CIMAC
INTERNATIONAL COUNCIL
ON COMBUSTION ENGINES

中国石油

Requirements of Marine Lubricants on Emission and Environmental Protection Regulations

11th CIMAC CASCADES
11 OCTOBER 2019 | WUXI, CHINA

Mr Piao Jicheng | PetroChina Lubricant Company

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Outline

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- Marine Lubricants & Drives
- MARPOL Annex VI--IMO2020
- New Requriments of Marine Lubricants
- The Selection of Marine Lubricants

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Marine Lubricants & Drives

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Marine Lubrication

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Marine lubrication includes the use of ancillary products such as hydraulic oils, compressor oils, gear oils and grease

Main Engine & Auxiliary Engine

VGP

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Vessel General Permit

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- The VGP regulates discharges incidental to the normal operation of all non-recreational, non-military vessels (>79 feet) in waters of the United States .
- From 19th Dec 2013 all 'vessels' in the 'waters of the United States' **must use 'Environmentally Acceptable Lubricants'** (EALs) in all oil to sea interfaces.
- 'Waters of the United States' means anywhere within 3 miles of the US coast.

EPA regulates vessel discharges with the Vessel General Permit

MOU between EPA and Coast Guard for implementing and enforcing the VGP

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Typical EAL

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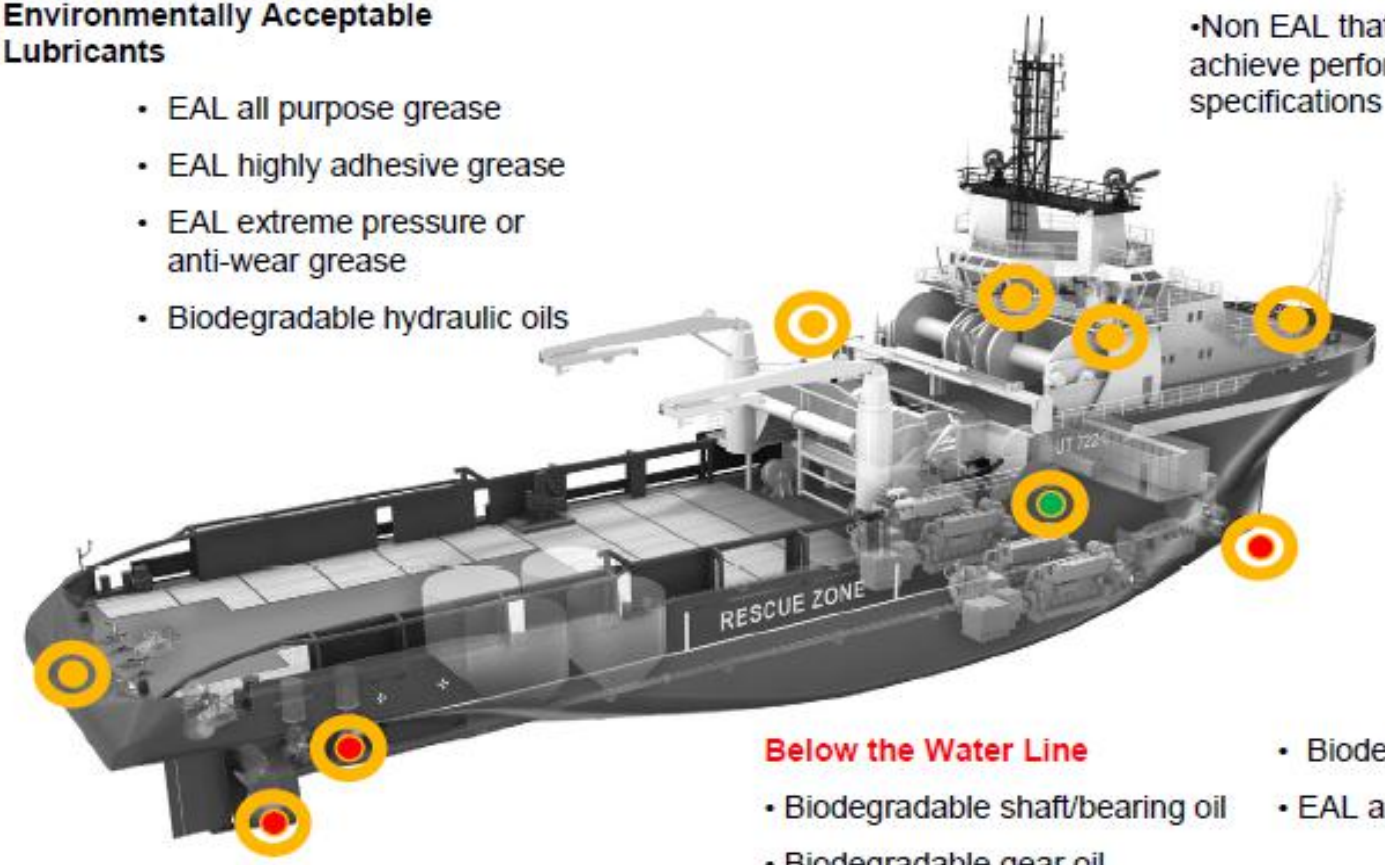
On Deck:

Environmentally Acceptable Lubricants

- EAL all purpose grease
- EAL highly adhesive grease
- EAL extreme pressure or anti-wear grease
- Biodegradable hydraulic oils

Below Deck:

•Non EAL that achieve performance specifications



Below the Water Line

- Biodegradable shaft/bearing oil
- Biodegradable gear oil
- Biodegradable hydraulic oil
- EAL anti-wear grease

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4-T & 2-T

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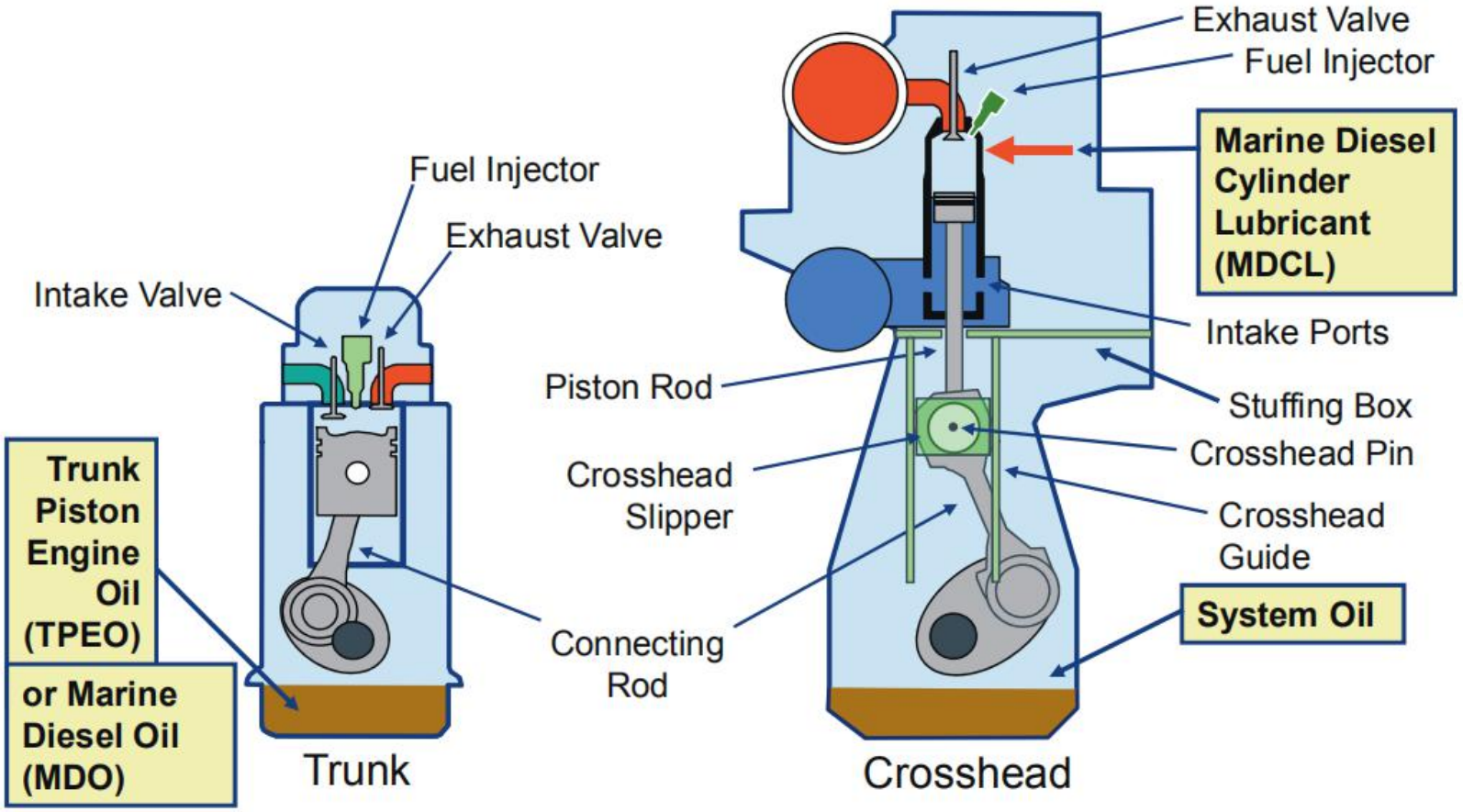
Main Engine & Auxiliary Engine



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4-T & 2-T Marine Lubricant

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	Viscosity	Base Number
System Oil	SAE 30 (or 40)	5 – 7
Cylinder Lubricant	SAE 50	70 – 100 ~40 for low sulfur fuels
Marine Diesel Oil	SAE 40 (or 30)	~15
Trunk Piston Engine Oil	SAE 40 (or 30)	40 – 55

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Drives

A	B	C	D
CO2 emission	NOx	SOx	Market Source
Fuel Economy	EGR SCR	low S Fuel	higher Saturated Base oil

Fuel Economy

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- Engine Design--Long Stroke
- Slow Steaming--Fuel Saving

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Group II--Asphaltene

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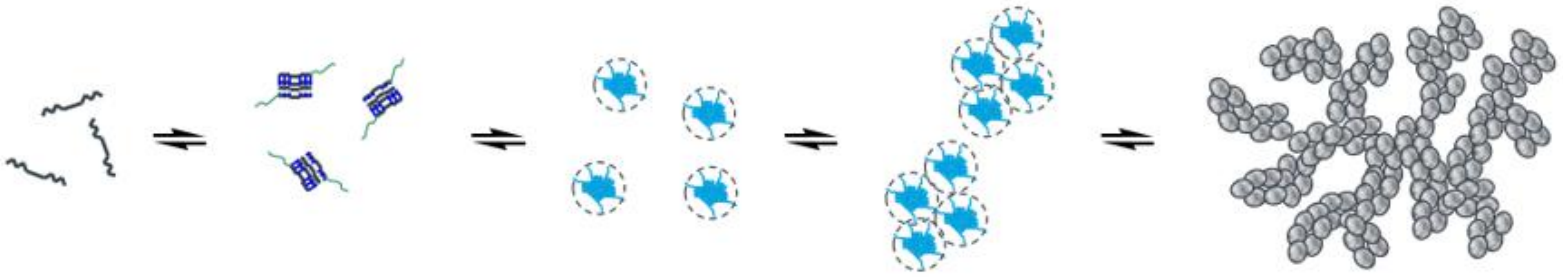
Asphaltene Stability



Asphaltene Sheets

Π–Π Stacks

Self Assembled 'Micelles'

Aggregates of 'Micelles'

Onset of agglomeration Leading to sludge

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MARPOL Annex VI--IMO2020

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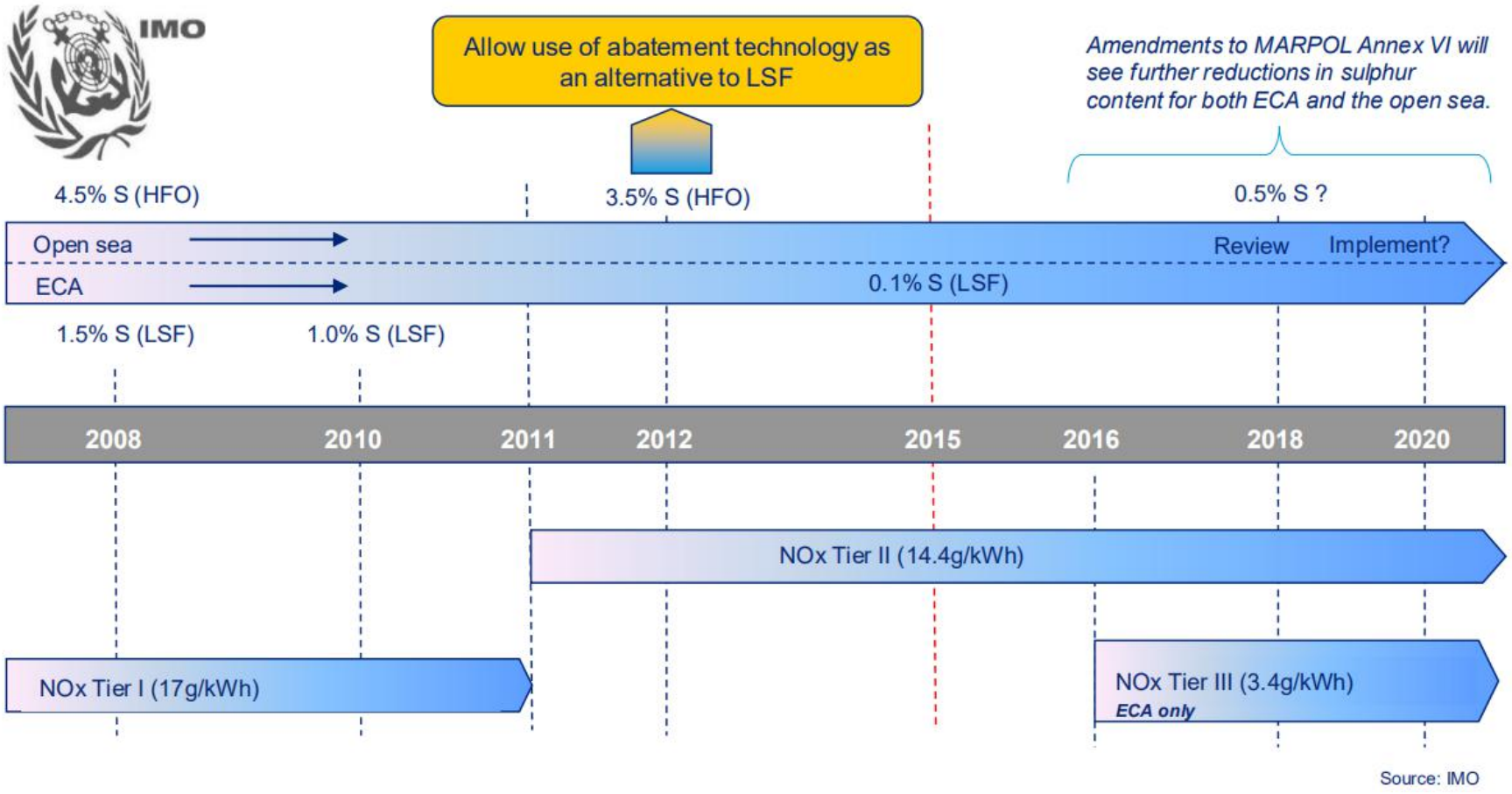
MARPOL Annex VI



Emission Control Areas

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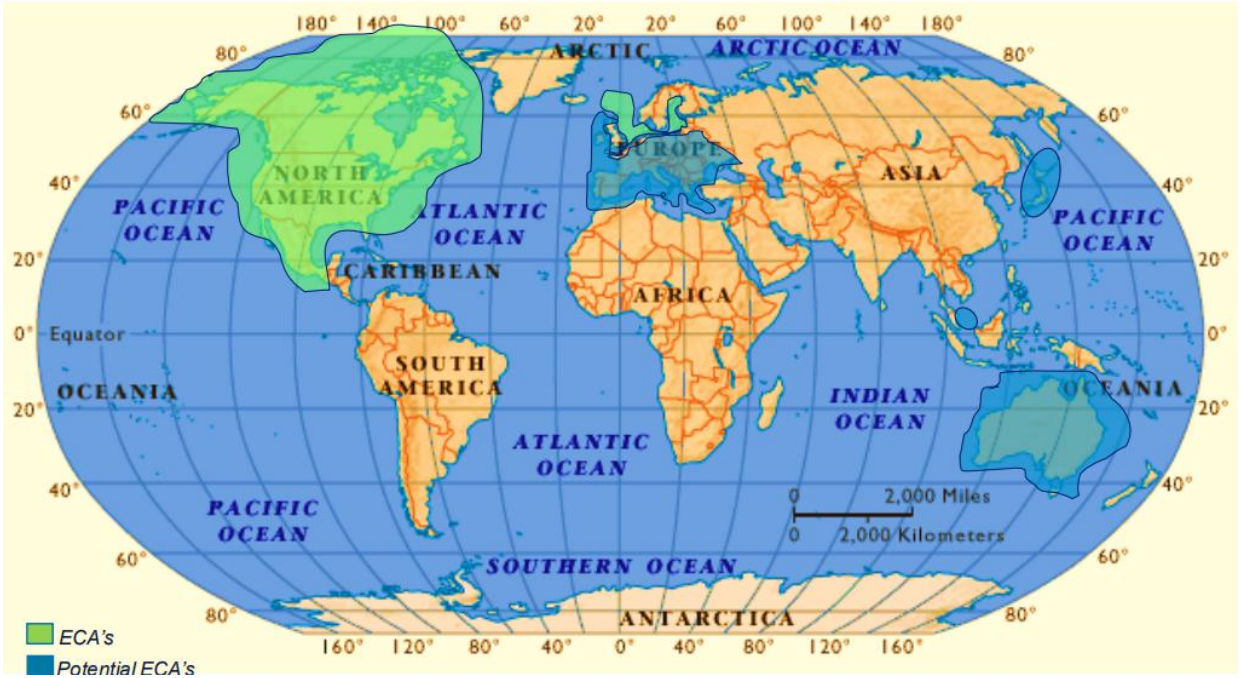

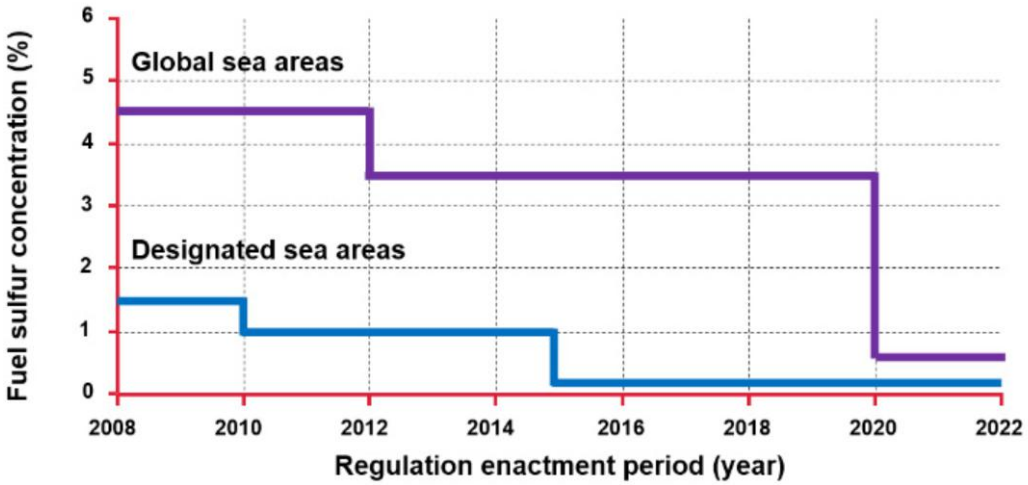

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2020 and beyond fuel outlook

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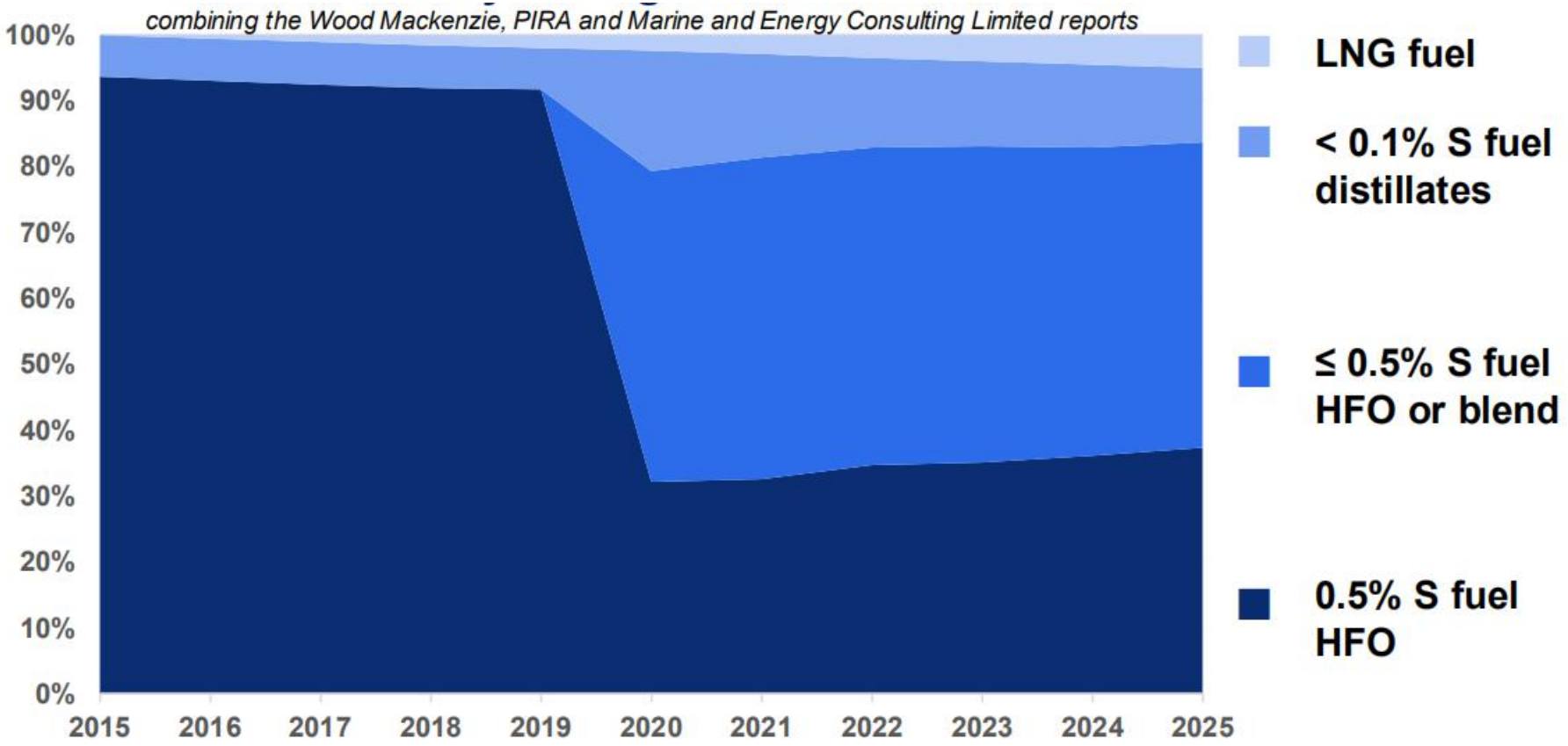

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New Requriments of Marine Lubricants

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Requriments

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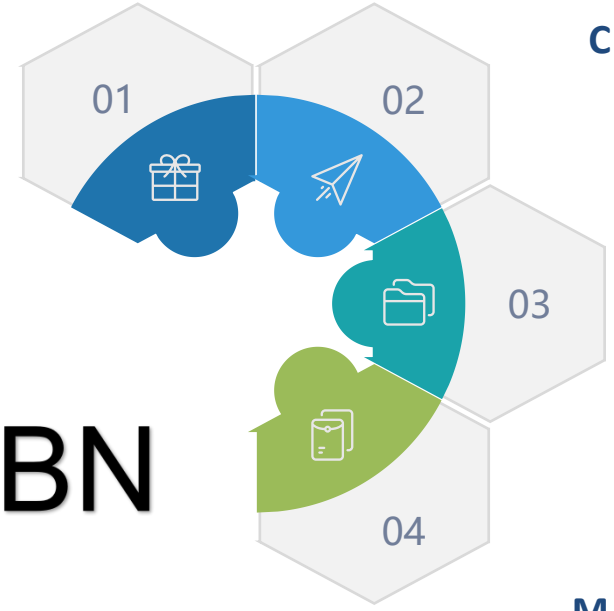
Control corrosive and adhesive wear



Control deposit formation

Provide stable oil film between ring and liner

Maintain good gas seal between ring and piston grooves

Viscosity & BN

Major OEMs:

- MAN Energy Solutions
- Winterthur Gas & Diesel (WinGD)
- Japan Engine Corporation (J-ENG)

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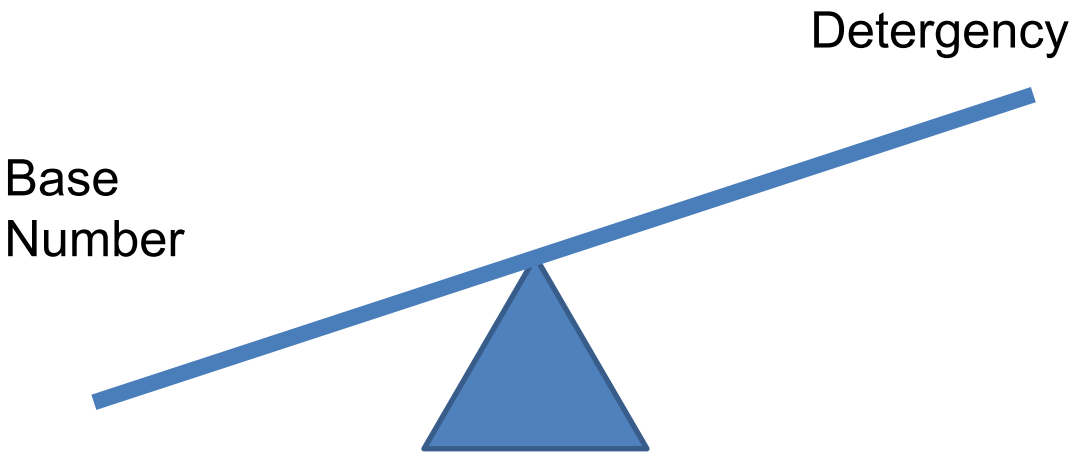
Basicity & Detergency

Balance between base number and detergency is important.

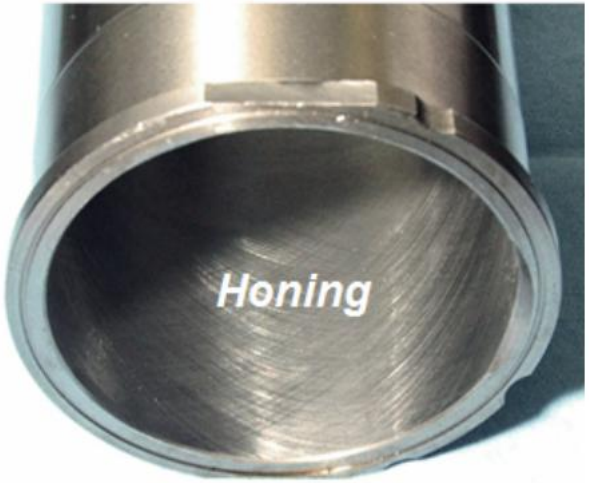


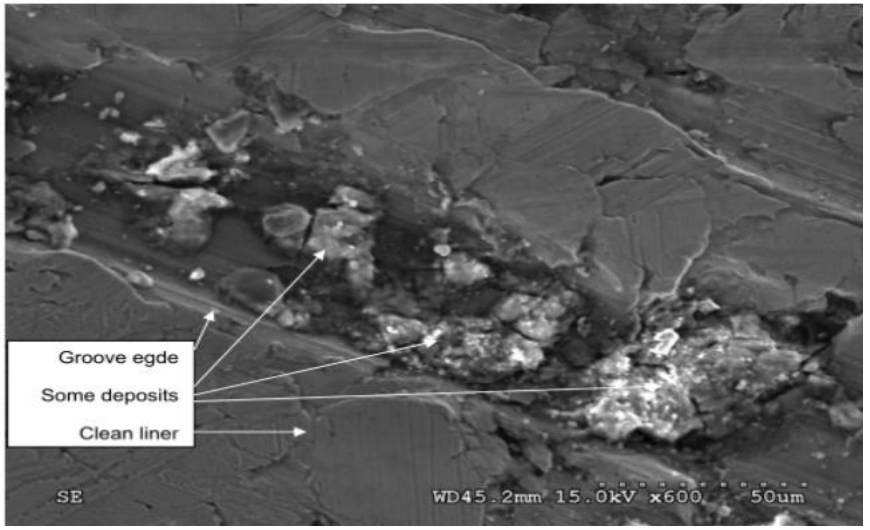
Fuel sulfur content	Typical MCL base number
≥1.0% HFO	70-140BN
≤0.5% HFO or blend	40BN
≤0.1% MDO/MGO (distillate) or LNG	15-25BN

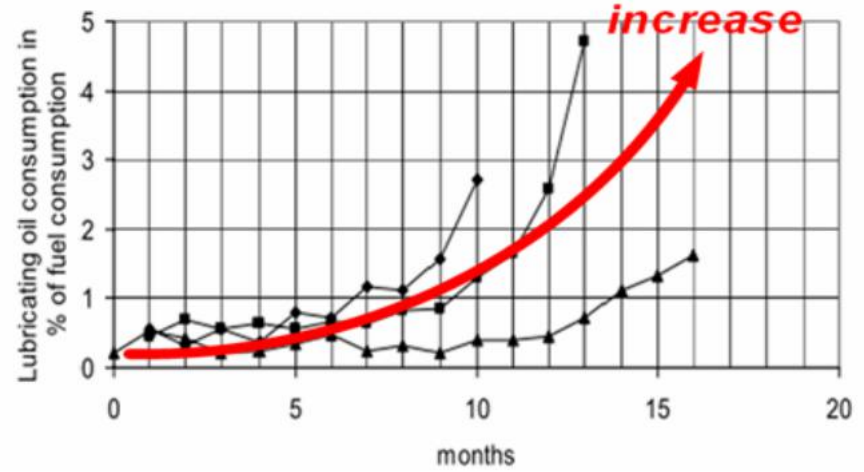
Base number requirement varies with the fuel sulfur level

- too little BN may lead to excessive corrosive wear
- too much BN may lead to hard piston deposits

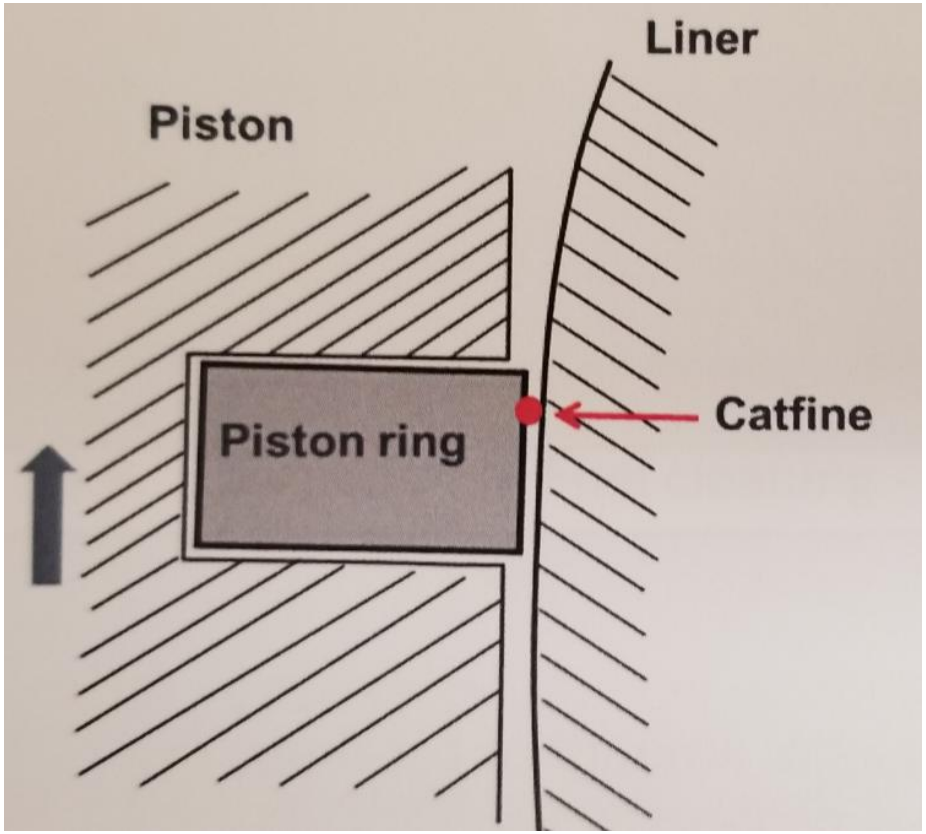
Lacquer Formation

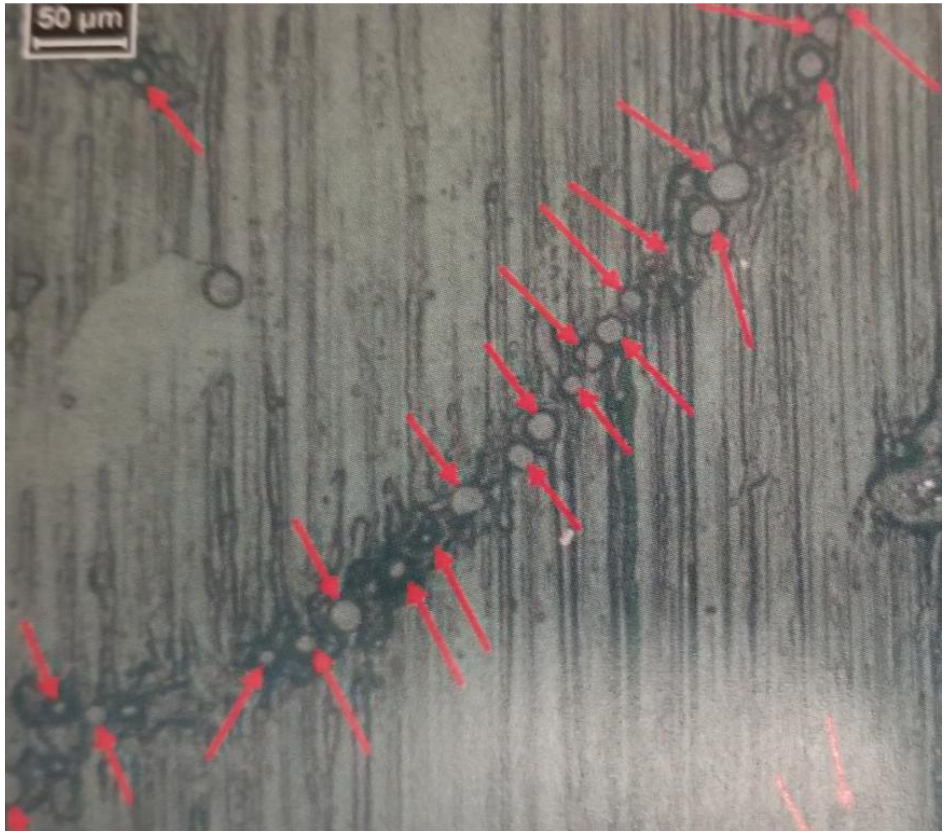






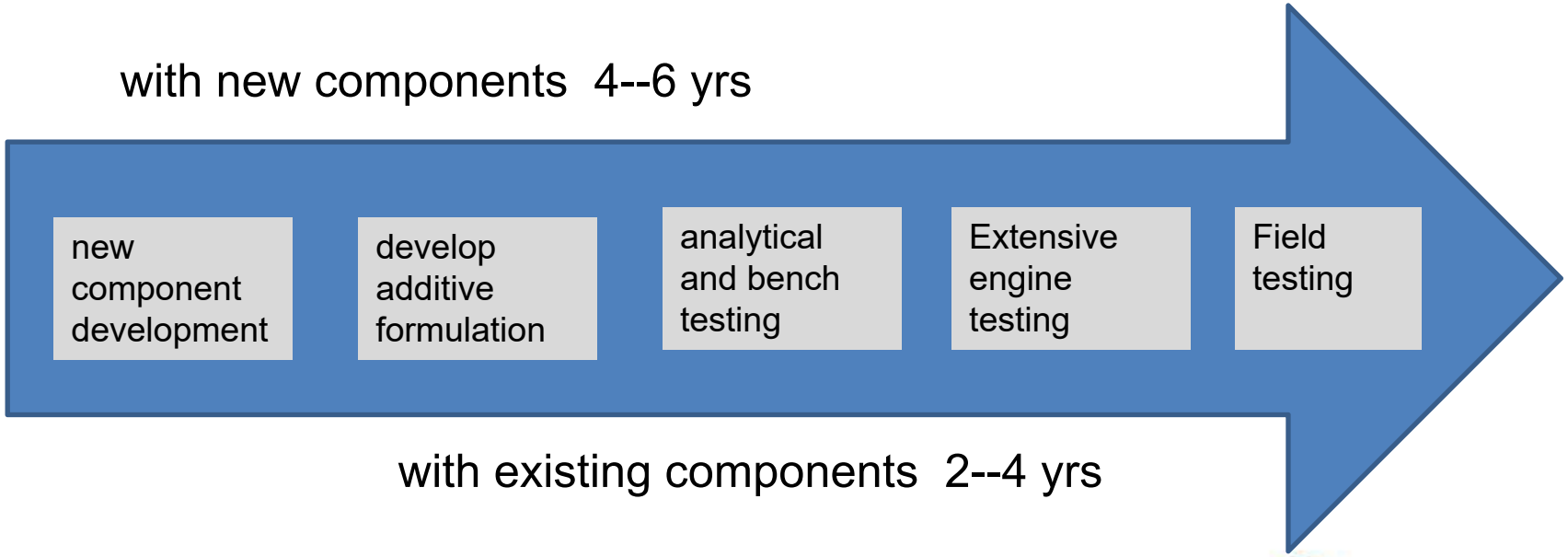
Cat Fine





R&D

The process continues with rigorous testing in our dedicated marine bench and engine test laboratory. Test results are compared to that of oils from major suppliers.
The additive is lastly tested in field as proof of performance to obtain OEM approvals.



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The Selection of Marine Lubricants

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Selection Criteria

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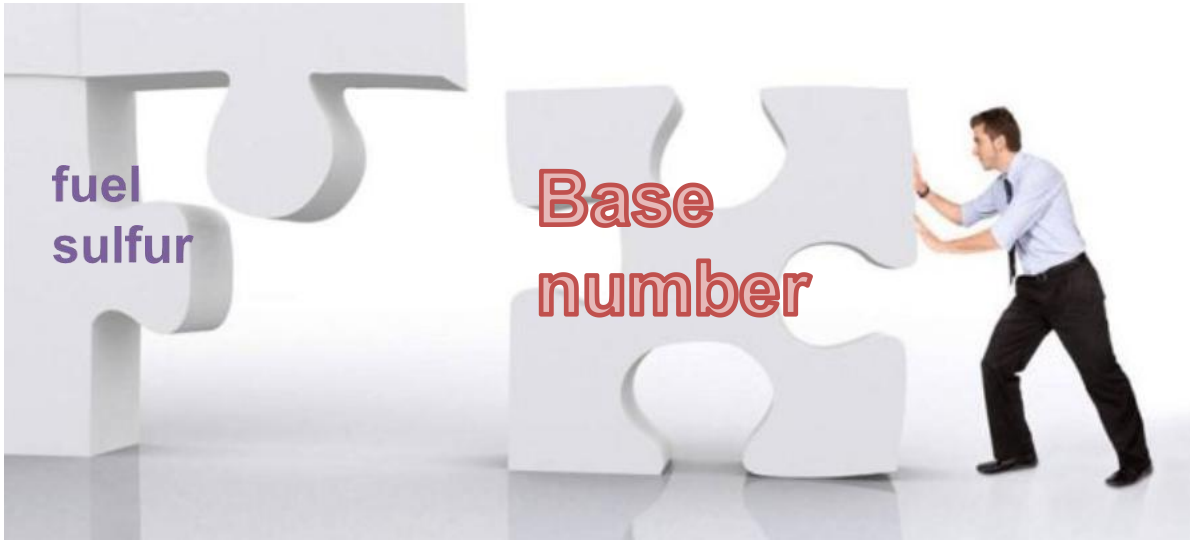
OEM Approval （NOL）

Base Number=====Sulfur

– Base number matched to fuel sulfur and engine operation



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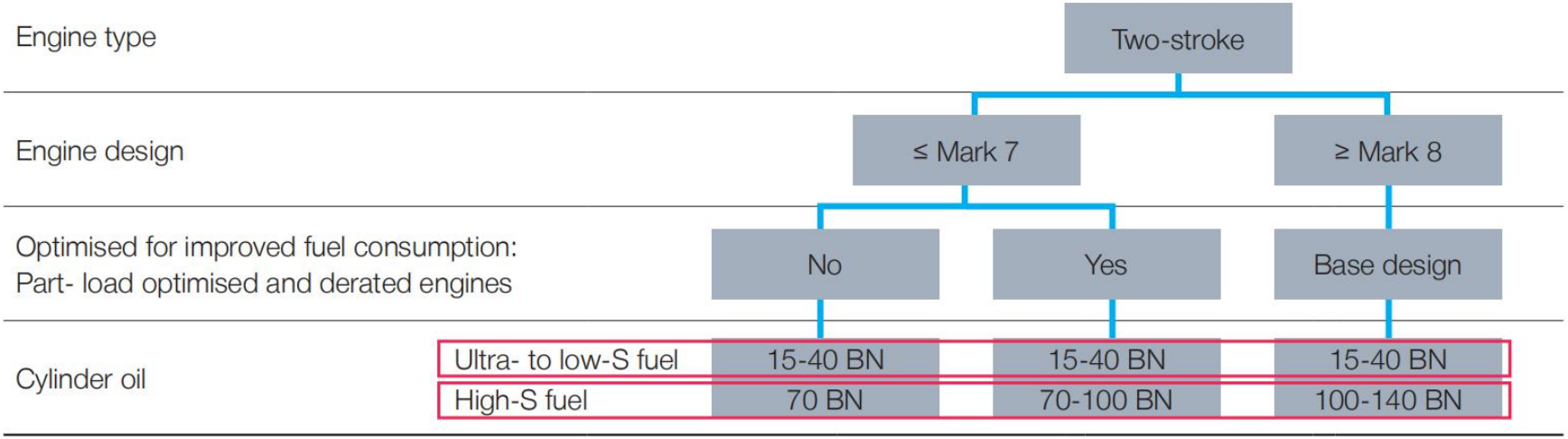
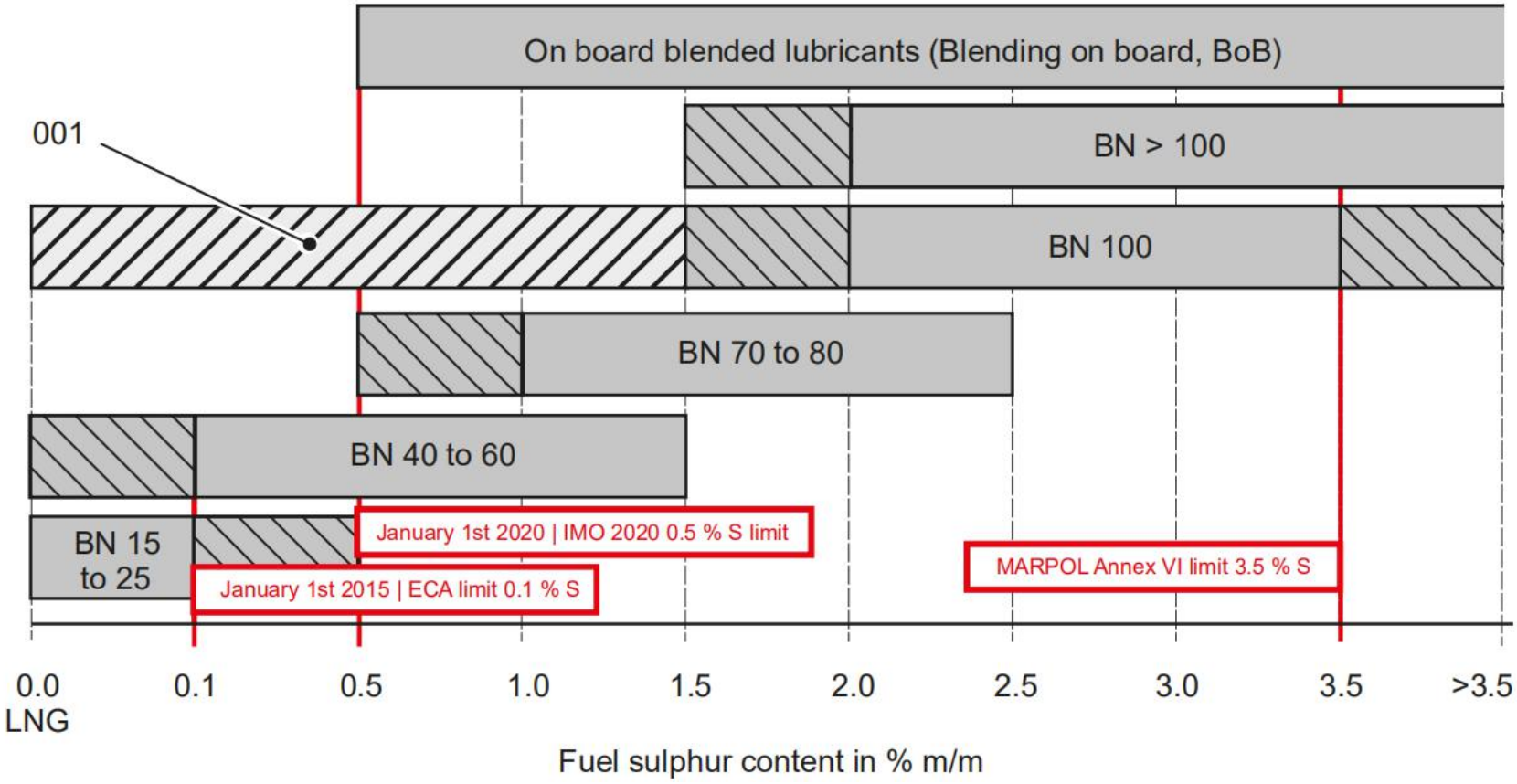
MAN ES


Engine type
Two-stroke
Engine design
≤ Mark 7
≥ Mark 8
Optimised for improved fuel consumption:
Part- load optimised and derated engines
No
Yes
Base design
Cylinder oil
Ultra- to low-S fuel
15-40 BN
15-40 BN
15-40 BN
High-S fuel
70 BN
70-100 BN
100-140 BN

WinGD


On board blended lubricants (Blending on board, BoB)
001
BN > 100
BN 100
BN 70 to 80
BN 40 to 60
BN 15 to 25
January 1st 2020 | IMO 2020 0.5 % S limit
January 1st 2015 | ECA limit 0.1 % S
MARPOL Annex VI limit 3.5 % S
0.0 LNG
0.1
0.5
1.0
1.5
2.0
2.5
3.0
3.5
>3.5
Fuel sulphur content in % m/m

Scrap Down Oil Analysis

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Main on borad analysis tools for checking the cylinder condition are:

- **cylinder lube drain oil analysis**
- scavenge port inspections
- wear measurements
- liner surface examination

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Scrap Down Oil Analysis--40BN+

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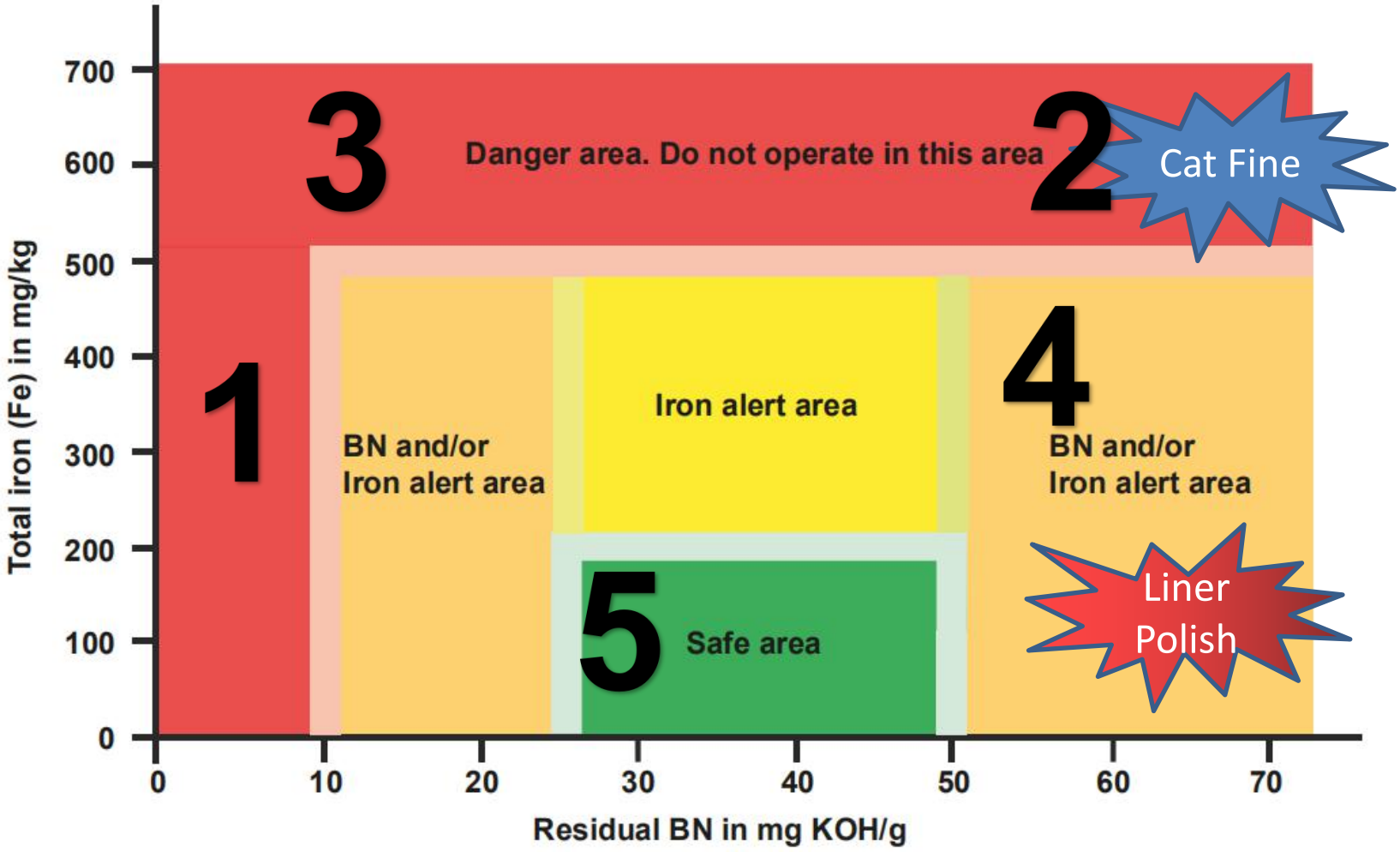

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Actions according Failure mode

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No.	Name	Failure mode	Actions
1	Cold Corrosion	The engine suffer from cold corrosion	Increase cylinder lube feed rate or change to higher BN oil
2	Cat fines in the fuel & too much BN	The engine suffers from abrasive wear from Cat Fines int the fuel, and might experience increased deposits from unused additives in the lube oil	Check fuel Centrifuge efficiency and decrease cylinder lube feed rate/change to lower BN oil
3	Cat fines in the fuel	The engine suffers from abrasive wear from Cat Fines int the fuel	Check fuel Centrifuge efficiency
4	Too much BN	The engine might experience increased deposits from unused additives in the lube oil	Decrease cylinder lube feed rate/change to lower BN oil
5	Safe area	The engine wear is low and deposits from the cylinder lube should be low	Keep the engine parameters

Summary

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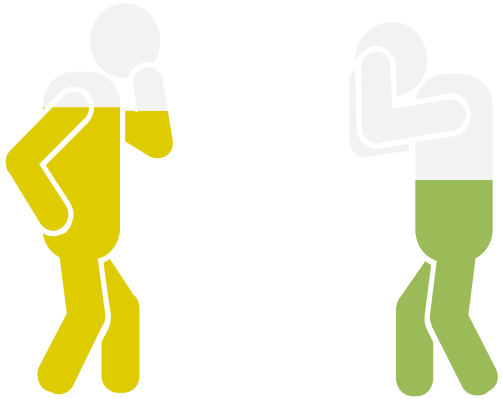
VGP

EAL



IMO2020

Match with Sulfur

more Requriments

Scrap Down Oil Analysis

suitable BN

suitable Feed Rate

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Thanks for your attention

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