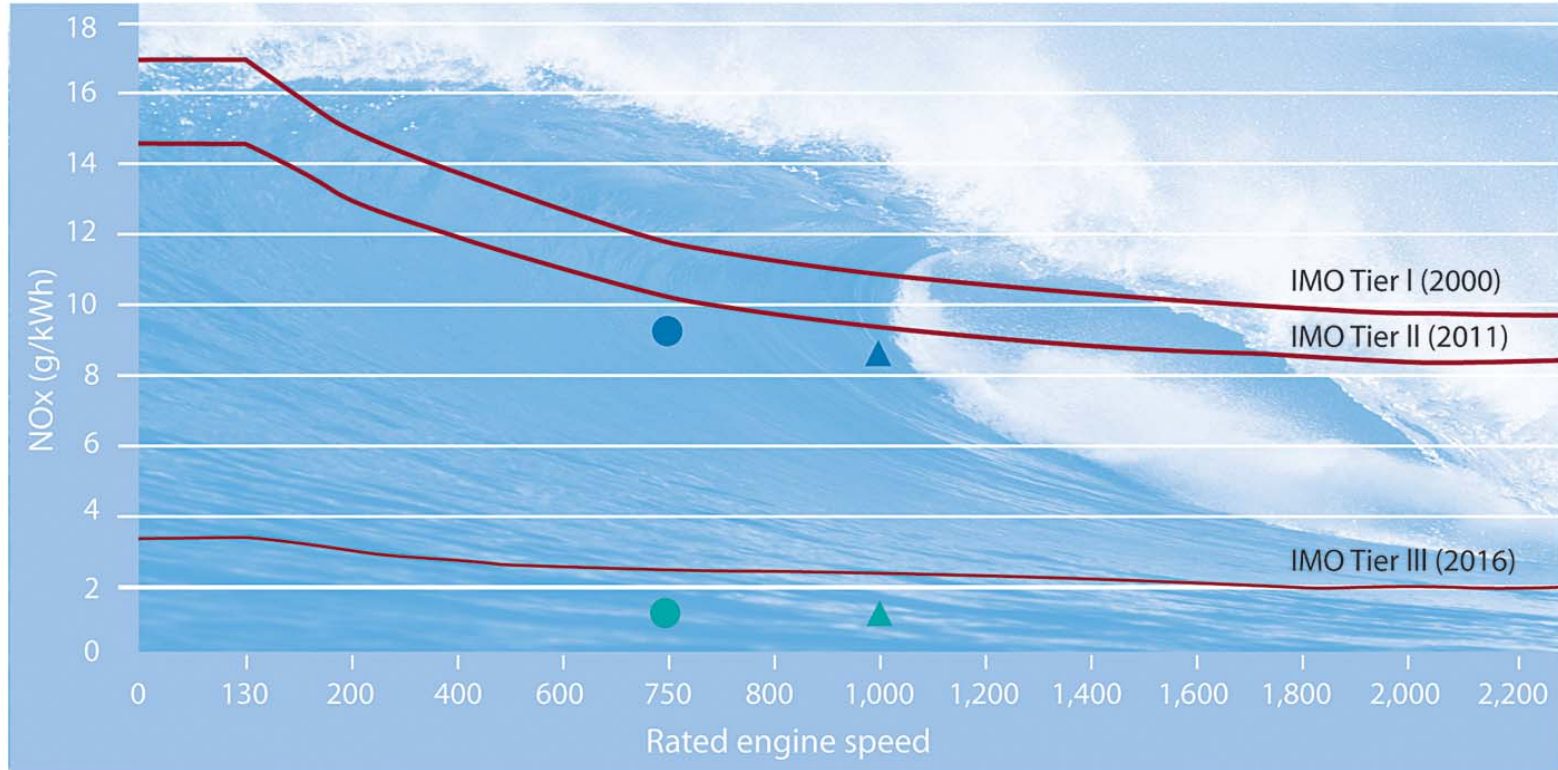
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Bergen engines: MDO vs. Natural gas emissions



NOx IMO emission limits

NOx emission for Bergen engines

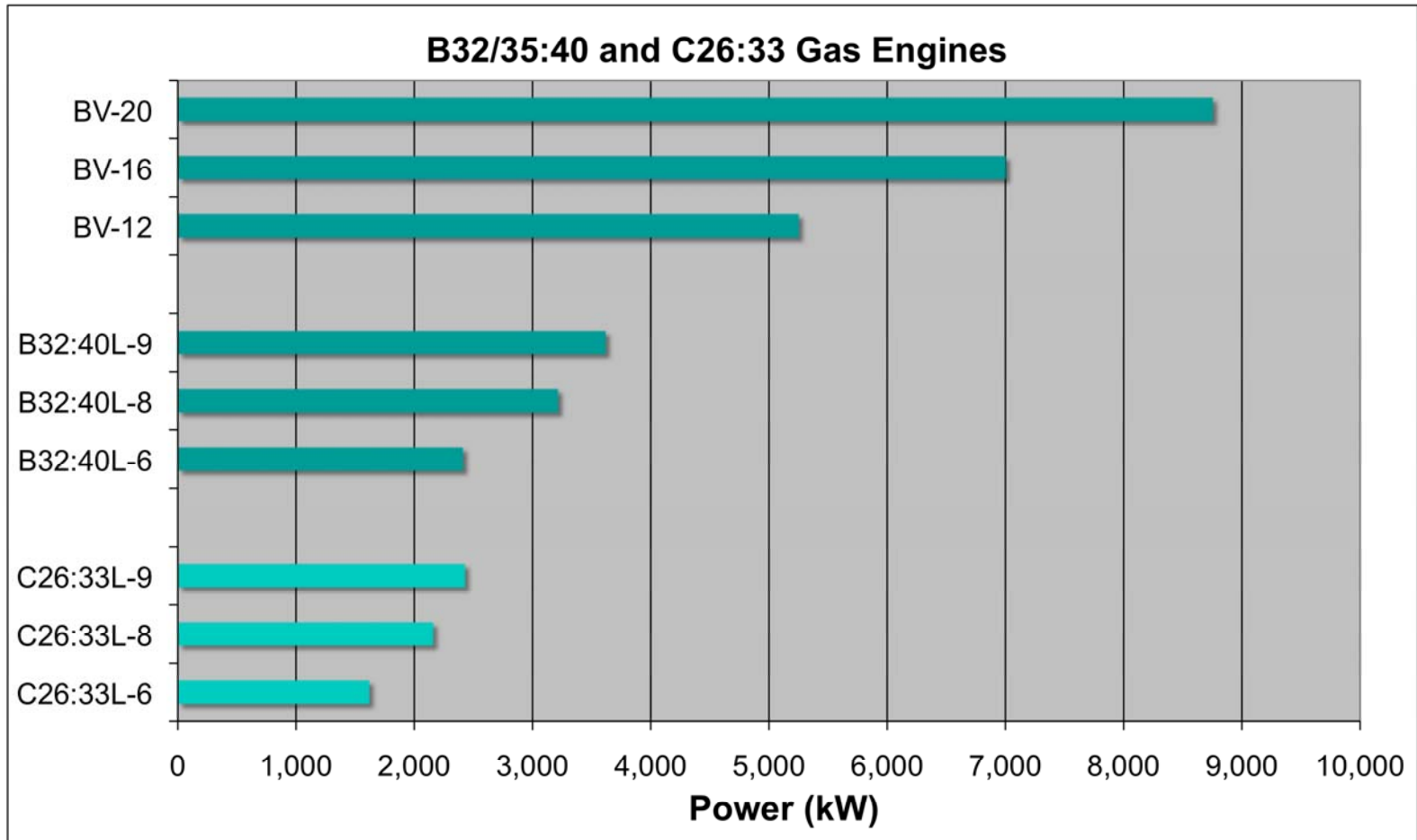


- B32:40 diesel with Clean Design notation
- ▲ C25:33 diesel with Clean Design notation

- B35:40 gas
- ▲ C25:33 gas



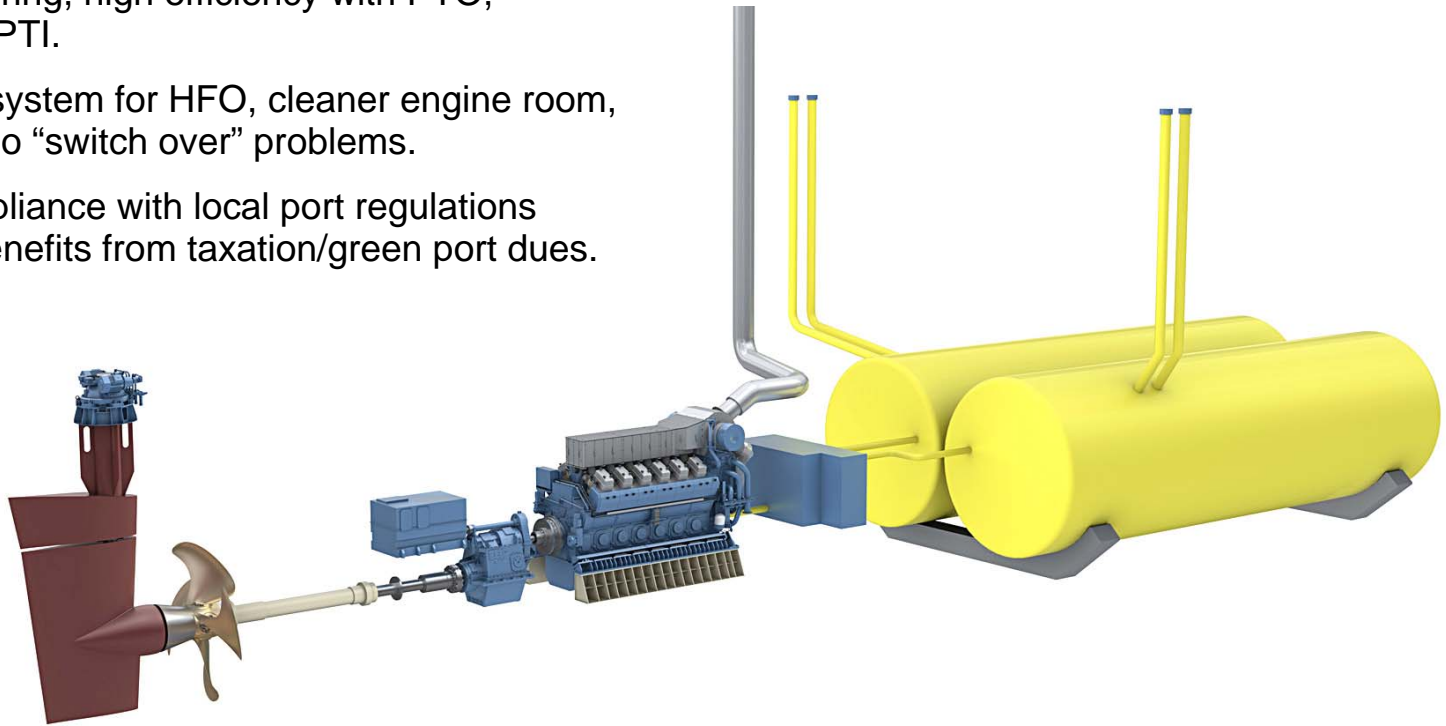
Power range Bergen gas engines



Dual fuels ships: gas fuelled propulsion system

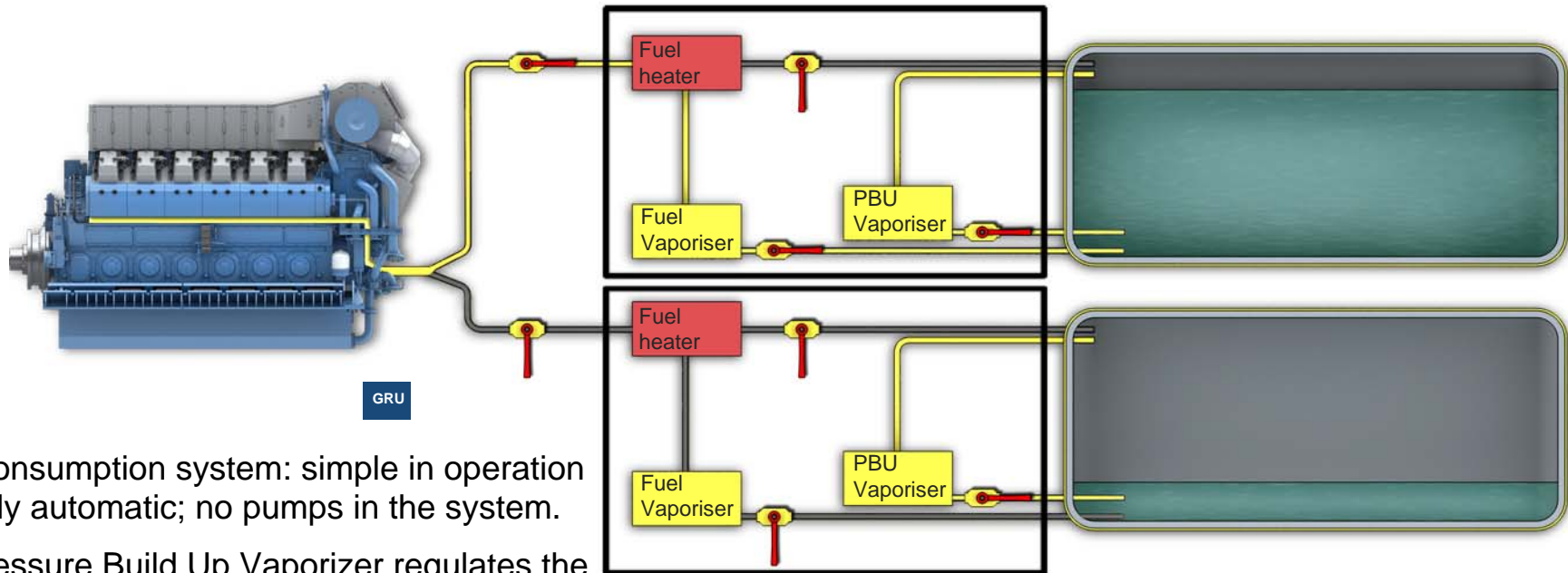
Operational benefits with LNG, single fuel main engine, MDO back up gensets

- One stop bunkering, high efficiency with PTO, redundancy by PTI.
- No purification system for HFO, cleaner engine room, less waste oil, no “switch over” problems.
- Long-term compliance with local port regulations and potential benefits from taxation/green port dues.



Gas fuelled propulsion system

No moving equipments in the vaporisation and heating processes



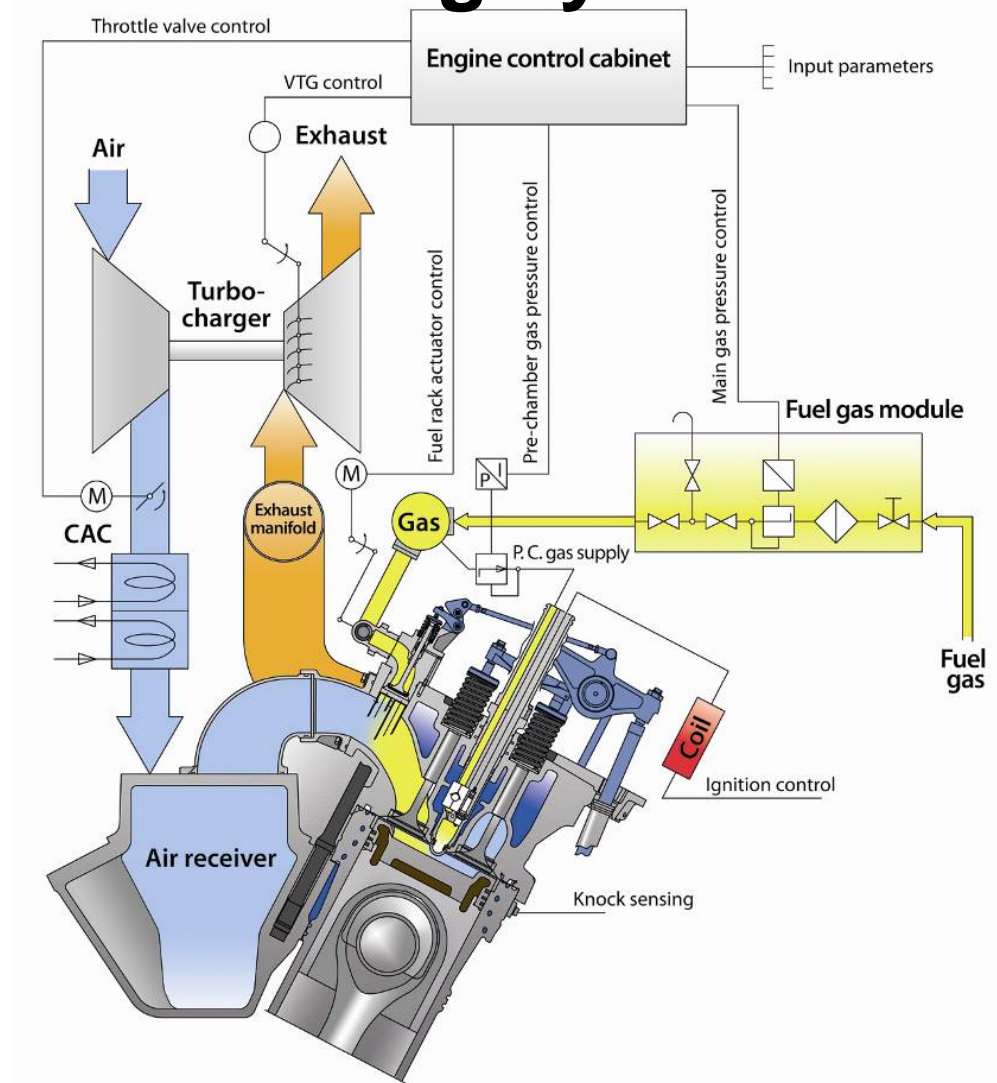
Fuel consumption system: simple in operation and fully automatic; no pumps in the system.

The Pressure Build Up Vaporizer regulates the pressure in the tank which is driving the LNG to the Fuel Vaporizer. LNG is vaporized to NG which goes to the Fuel Heater. The heater takes the NG to the temperature level required before entering the GRU-Gas Regulating Unit

Tank room arrangement

Bergen Gas Engines: feeding system

- The Fuel Gas Module controls the gas flow to the engine based on engine load control system.
- The Variable Turbo Geometry (VTG) gives the Optimum response at all engine load points



LNG bunker volumes

FUEL	LHV (MJ/Kg)	Density (Kg/m3)	Energy density (MJ/m3)
MDO	42.7	900	38.430
LNG	54.7	442	24.177
LNG / MDO energy density ratio (same volume): 1.6			

Specific fuel consumption of Bergen gas engines vs. MDO engines (@ MCR):

- Bergen MDO engines: 7770 KJ/KWh
- Bergen gas engines: 7500 KJ/KWh



LNG bunker volumes

- Considering the existing “C” type (pressure vessels) cylindrical LNG storage tanks
- Considering the additional available space due to absence of conventional fuels installations: heating system with coils, purifiers, treatment units, bunkering, service- and settling tanks
- Considering tanks insulations, additional bulkheads, access trunks, vents, etc.
- LNG could require up to 2.5 / 3.5 times as much space as MDO for the same amount of energy onboard.
- The forthcoming installations of prismatic and membrane type tanks for LNG as bunker will lower the volumetric ratio down to 2 times.

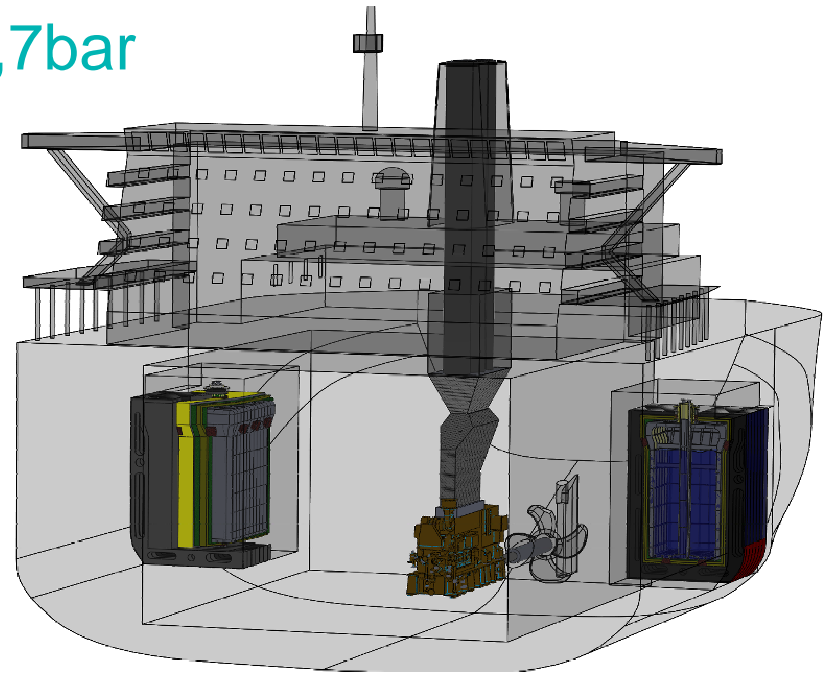
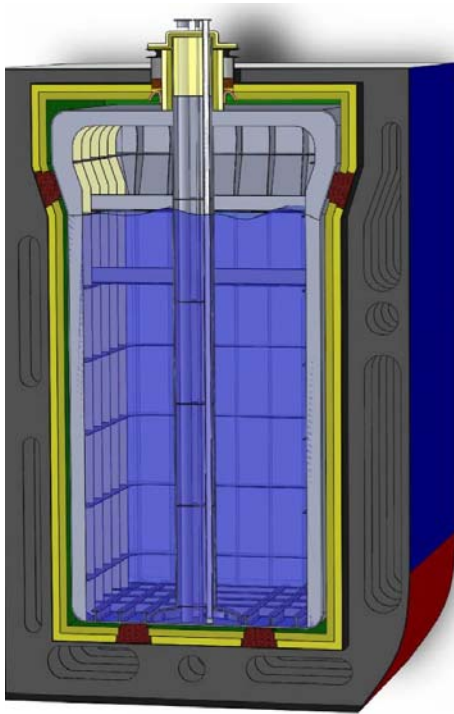


LNG bunker volumes

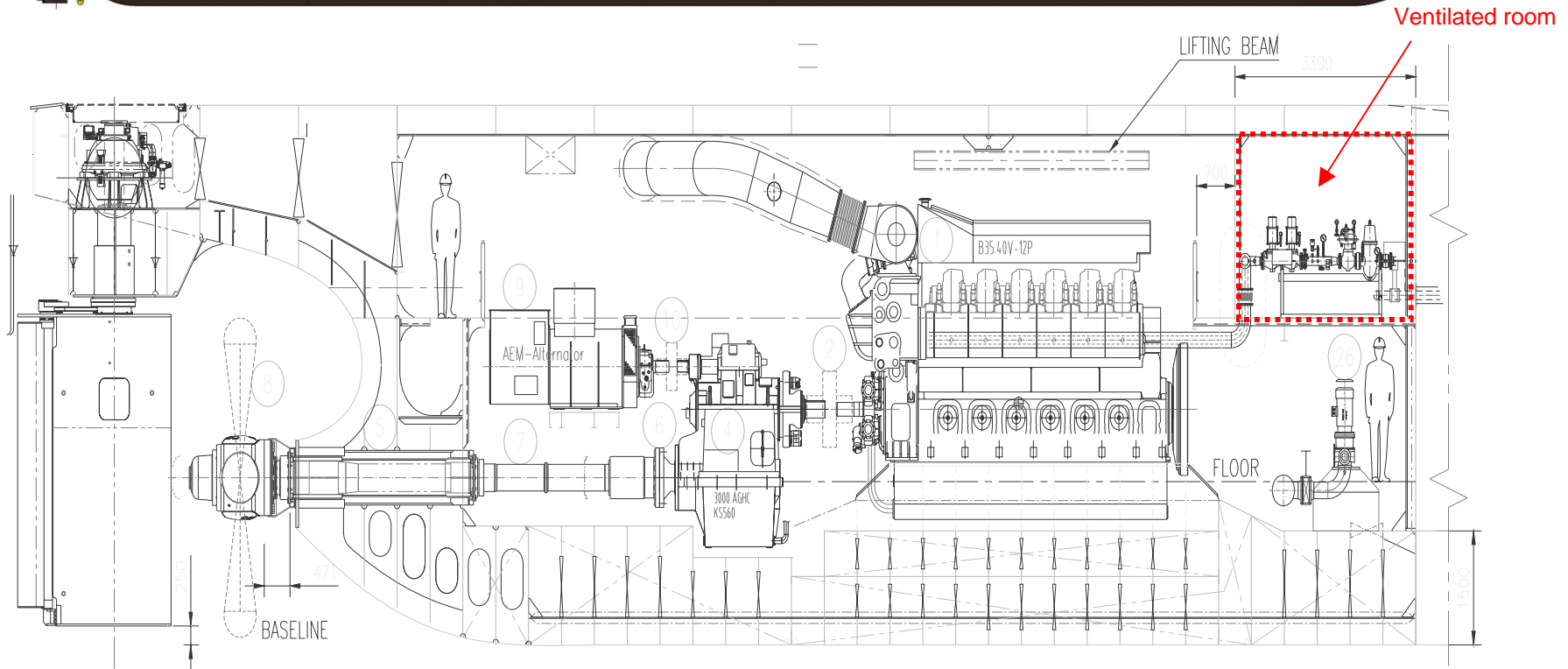
A-tank operating mock up in Bergen, NO.

Bunkering on A-tank and on Membrane tanks (prismatic tanks, hull shaped) will also be available

Hull integrated A-tank
Pressure-less – 0,7bar



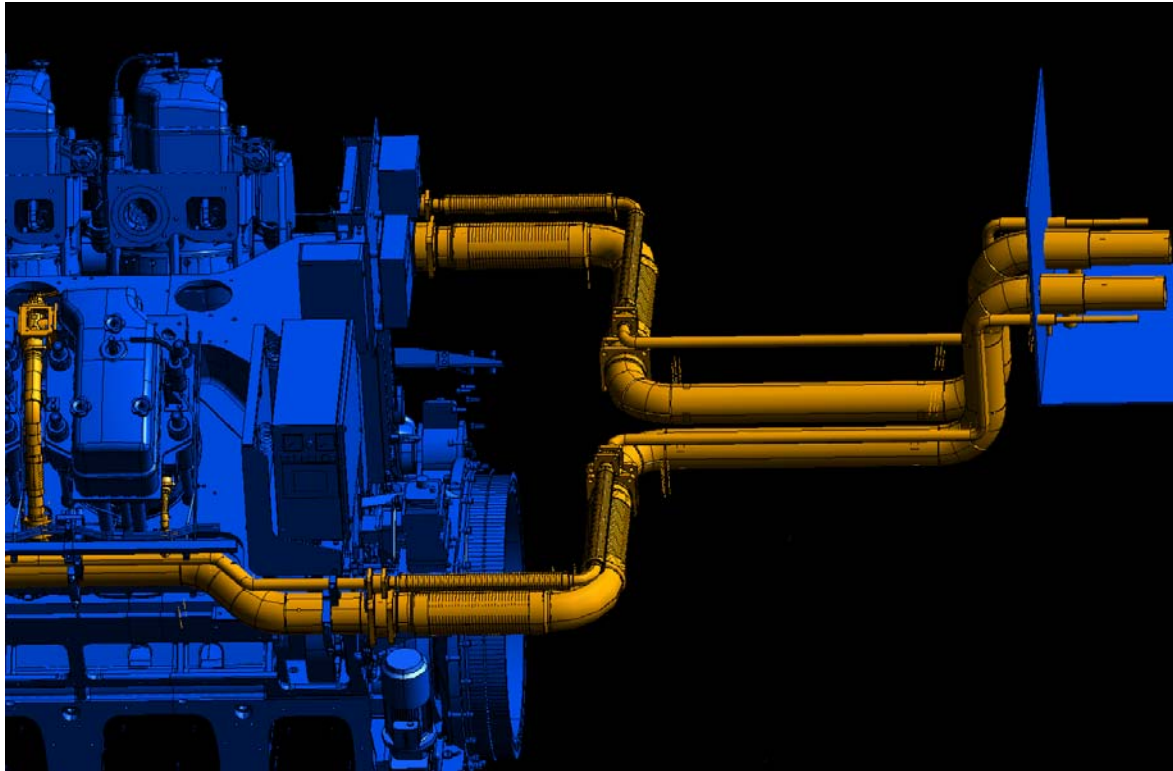
Inherently Safe Installation of engine



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Gas Engines: marine installation

- Double walled piping on main gas supply and pre-chamber gas for Inherently Safe Installation



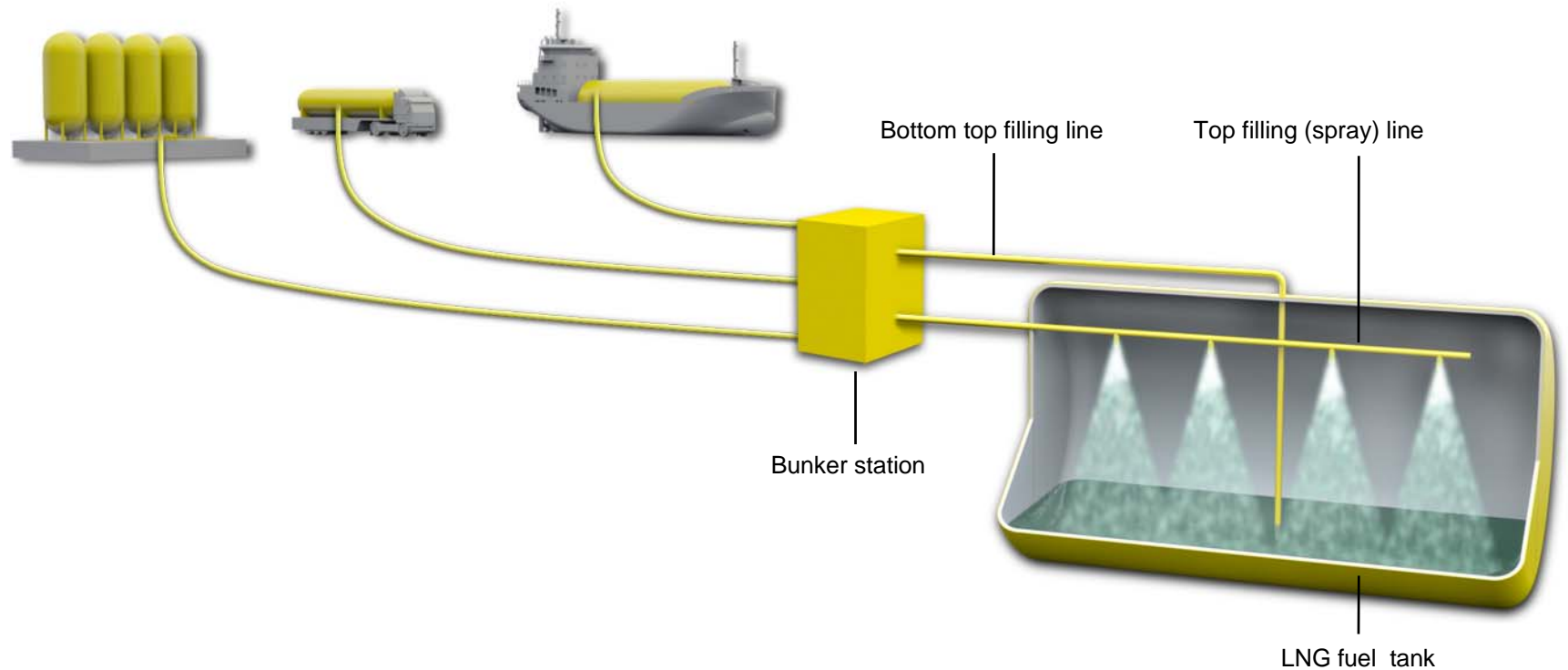
LNG supply chain for marine bunkering

- LNG can be supplied by:
 - Land based stations
 - Tank trucks
 - Coastal tankers
 - Bunker barges
 - Floating bunkering stations



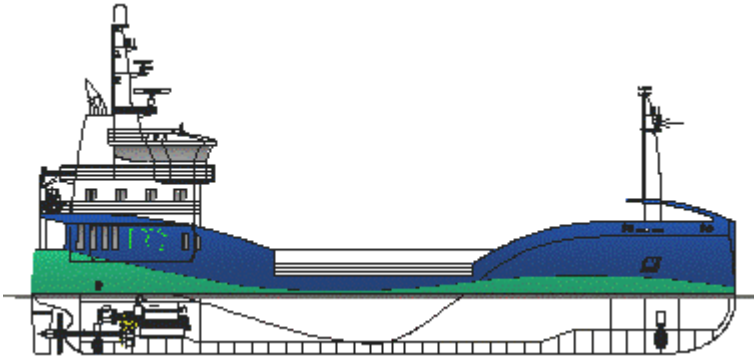
LNG bunkering

Liquefied Natural Gas (LNG) is bunkered by pressure from land based stations, tanker trucks, coastal tankers or bunker barges.

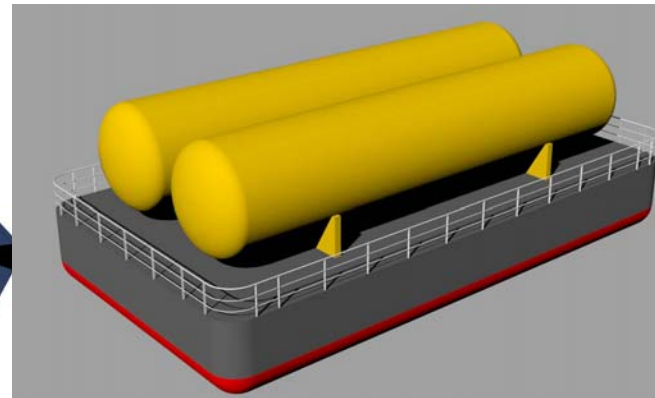
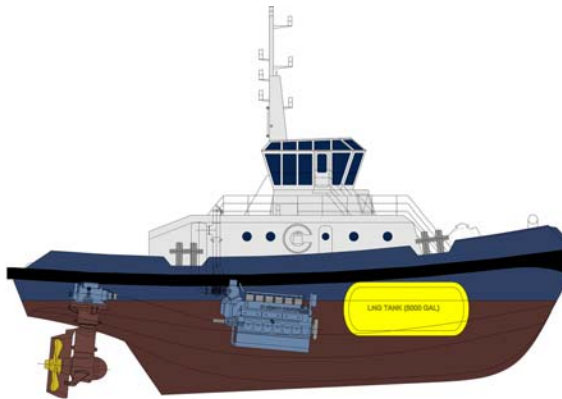


Forthcoming means for LNG bunkering operations:

- Dedicated bunkering vessels



- Bunker barges w pusher tugs



Coastal trading LNG carriers loading at a large import terminal



The bunkering terminal @ Halhjem 1000 m3 storage capacity



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LNG storage for ferries @ Halhjem



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Delivery - Bunkering



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LNG fuelled vessels payback period; availability and cost of LNG for bunkering

- The payback period is highly dependent on the ship value and the operating profile.
- Payback period for new building / retrofitting of our ongoing projects and operating ships is in the range of 2.5 to 5 years.
- LNG is currently available in many European Countries, including Italy. Most of the operating LNG fuelled ships are still bunkering LNG from trucks. Some bunkering facilities are equipped with satellite storage tanks (a few hundreds of cu.m. each)
- The FOB LNG price in Italy vary according to the traded magnitude, in the range of 350 €/ton to 550 €/ton.



Bergensfjord, double-ended car ferry

- NO_x reduction = 160,000 cars running for 1 year



Bergensfjord, double-ended car ferry

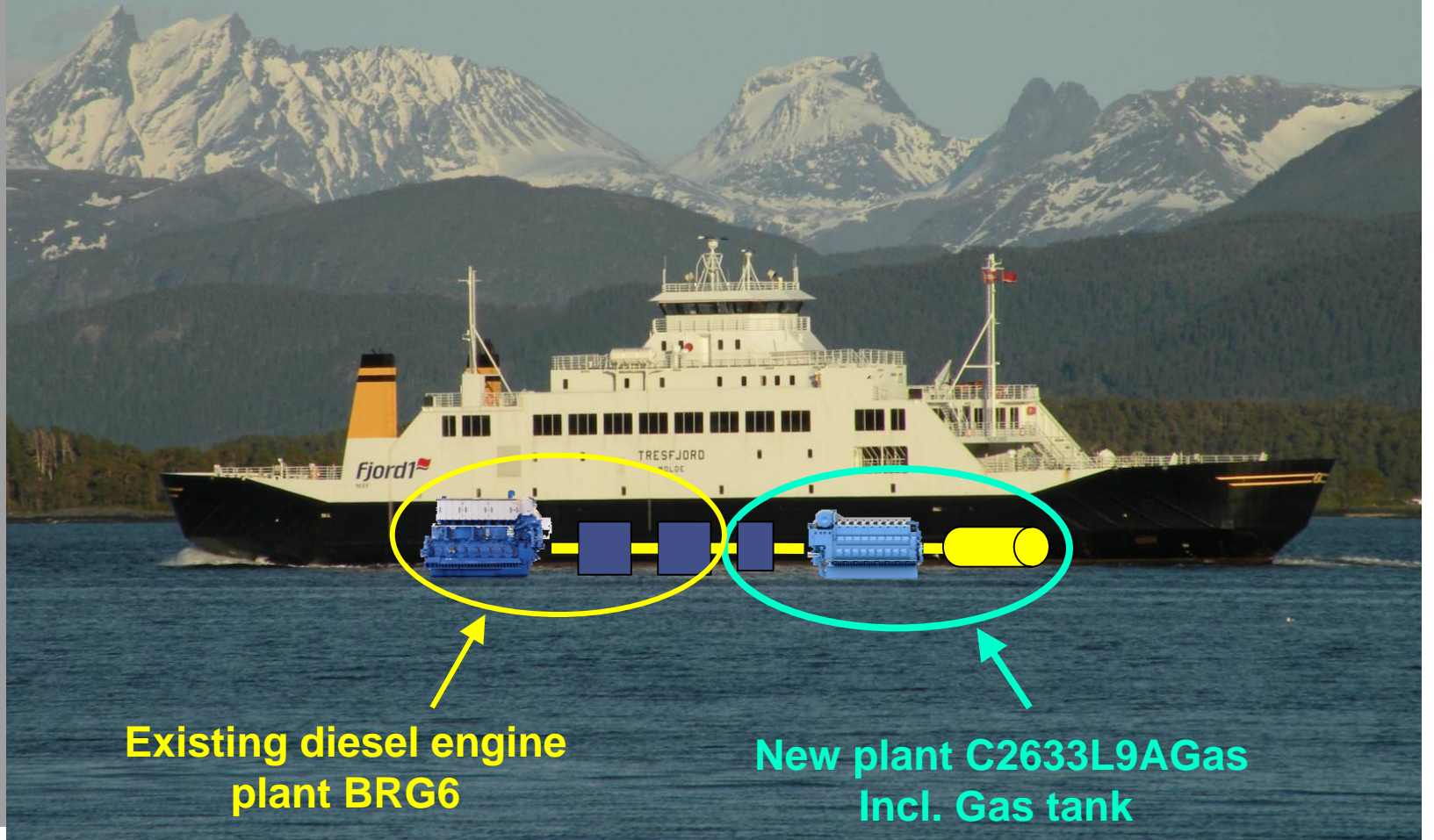
- 2 explosion inherently safe engine rooms
- 2 engines rooms divided by a cofferdam
- Gas Engines configuration: 2 KVGS 12GS + 2 KVGS 16 (c.a. 12.5 MW MCR), 21 Knots service speed
- 2 x 125 cu. m. LNG bunker tanks
- Double walled C type tanks vacuum insulated with perlite
- Tank design Temperature: +50 C° / -196 C°
- Tank design pressure: 10 bars

Tresfjord, double-ended car ferry

- Conversion of propulsion system from liquid fuel to natural gas



MF TRESFJORD



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On order LNG fuelled sea cargo vessels

The two 132.8 m LNG fuelled Sea-Cargo vessels will be able to carry 5,600 tonnes of cargo, with up to 94teu of containers on deck and 1,240 lane-metres of ro-ro capability.

Rolls-Royce reduction gear, tunnel thrusters, flap rudder and steering gear, automation.

Rolls- Royce LNG fuel storage and handling system complete the package.



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Bergen Lean Burn Gas engines:

- More than 500 sold, over 400 in operation
- More than 20 mill running hours
- Plants with more than 180.000 hrs
- Plants operating 8.500 hrs/year
- Bergen gas engines in operation since more than 20 years



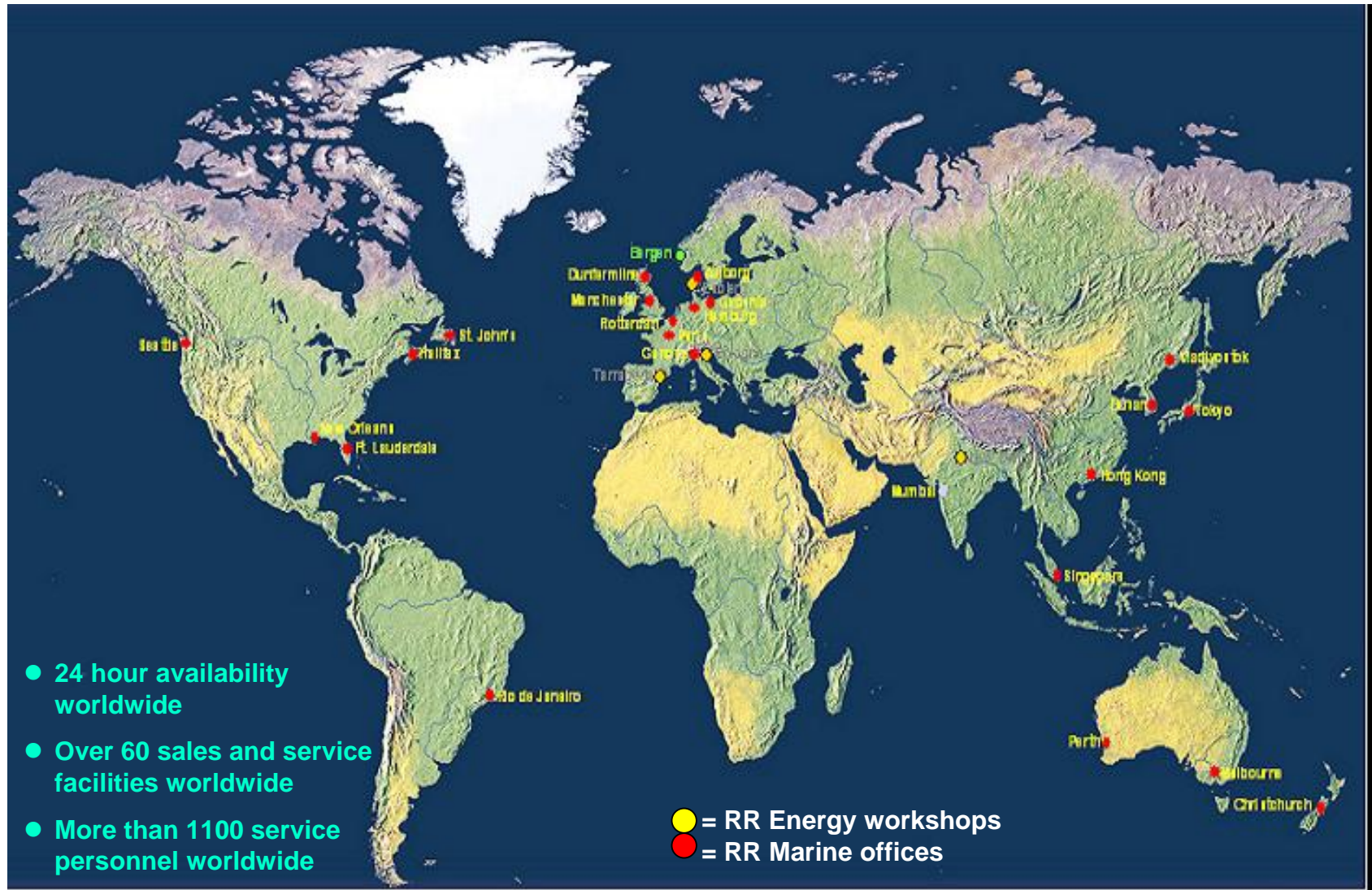
Rolls-Royce LNG marine propulsion:

- 4 LNG-powered RoRo ships for North Sea operation on order
- 2 RoRo / multi purpose vessels under construction in India single engine / single screw
- 1 + 1 fish forage vessel under construction in Turkey
- Two Platform Supply Vessels on order
- 1 Car ferry under conversion for MDO to LNG, ready for operation in February 2011
- 5 Ropax ferries in operation, + 1 under construction
- 4 Ropax ferries single screw gas engines on order
- The 5 ferries are doing 35 port calls/day-51000/year
- Order options and feasibility studies for LNG bunker barges, Ropax, container ships, tug boats, OSVs and general cargo vessels



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End

Thank you for your attention

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Technological and Business Development

LNG fuelled vessels Campaign

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