



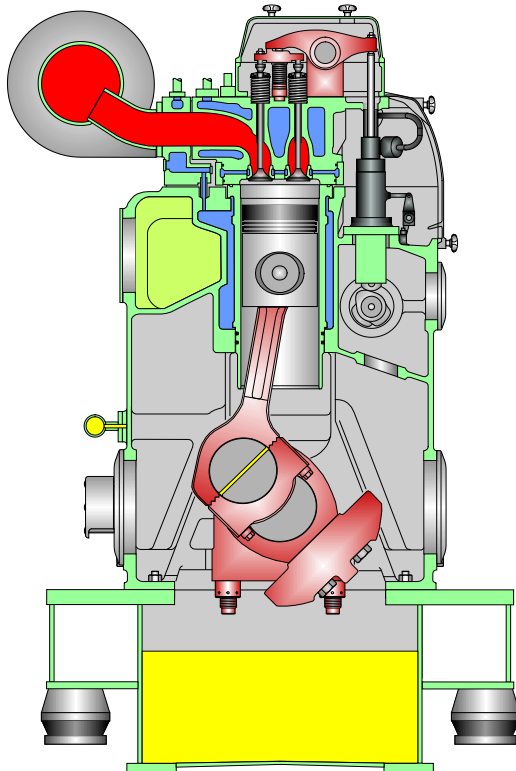
# Four-stroke Small bore GenSet Service Experience

# Small bore HFO gensets

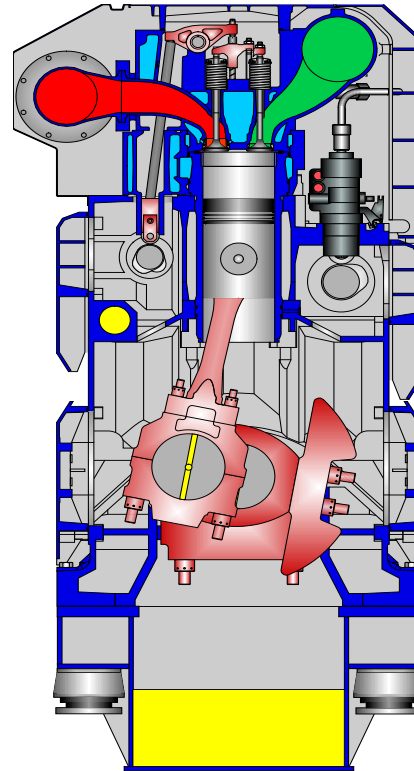
HFO 700 cSt @ 50°C



- 23/30
- 28/32



- 16/24
- 21/31
- 27/38



# Service Experience



## Genset operation task force

Onboard performance and installation checks carried out on 29 ships with L16/24 engines showing below-average performance .

## The four most common issues

- High exhaust gas temperatures
- Low TBO on fuel nozzles
- Sticking exhaust gas valves
- Low lifetimes on TC nozzle ring



## Most Effective Countermeasures

### Fuel

Installation of 25  $\mu\text{m}$  safety filter and 10  $\mu\text{m}$  backflushing filter  
Separator adjusted to min. 98°C and flow reduced

### Lube oil

Separator temperature adjusted to 95-98°C  
Flow reduced to 500-300 l/hr.

### Turbocharger

Daily dry cleaning and weekly wet cleaning of TC - DDWW

### Results

Increased lifetimes on fuel nozzles – 12,000+ hrs.

Increased lifetimes on TC nozzle rings – 16,000+ hrs.

## 2. Correct Atomization

Essential for Combustion



Damage due to cat fines



Combustion  
depends on  
molecular contact

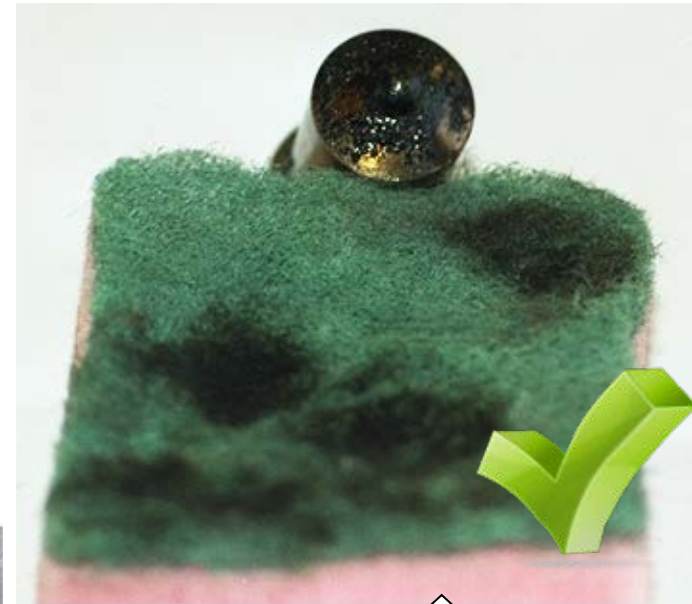
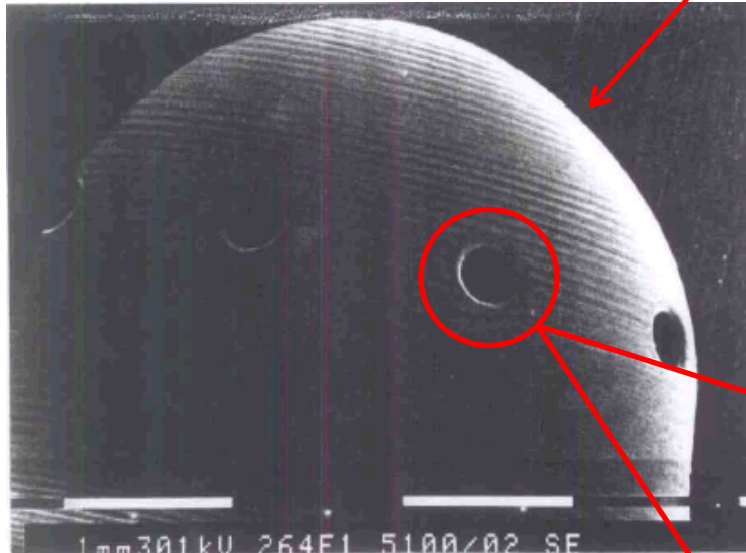


## 2. Fuel Nozzle Treatment

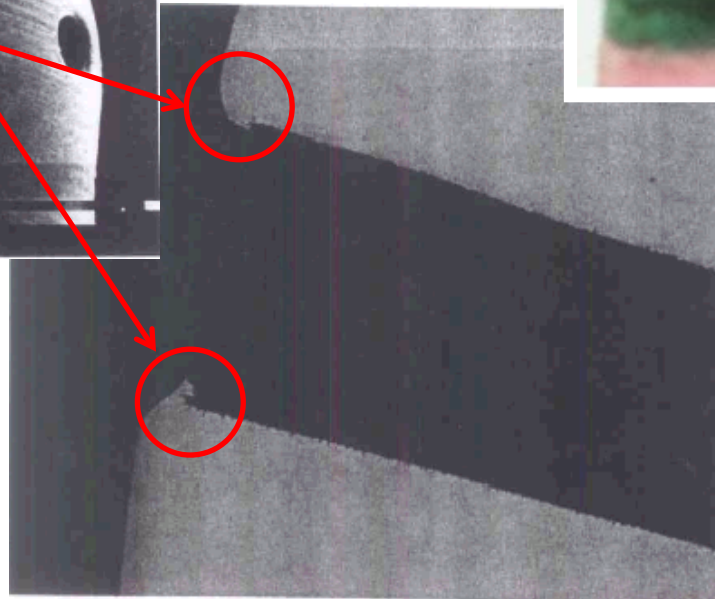
Warning



Damage from rotating steel brush



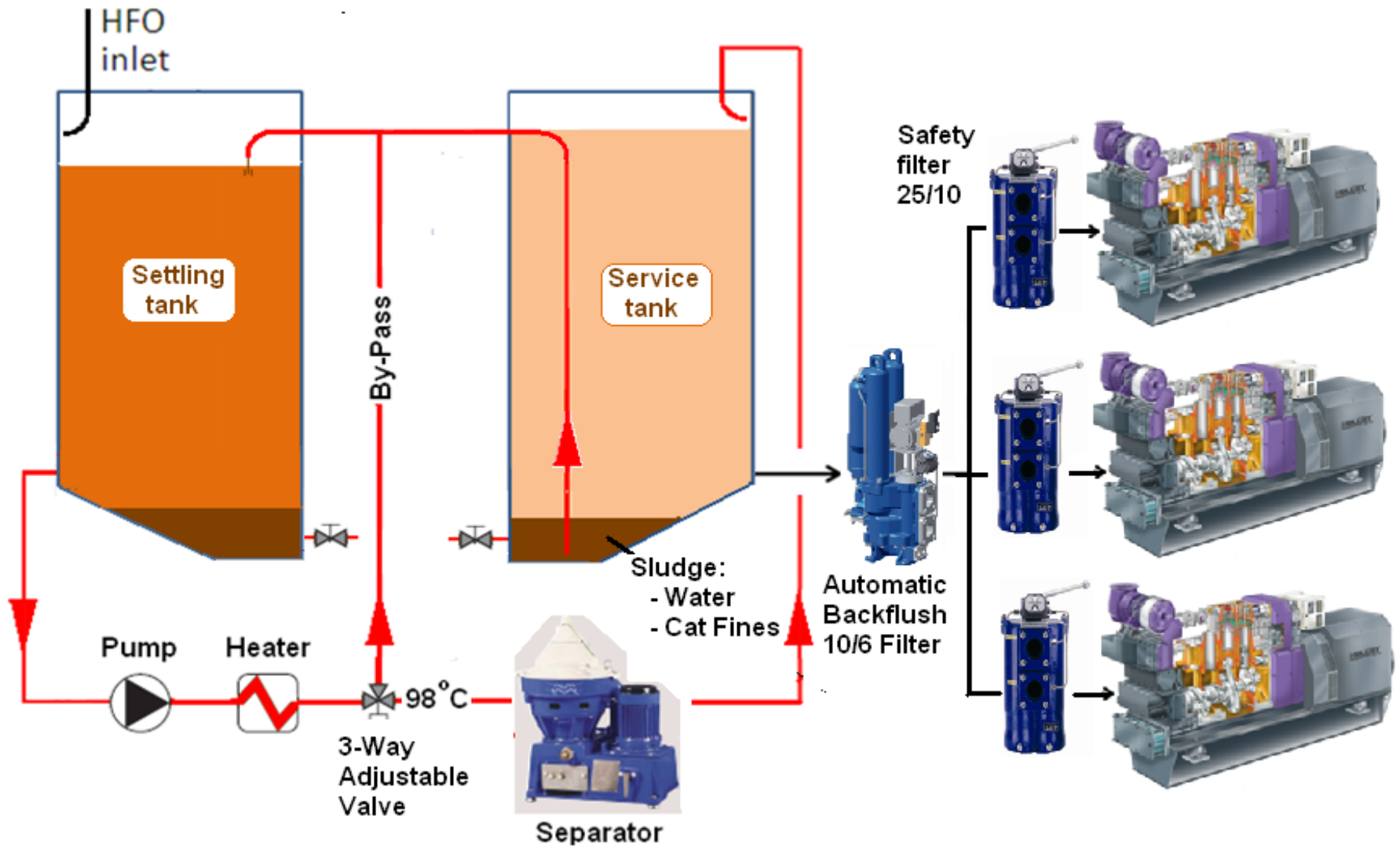
...cause poor combustion



Use 'Scotch Brite' and diesel for cleaning

# Fuel Oil

## Optimised separator flow and ST cleaning flow

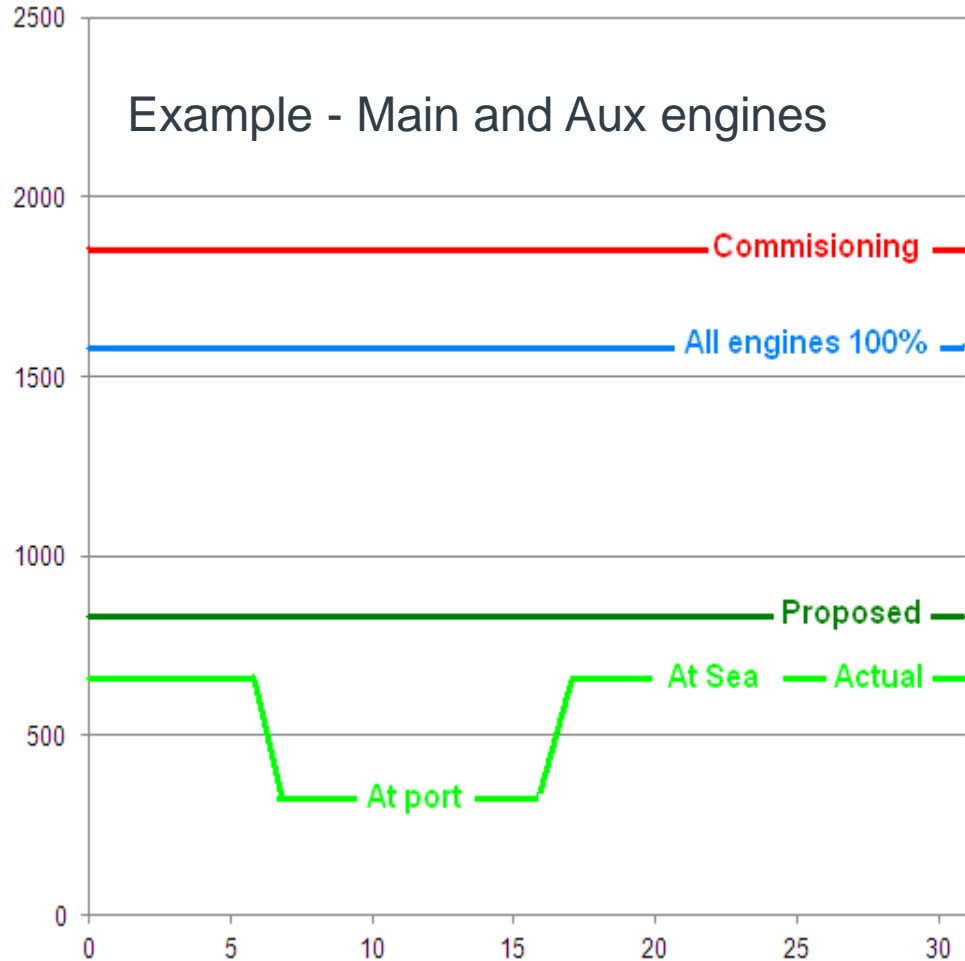


# Fuel Oil Separator - Optimized flow

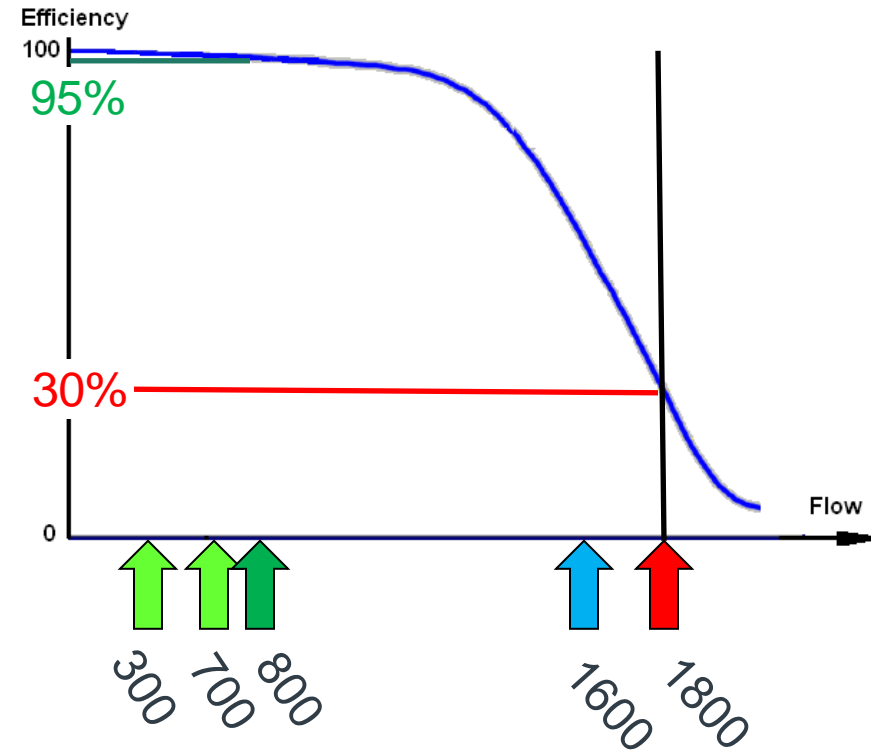
## Flow according to actual trade (slow steaming)



Separator flow



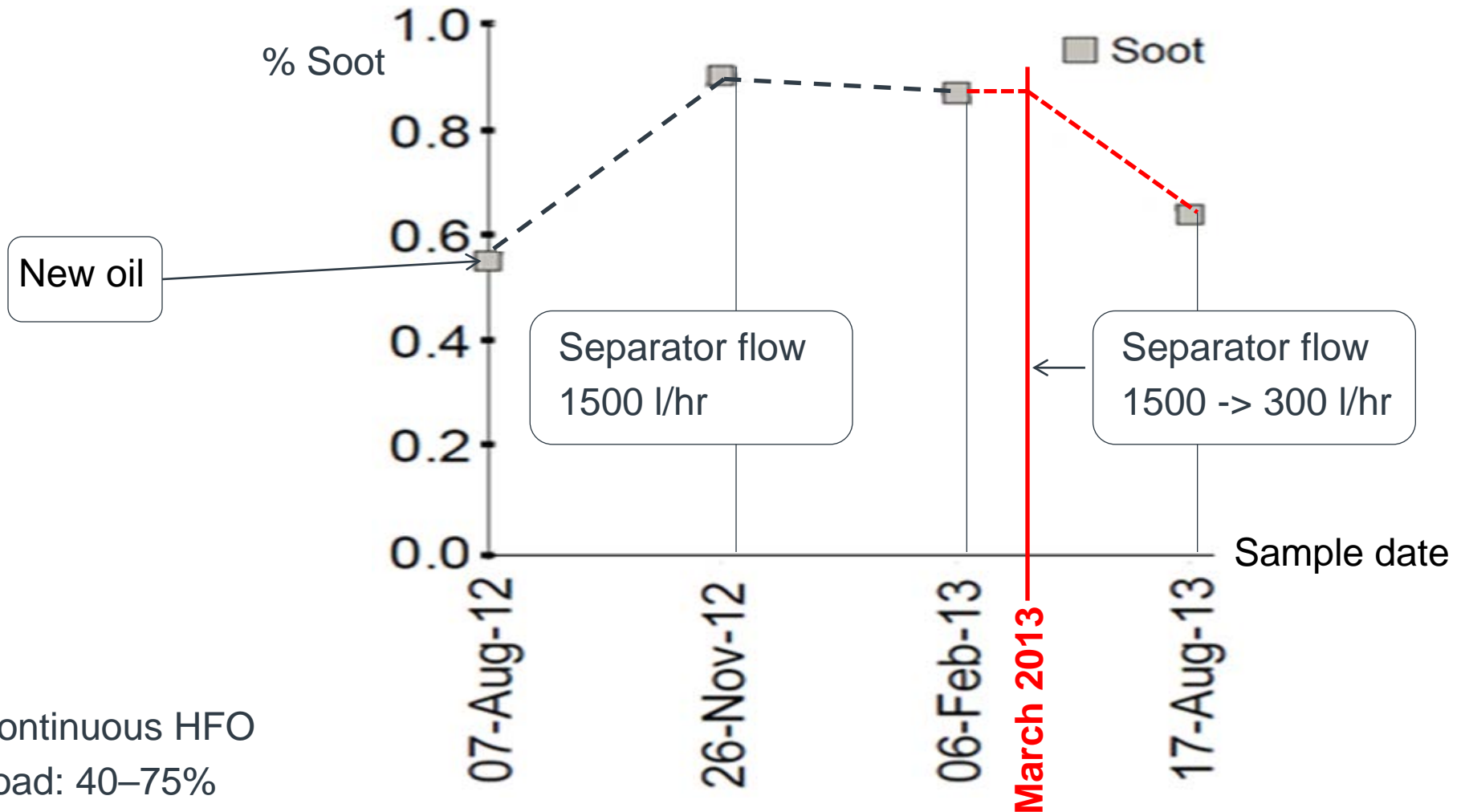
Separator efficiency curve





# Lube Oil Contamination Measurements

## Field test results



Continuous HFO  
Load: 40–75%

# Turbocharger Cleaning

Size matters



Engine Type	Nozzle Ring Area mm <sup>2</sup>	Fouling mm	Reduction mm <sup>2</sup>	Area reduction %
5L16/24	125	1.0	40.7	32.6
9L27/38	625	1.0	96.0	15.4

**Size Matters!**



# Exhaust Temperature

## Turbocharger fouling



Service letter coming!

→ Fouling turbine (coke deposit).

→ Lower turbocharger performance.

→ Lower air-flow/-pressure through the engine

→ Increasing exhaust gas temperatures.

**Daily: Dry cleaning**  
**Weekly: Wet cleaning**



Improved Texh: 30°C

# Service Experience M/V *Warnow Mars*

## Nozzle ring



2,000 running hours  
No cleaning of TC,  
neither by water nor by dry means

Worn out



6,000+ running hours  
Daily dry cleaning, weekly water washing  
Surface-coated nozzle ring  
**Good fuel treatment**

Expected lifetime – 16,000+ hrs.



# Cylinder Condition

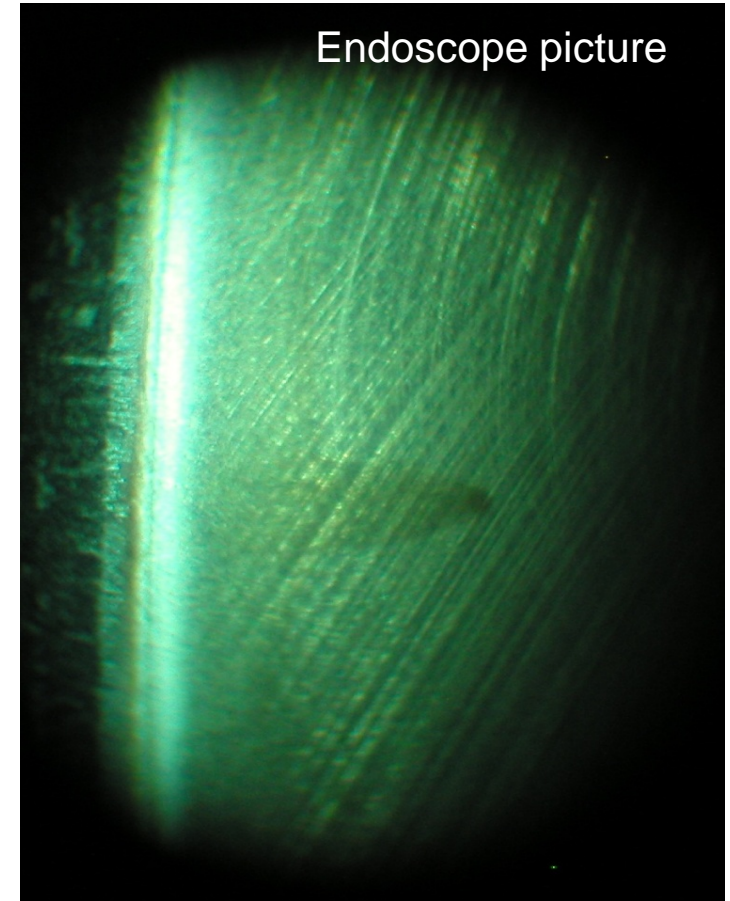
## Overview



**Good cylinder condition on 4-stroke engines is normal**

**Watch out for...**

1. Water carry-over - condensate
2. Cat-fines – coming in by HFO



L23/30 Liner condition after 32000 hrs



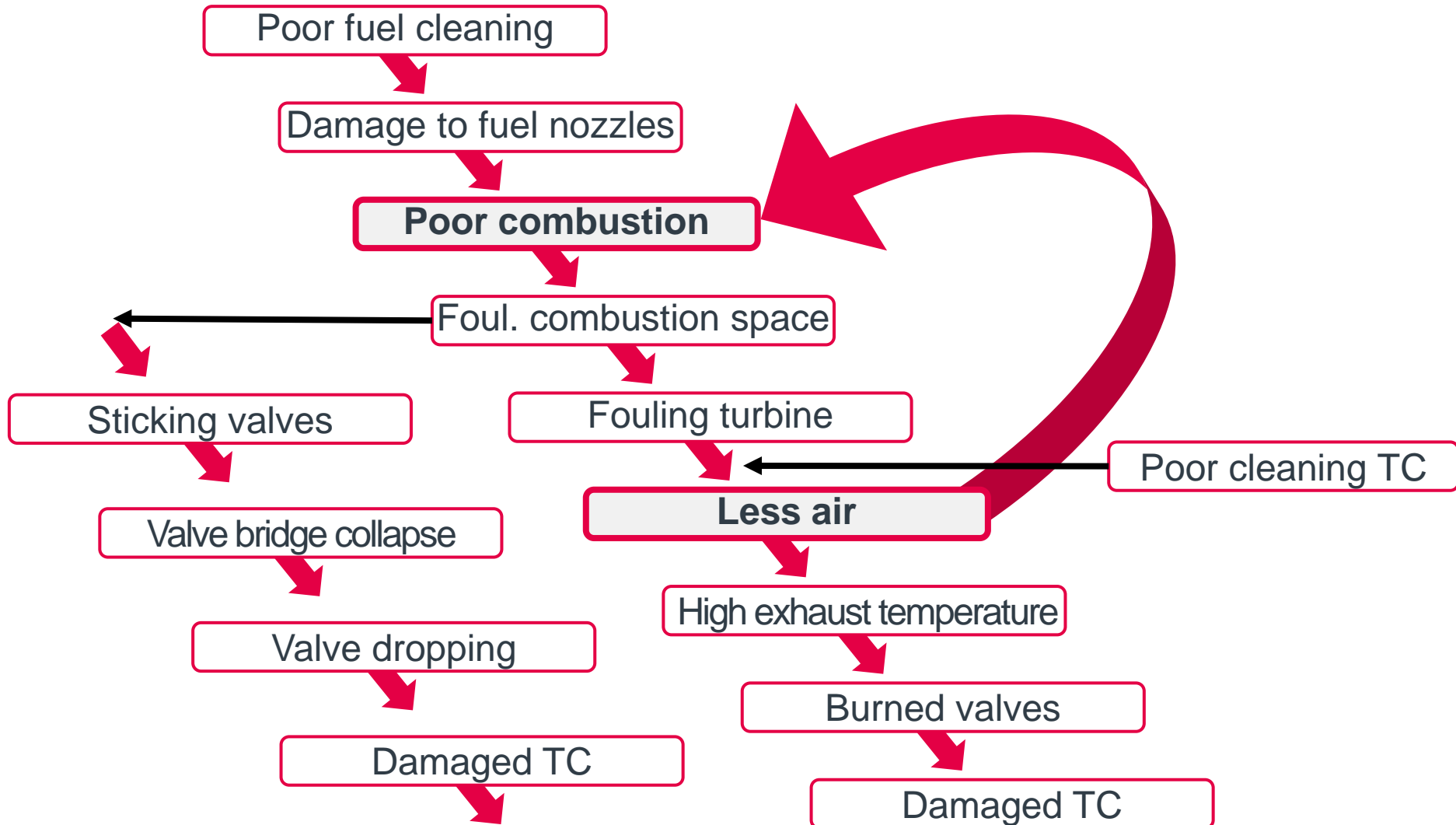
# Avoid Burned Valves

## Reasons...



1. Valve rotator
2. Seat angles
3. Worn valve guide
4. High temperatures
5. Material properties

# The Evil Circle...



A large dark grey ship hull is shown in a dry dock. The hull is supported by a yellow crane structure. Several workers in orange and white uniforms are visible on the dock. The background shows a body of water and other industrial structures.

# Recent Results

## Changes introduced:

- 25  $\mu\text{m}$  fuel safety filter installed,
- 6/10  $\mu\text{m}$  backflushing in Genset branch pipe
- Lube oil purifier: 85°C- $\rightarrow$ 95°C. 1000- $\rightarrow$ 500 l/hr. Running engine
- Turbocharger: water washing added to dry cleaning (DDWW)

# Recently obtained results:



## Fuel nozzles:

TBO-Initially (owner): 400 hrs.

Now - and continuing: 12.000 hrs.



## Fuel filters

25/10 µm safety filter 2 times cleaning per day, initially

25/10 µm safety filter 10-14 days after cleaning tanks

10/6 µm Auto-Backflush 5 month and happy crew 😊



## Lube oil:

Soot content: Within limits

Spin filter Within limits 10 mm Sludge/150 hrs

Replacement freq. 500 hrs → 2500 hrs.



## T/C, NR12/S, (DDWW)

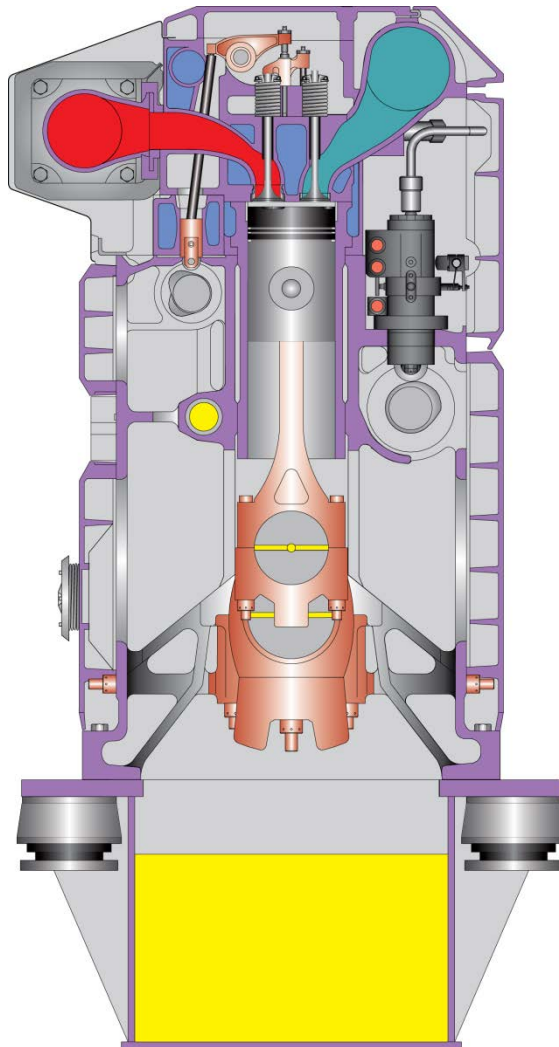
Inspection @ 6000 hrs: Very clean & low wear



**Exhaust Temperature Stable!**



# L16/24 - 2015



## Data

Bore	160 mm
Stroke	240 mm
No. of cyl.	5-6-7-8-9
Speed	1000 / 1200 rpm
Output / cyl.	90 / 110 kW

## Mean Effective Pressure

5 cyl. engine	22.4 / 20.7 bar
6, 7, 8, 9 cyl. engines	23.6 / 22.8 bar
Mean piston speed	8 / 9.6 m/s
Combustion pressure	170 bar
HFO	700 cSt

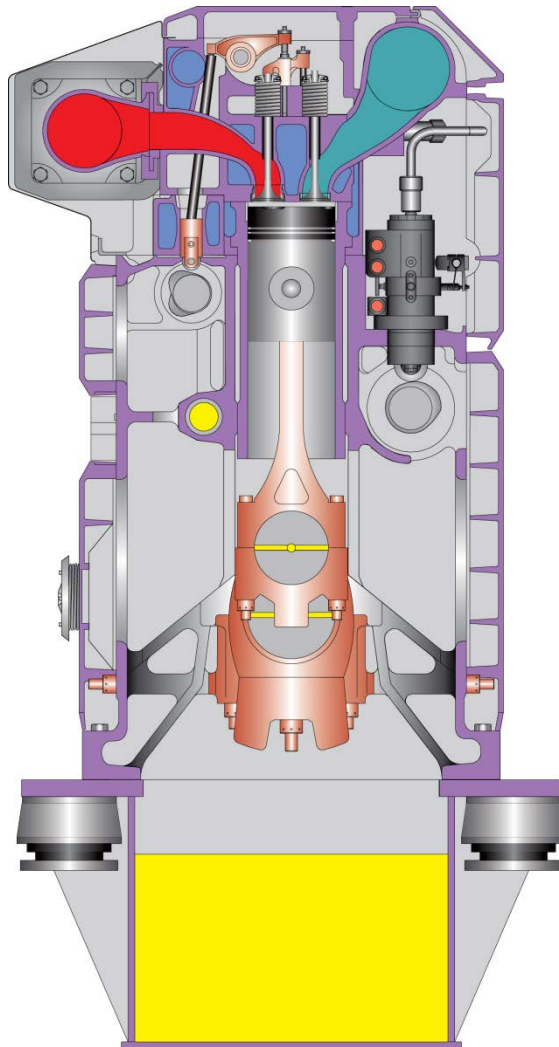
## General news:

- On-Engine fitted fuel safety filter – 25/10
- External automatic fuel filter 10/6
- TC cleaning optimised - DDWW
- Important service instructions as 'short/easy'-reader
- Technical training for ship crew
  - Officers conference – Holeby-hands on

**16,000 hrs. Engine TBO**  
**8,000 hrs. Fuel valves TBO**  
**3-year design warranty**



# L16/24 – Release January 2016



## Applications:

- Part load optimised
- 3-point installation

## New cylinder unit:

- Valve, exhaust DuraSpindle or Top Premium (Nimonic81 + Crystal coat)
- New piston ring pack

## Turbocharger:

- TCR10 (5L)

## Others:

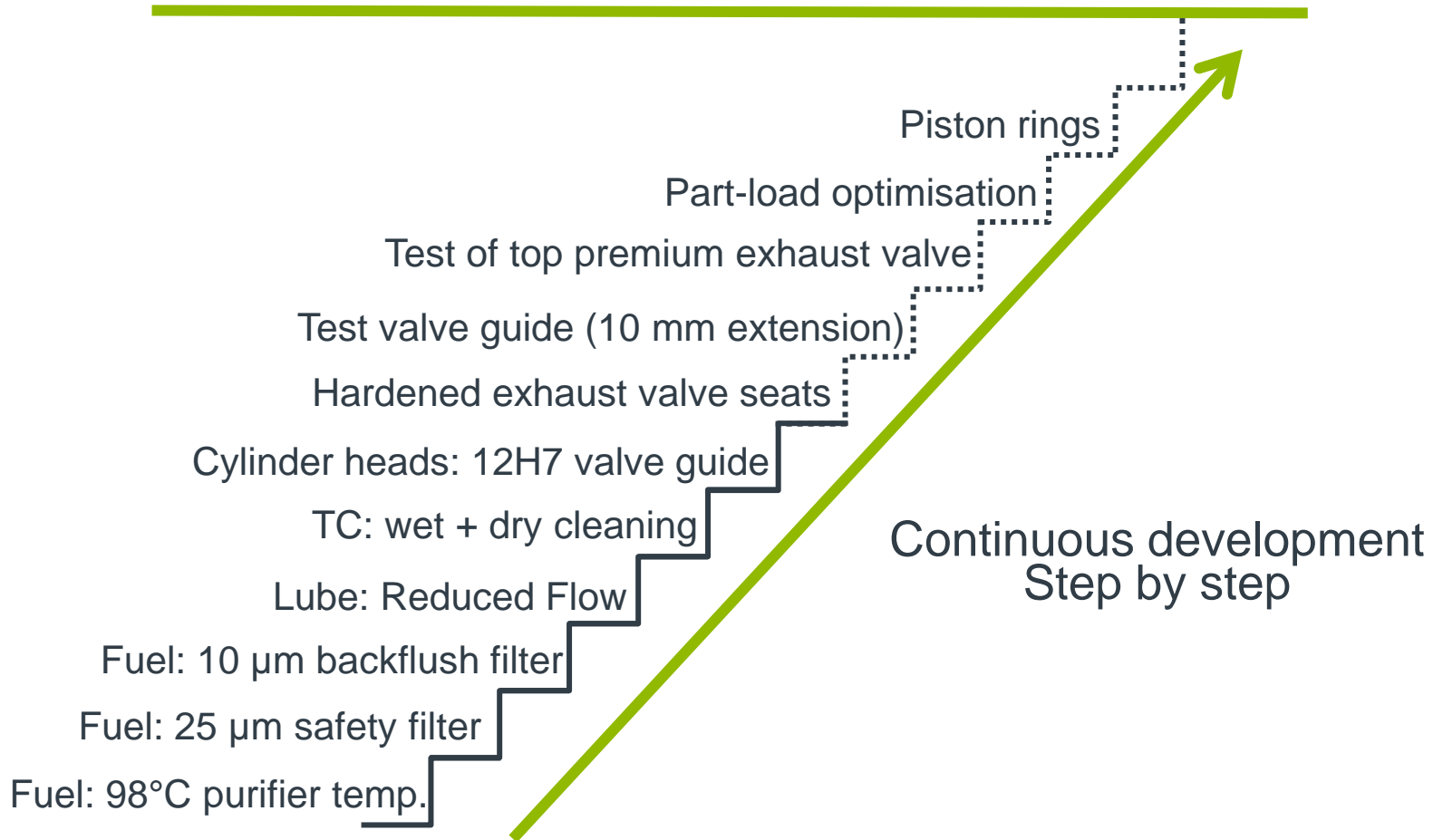
- Heat insulation on top FEB

# Project P25

Target 25,000 hours TBO



25,000 hrs. target – world class performer



# Thank You for Your Attention!



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