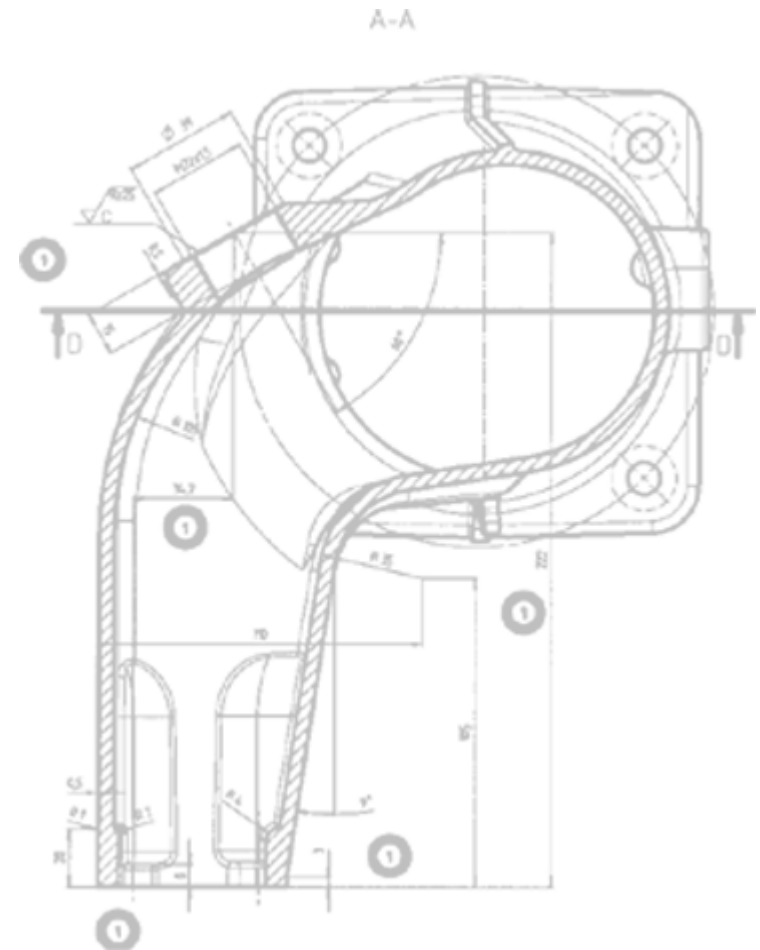


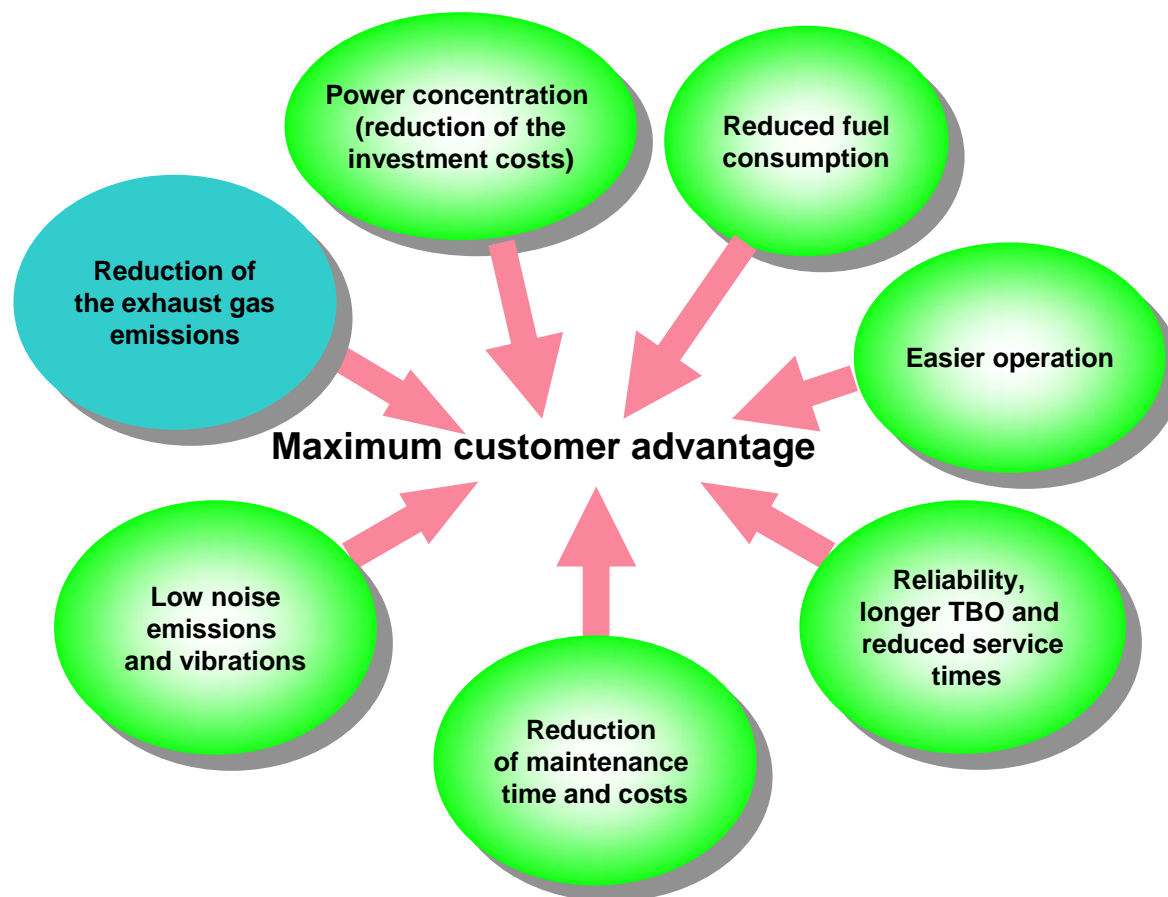
Considerations of Engine Manufacturers on Reduction of Emissions From Seagoing Ships

Lisbon
15 Feb 2007



The Euromot Position at BLG

Requirements on Marine Diesel Engines



Euromot Proposal to BLG10 Based on Fuel Types Engines are Designed for

Euromot proposals on new emission limits

- 1 Euromot proposes to introduce new emission limits based on the fuel type the engines are designed for and the engine size, as given by the cylinder swept volume.
 - (a) Regarding NO_x a reduction of 2 g/kWh against current limits (as given by the formulae in paragraph 3(a) of Regulation 13 of Annex VI) is proposed
 - for engines with a displacement ≥ 30 liters/cylinder
 - for engines with a displacement between ≥ 5 liters/cylinder and < 30 liters/cylinder that are designed for Heavy Fuel Oil operation
 - (b) For engines with a displacement < 30 liters/cylinder and a power output of more than 130 kW that are designed for Distillate Fuel Oil operation an adoption of EU Stage IIIA emission limits for inland waterway vessels and US-EPA Tier 2 emission limits for category 1 and category 2 marine engines is proposed.
 - (c) The new emission limits should enter into force not earlier than three years after adoption by MEPC.

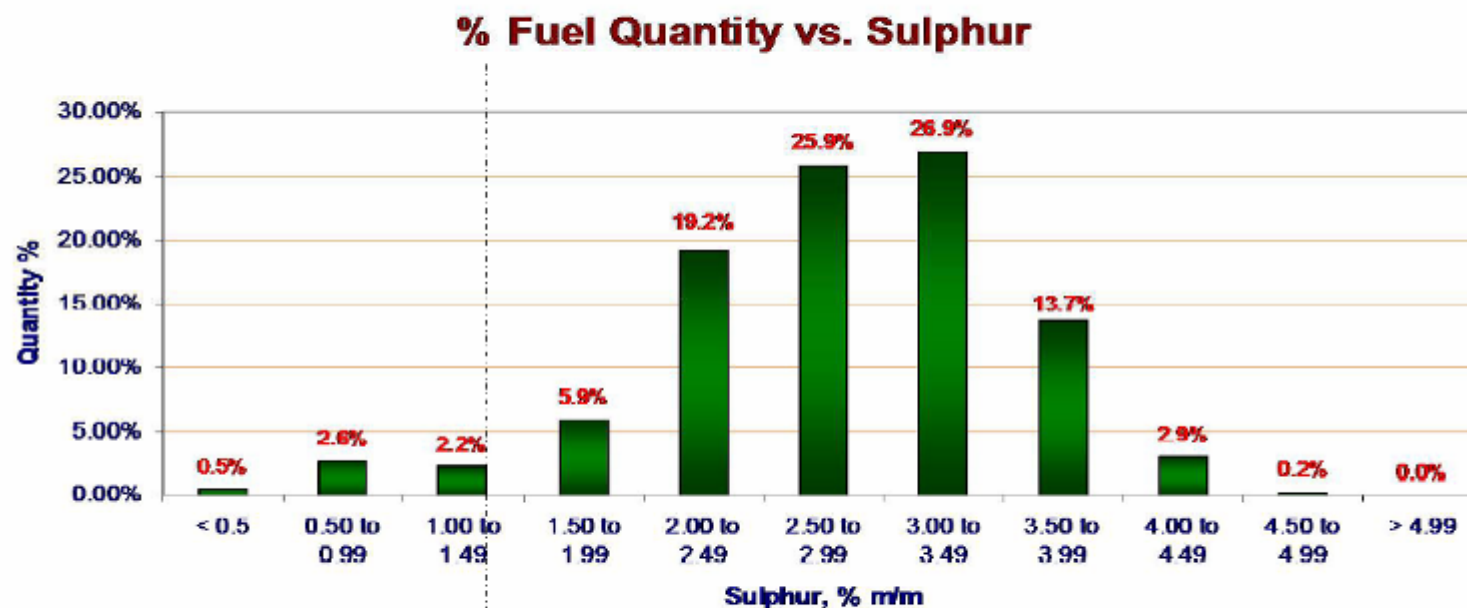
Results from IMO BLG WGAP Meetings

- Annexes 5 to 7 from BLG10 WGAP Report on technical options for
 - 2-stroke HFO
 - 4-stroke HFO
 - 4-stroke Distillate
- Results of the Oslo 2007 WGAP meeting (Splinter group on emissions)

Considerations on Fuel

Sulphur Content of Bunker Fuels (HFO)

2004 Worldwide fuel sulphur distribution



1.5%

Fuel Constraints for Large Marine Diesel Engines

- Envisaged to be valid 2015+
- MDO/MGO (distillate fuels) particularly in environmentally sensitive areas
- HFO with reduced sulphur content, e.g. in SECAs
- HFO, possibly even with lower grade than today

Criteria for Fuel Selection

Legal requirements

- Air pollution
- Waste from fuel treatment and from fuel combustion

Availability

- Infrastructure
- Risk of discontinuance

Fuel costs

- Fuel price
- Costs for treatment (investment for equipment and operating costs)

Plant investment costs

Plant maintenance costs

General Considerations on Emission Reduction Options

Emission Reduction Requirements for Large Marine Diesel Engines

IMO considers following requirements:

- NOx reduction in a 2-step approach:
 - from 2010/2011 „Tier2“ as achievable by in-engine measures
 - from 2015/2016 „Tier3“ possibly by using after-treatment
- SOx reduction by limitation of fuel sulphur content or by adequate exhaust gas cleaning devices
- PM reduction: as PM from HFO operated engines consist of mainly sulphates (up to about 80%) limitation may be done as for SOx

Summary Particulates

- Elemental carbon (soot) is by far the smallest part of the particulates emitted by HFO fuelled large bore medium speed Diesel engines.
The amount is comparable to automotive-derived high speed engines.
- The amount of organic carbon is larger for a medium speed than for a high speed engine. This is due to the higher oil consumption (lube oil exchange is not usual for big marine engines).
- The main part of the particulates in HFO operation consist of sulphur products and ash. These come from the fuel and cannot be influenced by the engine.

Summary SCR

- SCR is the most effective technology for the reduction of NO_x.
An efficiency of 85 % in dynamic operation is achievable.
- The space requirements, investment and operating costs are considerable.
- Operation on standard HFO with a sulphur content higher than about 1% may lead to clogging of the catalyst because the exhaust gas temperatures of today's four-stroke engines are too low, at least under most operating conditions.
- Several ships have been running with SCR and low sulphur fuel for some years now.

Technical Aspects for SCR Operation Near to Shore

- To avoid ammonia sulphate formation a minimum exhaust gas temperature is needed which depends on the fuel sulphur content.

For 4-stroke engines SCR operation typically is possible under the following conditions

- fuel sulphur content < 1% in general
 - fuel sulphur content < 0.5% at low engine part load
- Before entering the zone where SCR shall be used, switching from high-sulphur fuel to low-sulphur fuel (low-sulphur HFO or Diesel Oil) is needed
 - SCR components (honey-combs, urea injection) may foul if not used for longer time periods → open technical issue for SCR system suppliers

Safety Aspects for Switching between HFO and Diesel Oil

- Diesel Oil (DO) may have low lubricity → to be resolved by oil companies
- DO and HFO may show incompatibility → to be resolved by oil companies
- Low-sulphur DO need a lower lube oil TBN than high-sulphur HFO → not „consumed“
Lube Oil additives may cause cylinder liner lacquering and piston seizures → to be resolved by oil companies
- Switch-over from hot HFO to cold DO must be done „smoothly“ to avoid injection pump plunger seizures and asks for a minimum size of the booster circuit → vessel-side fuel system

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