



Uptime anytime

MAN Energy Solutions
Future in the making



L23/30 Service Experience

Strictly
confidential

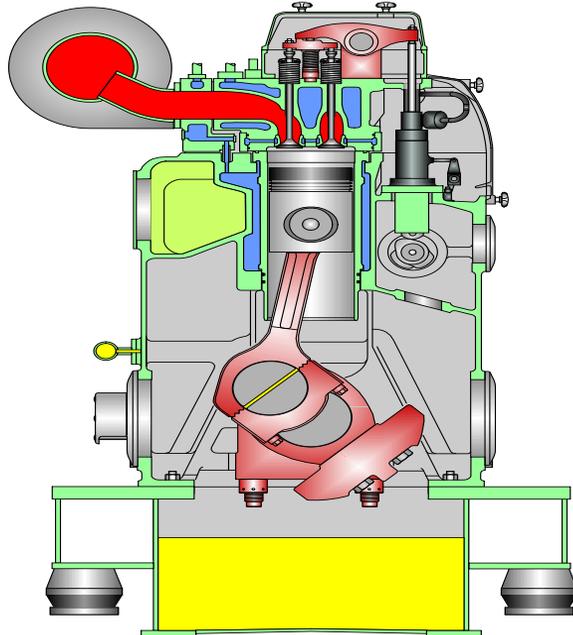
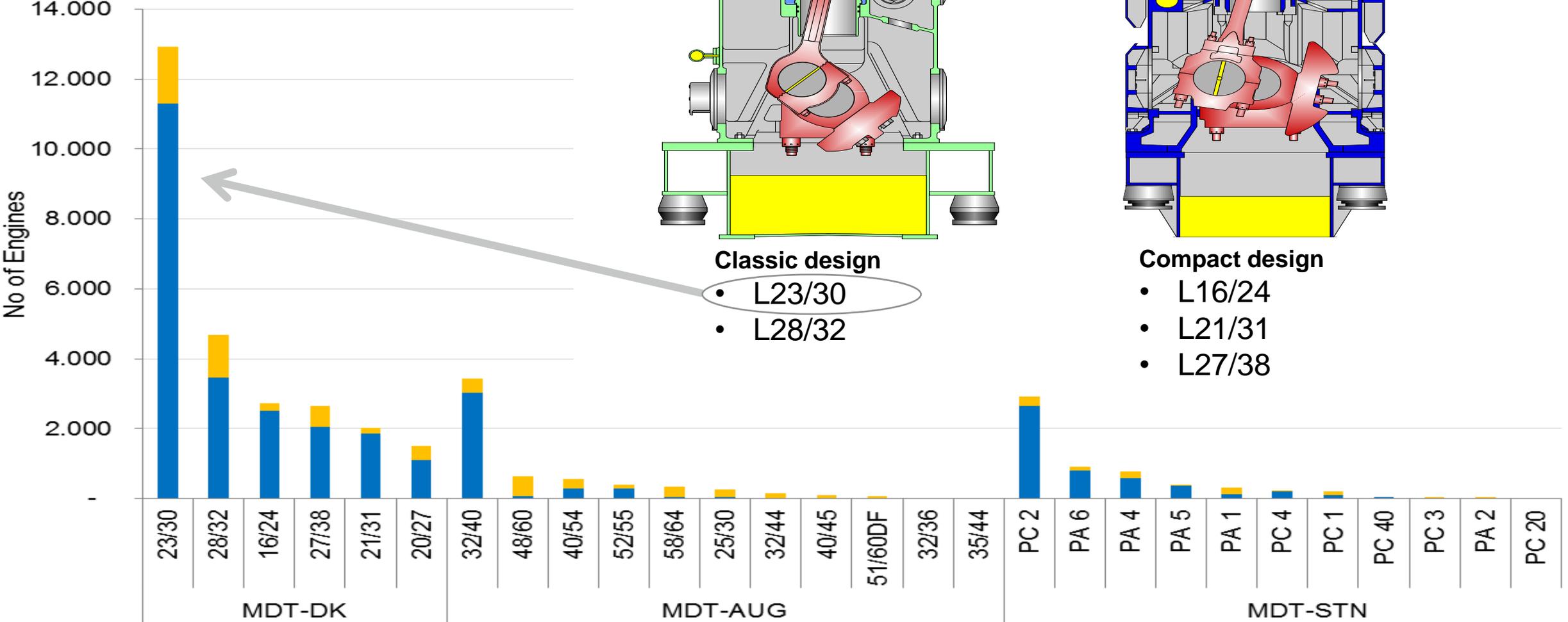
Proposals for safe and efficient running.

George Drossos
Marine New Sales and Promotion
6th June 2019



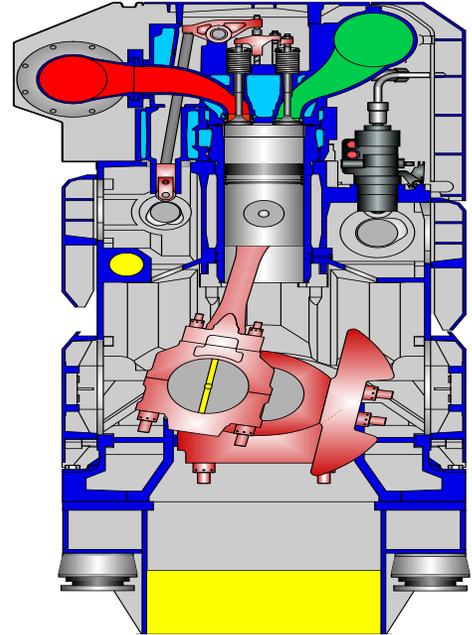
Engine Population

4-Stroke



Classic design

- L23/30
- L28/32



Compact design

- L16/24
- L21/31
- L27/38

Service Experience

Most Common issues



- Fuel nozzles - Low TBO
- TC nozzle ring - Low lifetimes
- Exhaust temp. - High
- Exhaust valves - Sticking/burning

Observation:
Correlated -
we often see
poor combustion

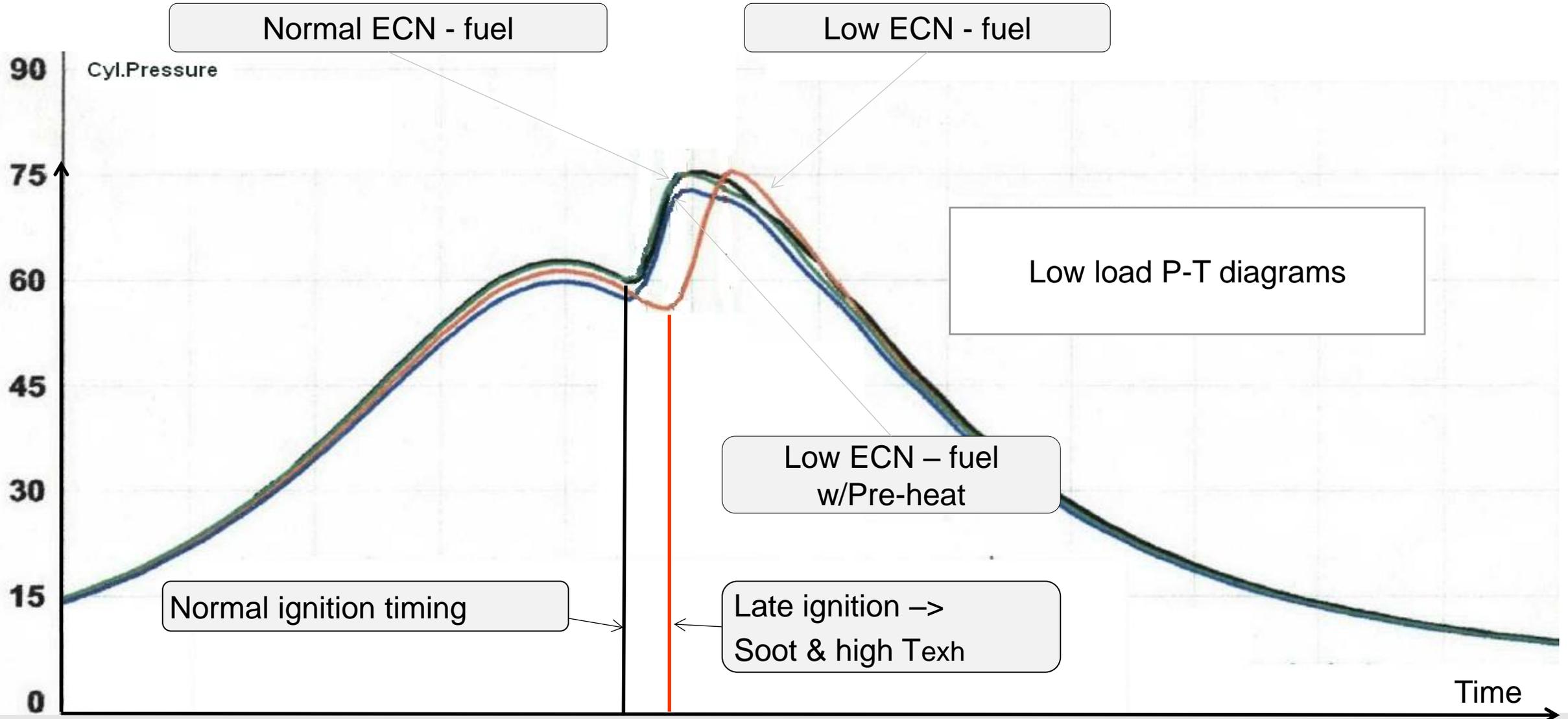


What is root cause?



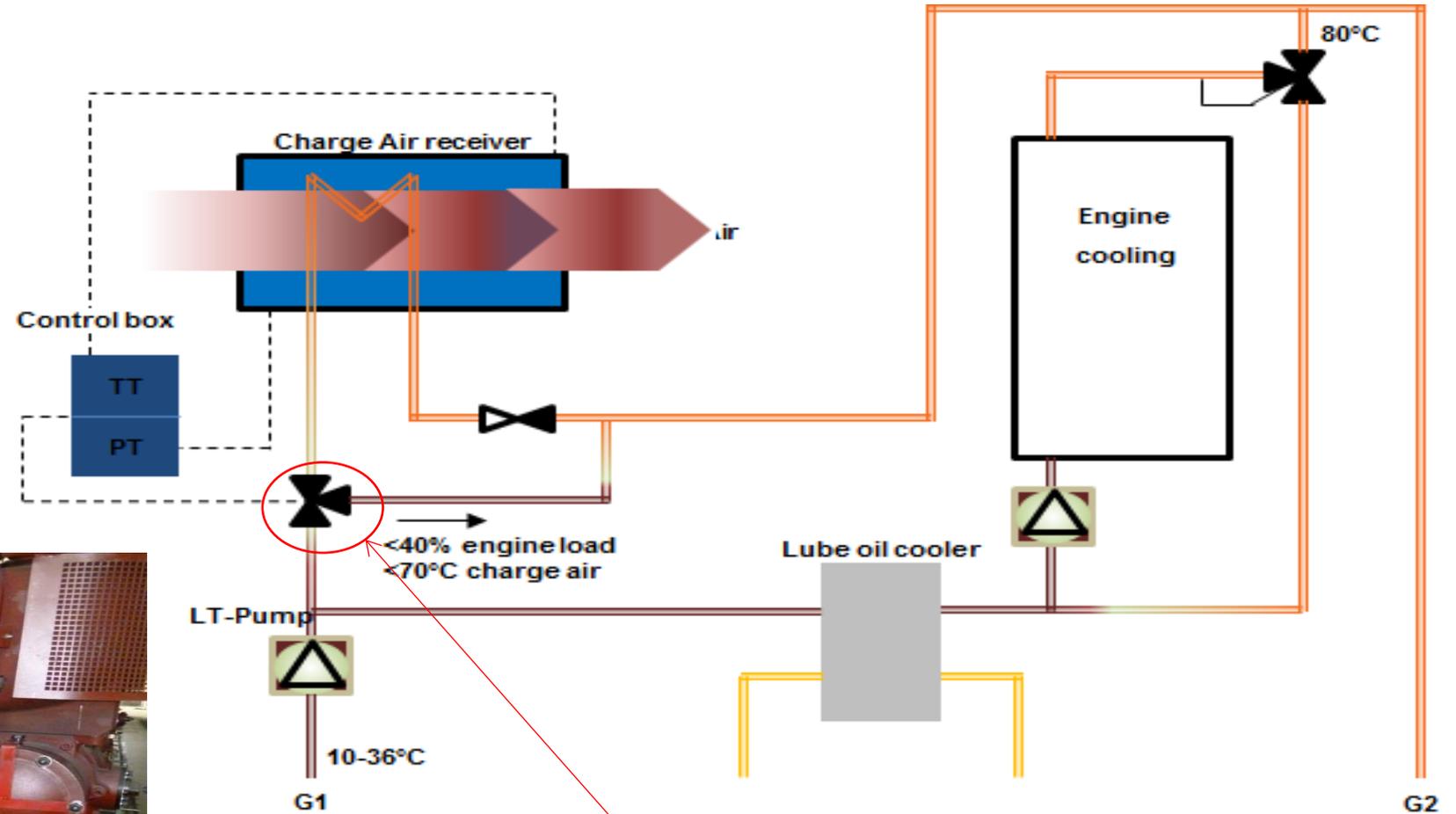
Ignition of Normal and Poor fuel – influence of preheat

The effect of low ECN-number



Preheat – necessary with poor fuel & low load

By-pass valve active at low load



By-pass thermostatic valve

Nozzle spray - Depends on pressure

Don't get fooled

Higher pressure – Better spray

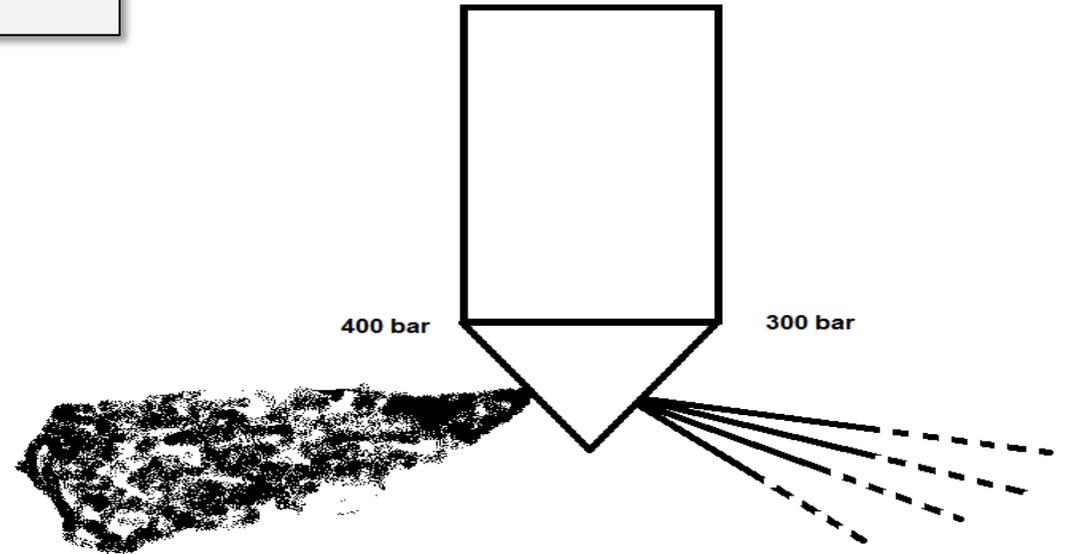
BUT it does NOT change seat condition

You are just overloading the spring



Low test pressure – produce 'showery' spray

High test pressure – produce 'cloud' spray



Test spray pattern do NOT reflect behaviour during engine operation
DO NOT use as a criteria

Using injector testing device

Measuring the test pressure



Parameters which CAN be tested:

1. Test Pressure: Condition of nozzle seat
2. Spray: Are all nozzle holes free?
3. Tightness: No leakage (The drop)

Parameters which CAN NOT be tested:

1. Atomization during engine operation
2. Opening pressure during engine operation

Reason:

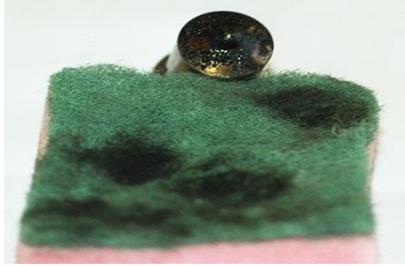
1. Test performed at 300 - 400 bar
2. Engine operates at 1100 -1600 bar



Fuel injector test device

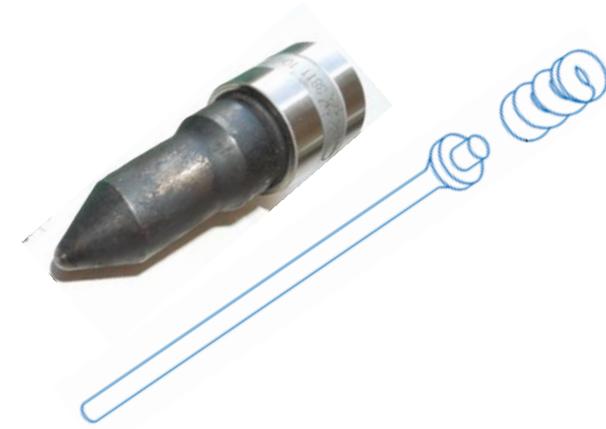
L23/30, Fuel Injection Valve – 8000 hrs TBO

Hands-off strategy



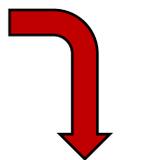
Do NOT remove fuel valve, unless:

1. Exhaust gas temp. dev. > 40°C
2. Exhaust gas temp. before TC - High
3. Exhaust - Black smoke



Check if...

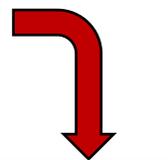
Test pressure
Below 210 bar



YES



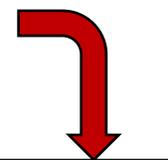
Nozzle
Leaking



YES



Spray holes
Blocked



YES



Reuse
as is



Replace
Spring & Nozzle

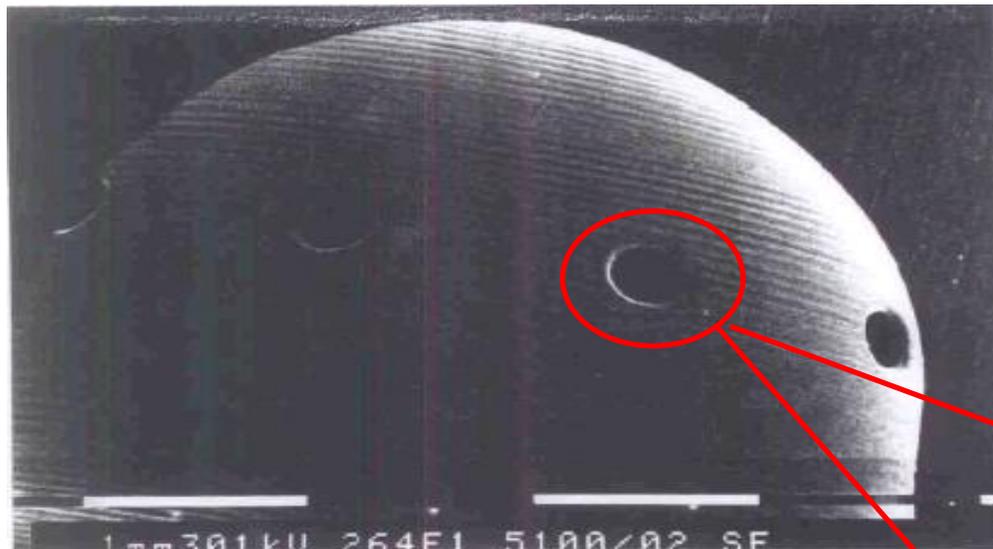
NEVER Adjust Testpressure

A worn/damaged seat does not get better by (over) tightening the spring

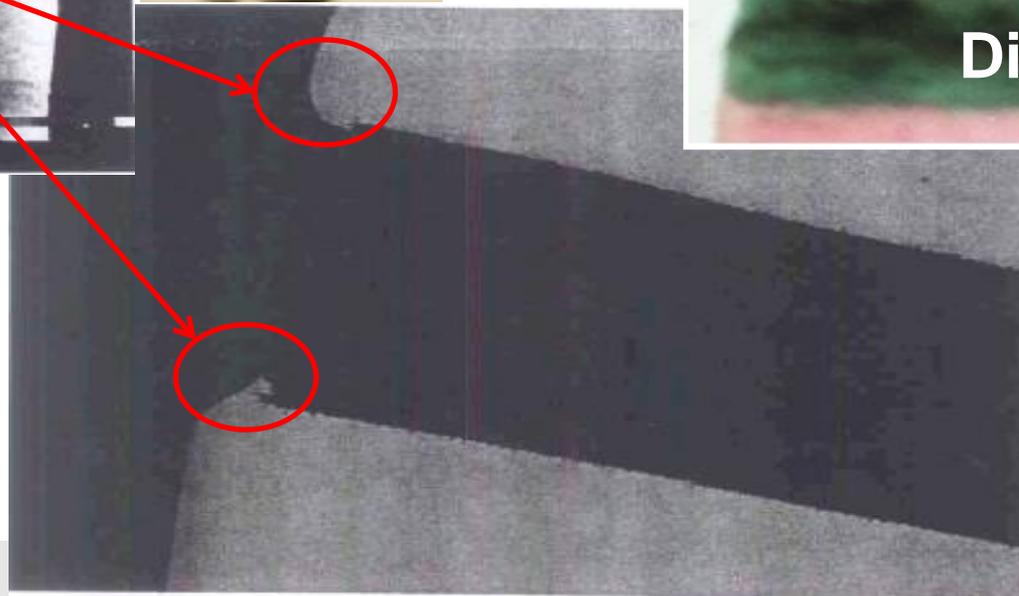
Fuel nozzle treatment

Warning! – severe damage to entire engine!

**Never use
Rotating steel brushes**



**Poor spray
Cause poor
Combustion**



Fuel Treatment



MDT Fuel oil Spec. – the MINIMUM requirement

Cleanliness at engine inlet

Definition	Particle size	Quantity
Inorganic foreign matter including catalyst particles	<5 µm	<20 mg/kg
Al+Si content/Cat-fines	<5 µm	<15mg/kg

Obligation of operator:

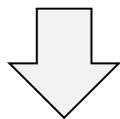
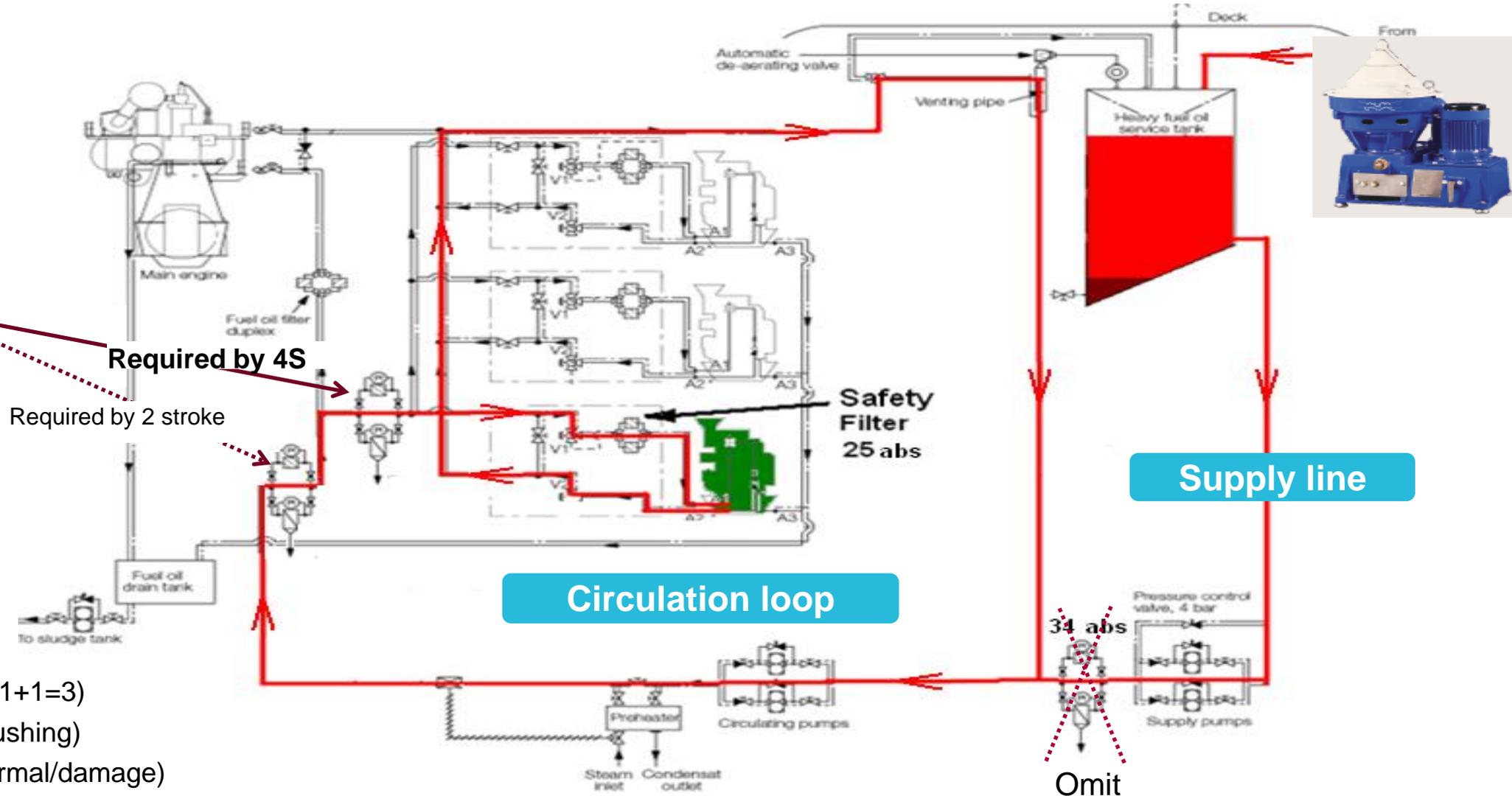
Fuel oil delivered to engine –

according to specification or better

Clean fuel oil → long TBO

Cat-fines filter in Circulation loop

Uni-fuel system - 2 stroke ME & 4 stroke AE

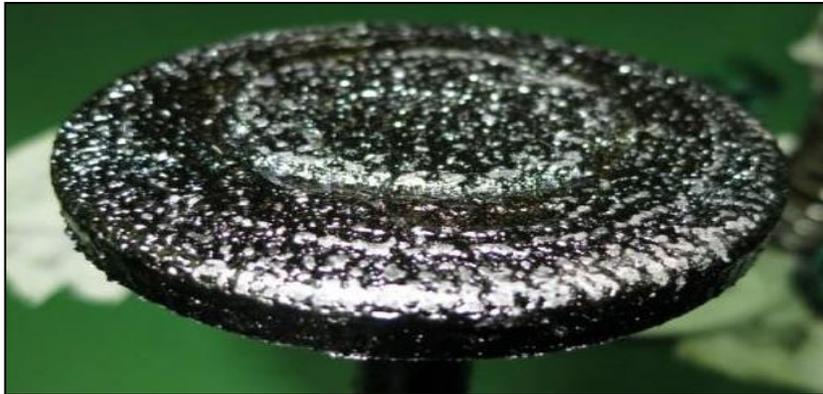


- Repeated cleaning
- Synergy with Separator (1+1=3)
- Commission/overhaul (flushing)
- Generated in system (normal/damage)

Case Study - Install 10µm Cat fines filter

In circulation loop

Before



10 µm abs



Filter

After



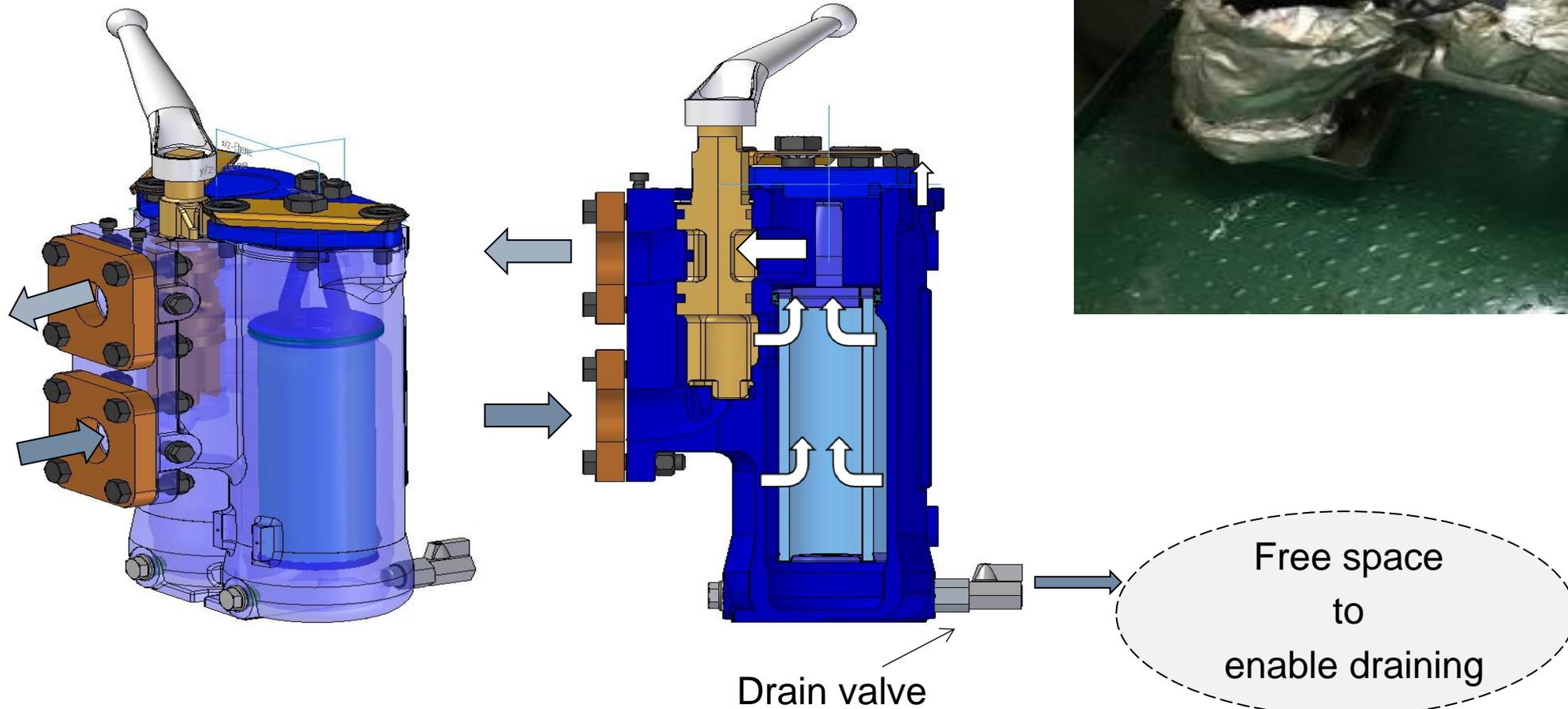
Clean combustion

- No particles
- No damage to nozzles
- No sticking fuel pumps (seizure)

Fuel safety filter – Drain before lifting insert

25 µm abs

Is draining possible before cleaning?



See Service Letters
SL2017-640
SL2016-615
SL2014-595
SL2013-577

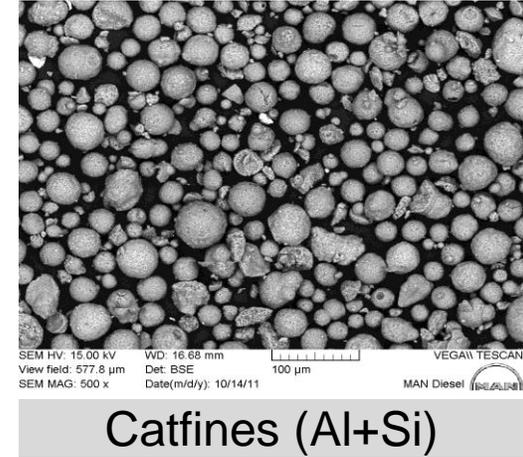
Fuels 2020



VLSFO – 0.5% Sulphur. General characteristics

Vary between batches of same grade

- Viscosity: Higher than distillate
- Density: Varying
- Al+Si: Probably yes
- Pour points : Could be high (heating)
- Compatibility: May be problematic
- Lube Oil: Start low: TBN 20 (Asphalteens can affect)



0.50% S VLSFO	Kin. Viscosity at 50°C, cSt	Density at 15°C, kg/m ³	Pour point, °C	Cat fines, Al+Si, ppm
Fuel 1	45	990	27	< 15
Fuel 2	360	969	<24	55
Fuel 3	7.4	885	-24	28
Fuel 4	215	942	30	45
Fuel 5	60	985	< -3	33



Cat-fines impact on 4 stroke engines

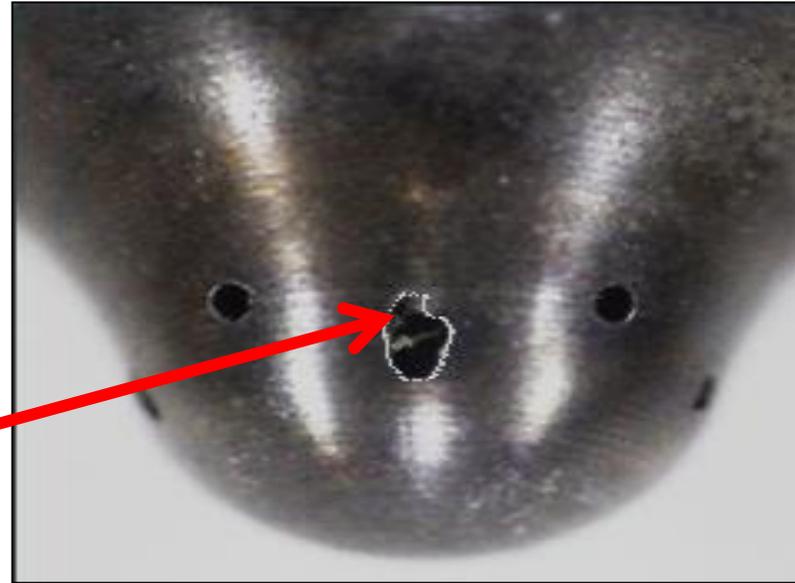
Damage from catfines particles in nozzle holes



Particles in fuel

- Damaged fuel nozzles
- Poor combustion

Damage due to abrasive particles
Causing poor spray



Clean fuel

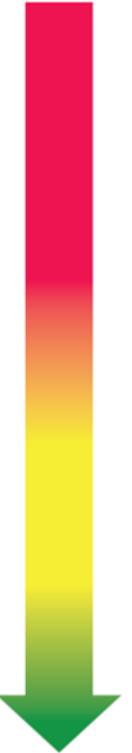
- Good condition of fuel nozzle
- Perfect combustion

Al + Si
At engine inlet

>15 ppm

10 ppm

<5 ppm



ULSFO Genset Service Experience

6L28/32H, 0,08% S

Inspection at 2225 hrs. Cyl. No. 1. Conclusion:

- All parts in good condition
- No abnormal or extra wear
- Some lacquer and coke deposits on liner and nozzle

Reason most likely:

- Low load operation
- Lube oil additives to be adjusted to ULSFO



Continuous operation on Low viscosity/sulphur fuels

1) Avoid seizure of fuel oil injection pump

- 1) Min 2 cSt
- 2) Install coated plunger
- 3) Installation of cooler/chiller may be needed

2) Increased drain from fuel injection pumps/valves

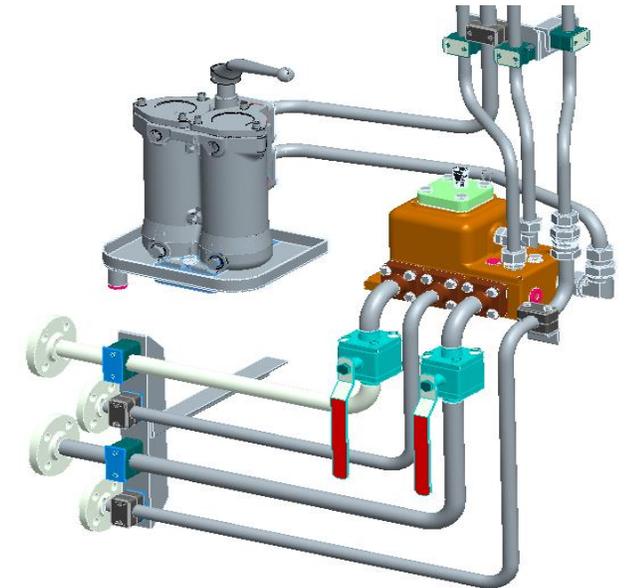
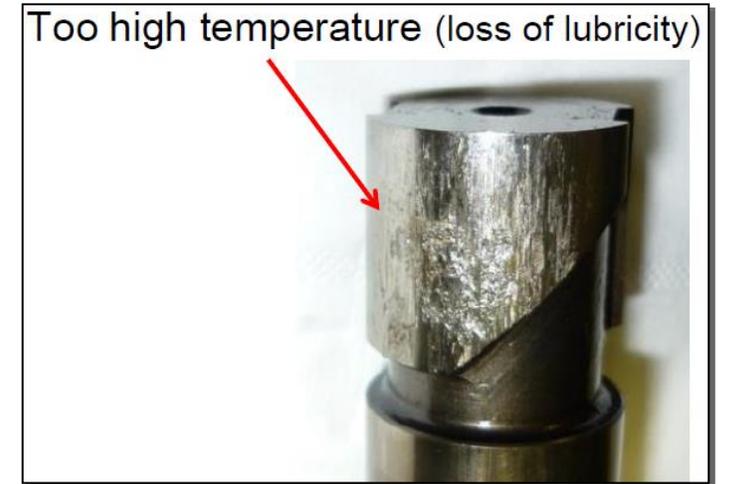
1. Install split drain
2. Reuse drained fuel oil possible

3) Increased wear, valve spindles

1. Install T400 hardfacing spindles/seats

4) Select correct lubricating oil

1. TBN 20 – as a starting point
2. Select Lube oil approved for low Sulphur (additive package)



Service Experience, DM - Arctic Gas Oil,

L16/24. DM with 0.2% S

Remote power station working in extreme arctic climate: Arctic gasoil w/ 0.2% S

Overhauling:

- 12,000 running hrs.
- 30,000 running hrs.
- 72,000 running hrs. (2010)

Today approx. 100,000 running hrs. (standby)

Two new (extra) engines in 2006

Planned TBO of 42,000 running hrs. (2018)



Lubrication oil



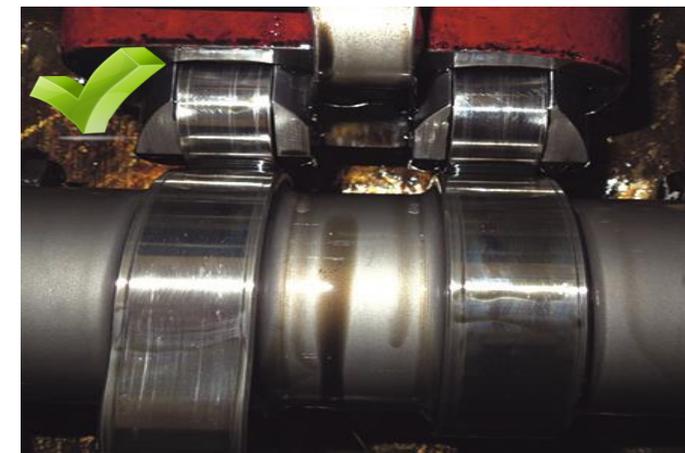
Lube Oil Contamination

A result of...

➔ **Fuel Equipment – *producing* contaminant**
Combustion efficiency, Fuel Quality, Fuel Nozzles, Mechanical condition

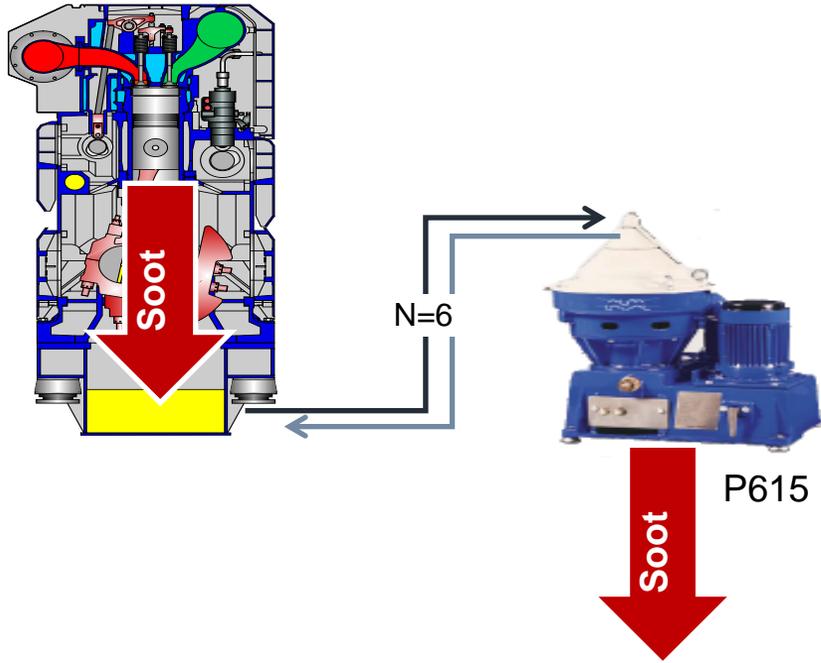
➔ **Cylinder unit – *protecting* contaminants way to Lube Oil**
Piston rings, Cylinder liners

➔ **Lube oil cleaning – *Removing* contaminants**
Separator, filters



Soot level in Sump tank

Depends on soot input

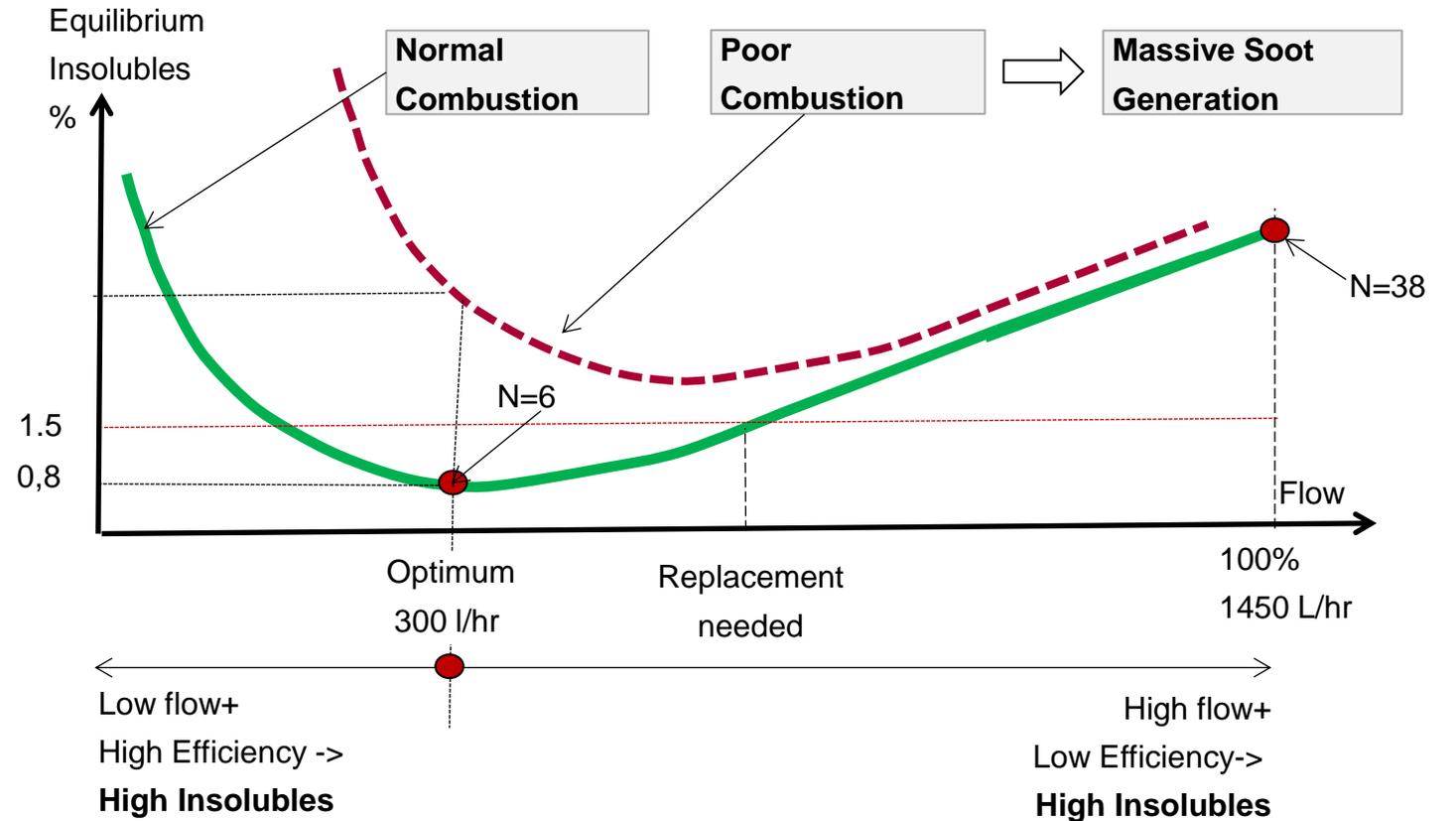


$$Q = \frac{P \times 1.36 \times n}{t}$$

Example

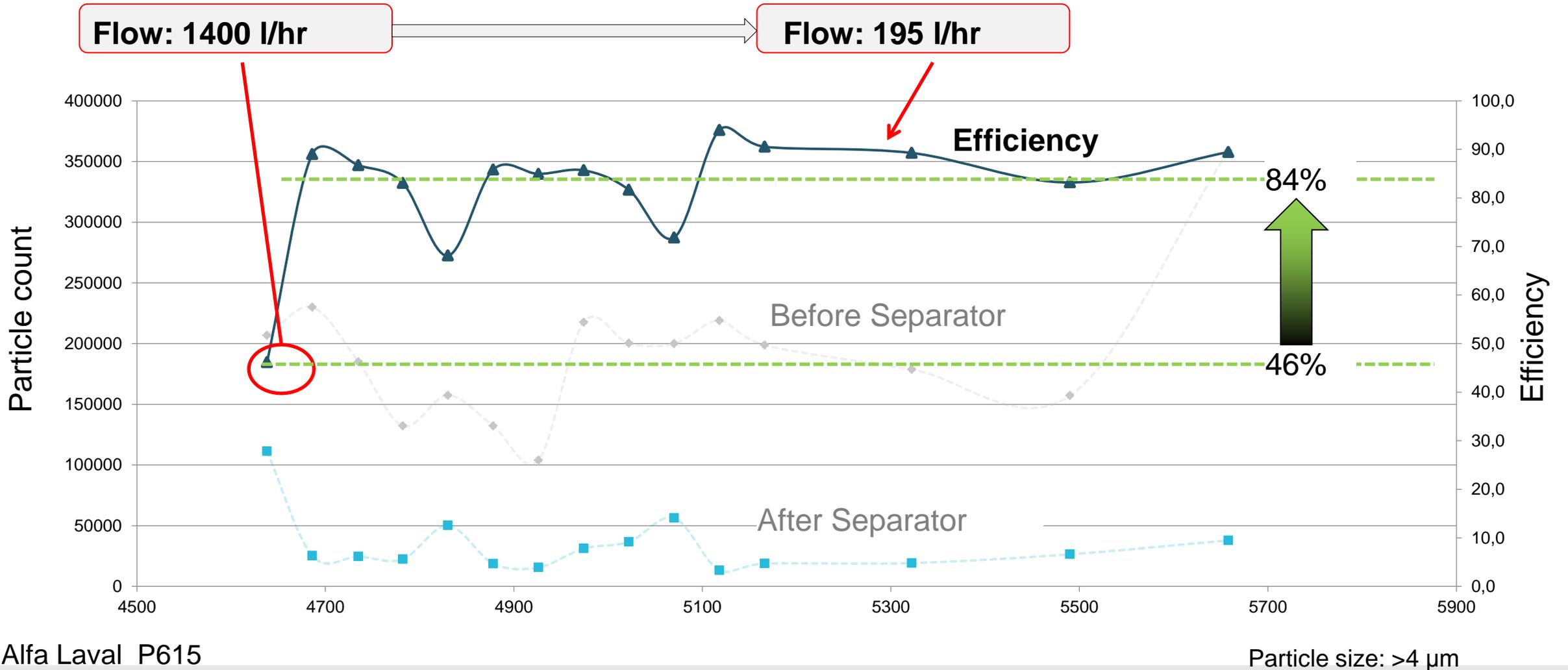
Genset 660 kW -> 229 l/hr

3 gensets, average 1.3 running: 229 x 1.3 = 300 l/hr



Lube oil – The positive effect of reduced flow

Field test result



Alfa Laval P615

Particle size: >4 μm

Centrifugal By-pass filter

Field test results

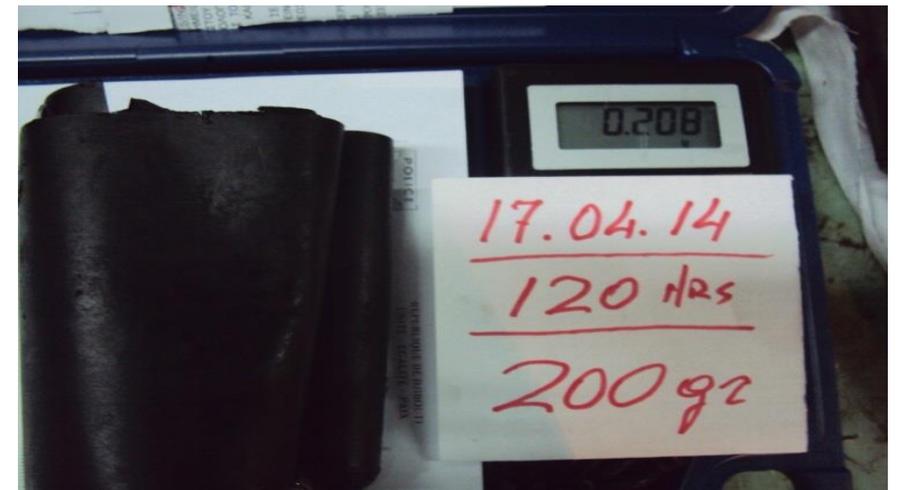
L.O. Separator: Alfa Laval PA615

- Temp.: 92-95°C.
- Continuous separation

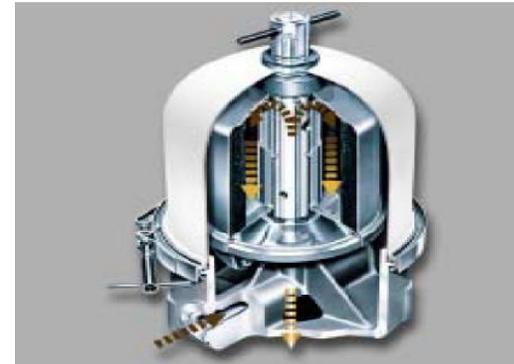


Original flow: 1500 l/hr
2008 g/100 hrs

Factor 10



Reduced flow: 195 l/hr
200g/100 hrs



Indicates lube oil

- Cleanliness
- Separation efficiency

Extend Lube oil filter life

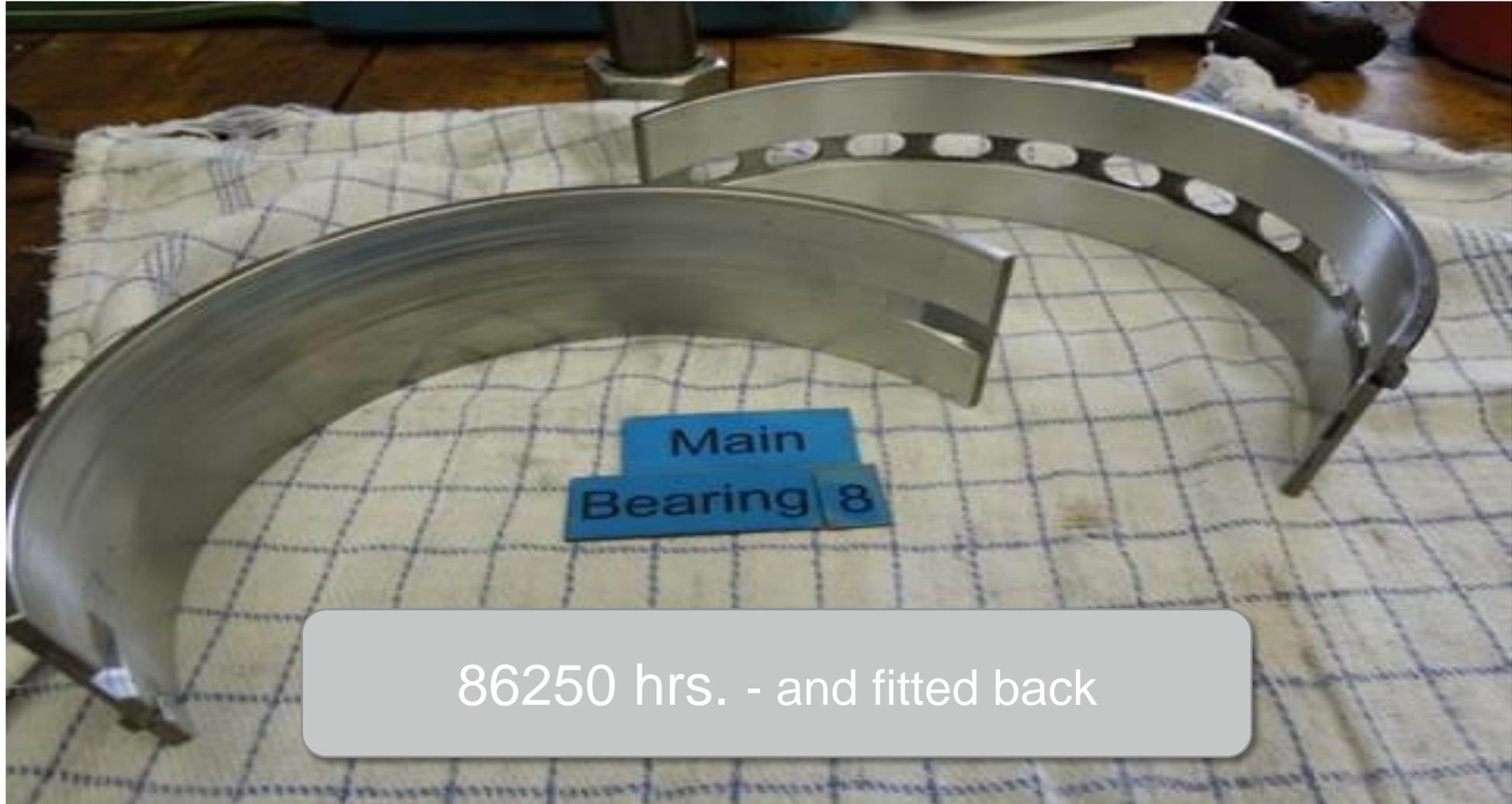
Lube Oil – Result of contamination

Ridge wear on bearing journal



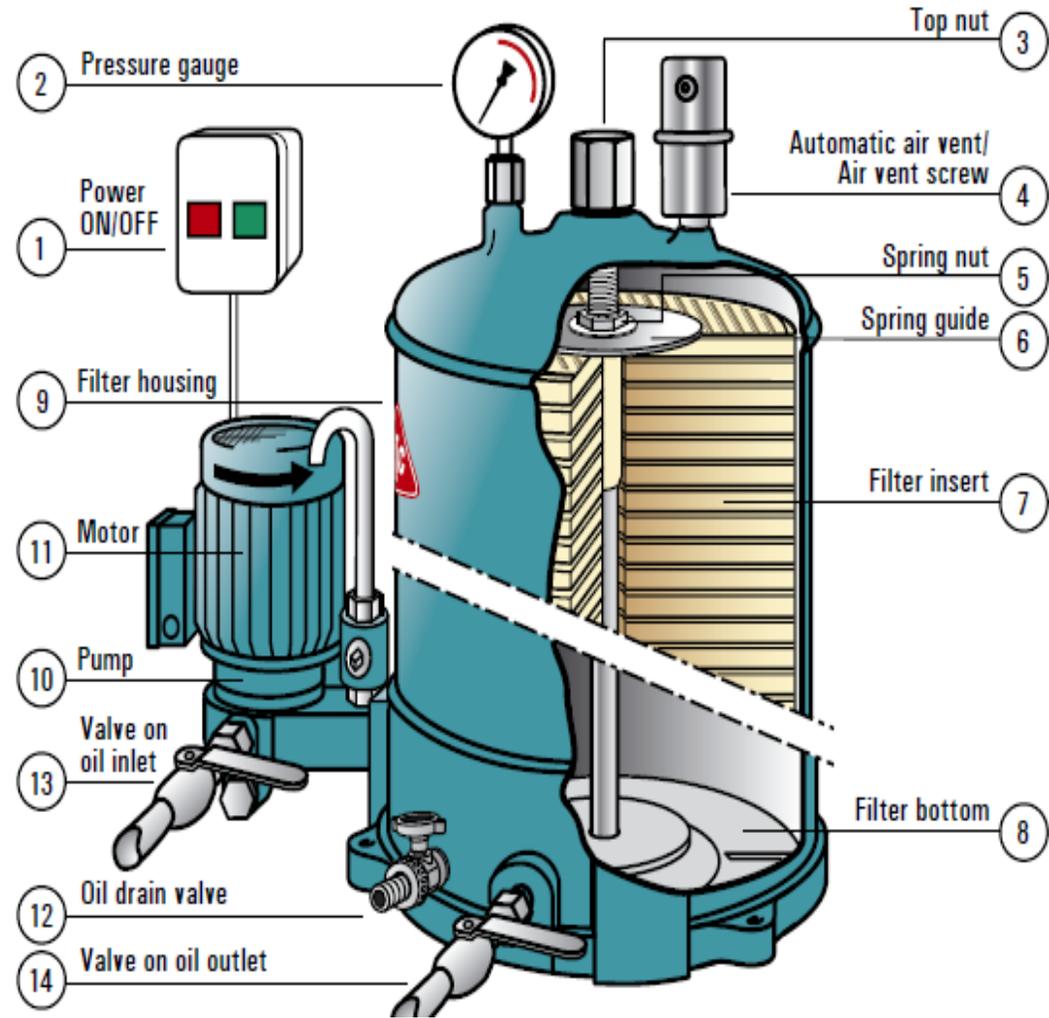
Lube Oil – Result of clean lube oil

L16/24 Main Bearing



Lubrication oil – filtration

A safe alternative to separators



L23/30H Lube oil consumption – What is normal?

Calculation of Specification of lube oil consumption

Specified lube oil consumption (SLOC) : 0,6 – 1.0 g/Kwh, based on MCR

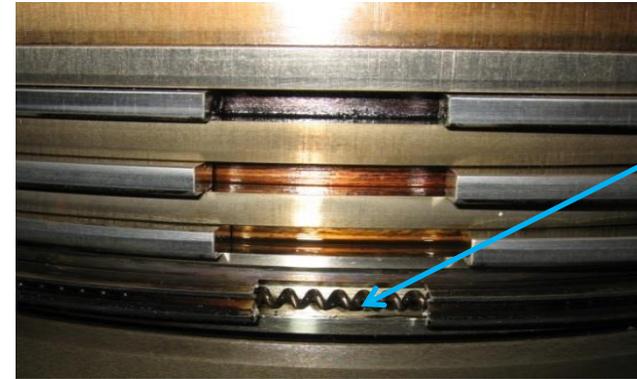
L23/30H 900 rpm, std. rating 160Kw/Cylinder -> max 4,3 L/cyl./24 run hrs.

6	L23/30H 900	25,8	L/24 Running hours
7	L23/30H 900	30,1	L/24 Running hours
8	L23/30H 900	34,4	L/24 Running hours

Latest piston ring design

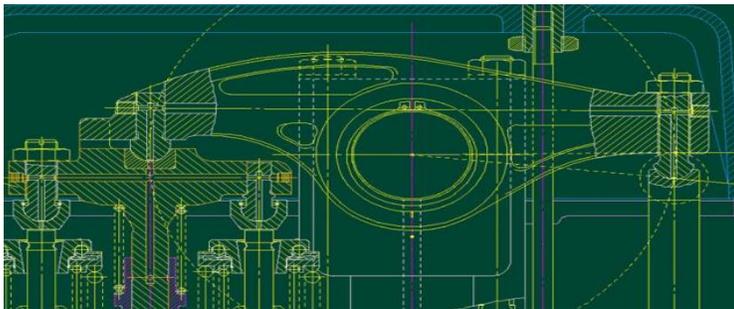
3 actions – reducing consumption

1. Reduced flow to Cyl.
 - a) Bushing in rocker arm (new engine)
 - b) Orifice in LO inlet to cyl Head (retrofit)
2. High pressure Oil scraper ring
3. 3rd Piston ring shape

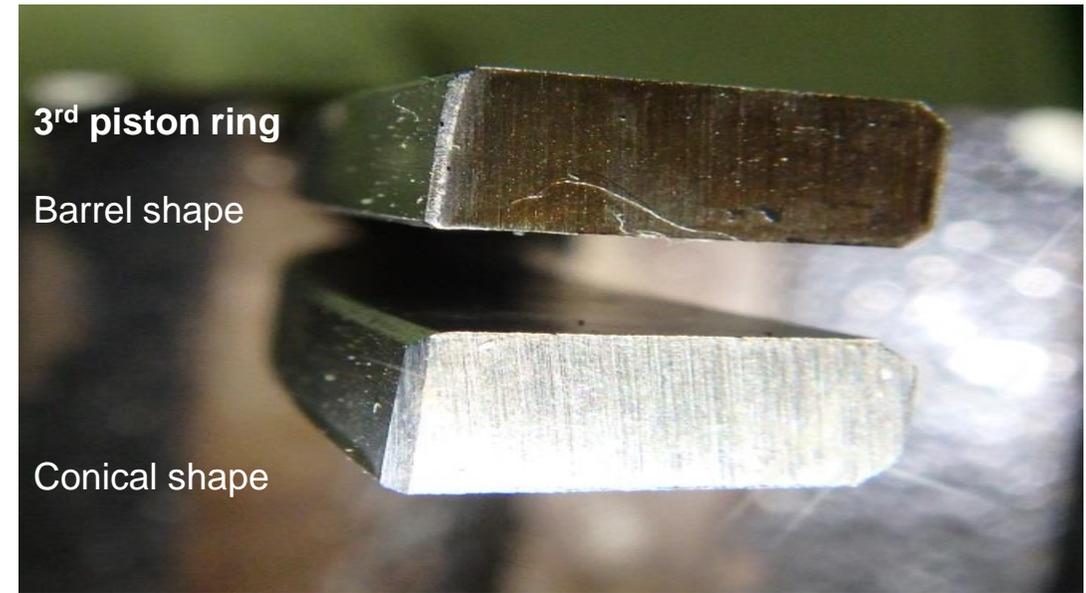


Oil scraper ring

Tubular spring increased from 100-140 N to 135-189 N



High oil level, top cover – flow through guide



3rd piston ring

Barrel shape

Conical shape

Ring pack design stabilizing lacquering

L23/30H Lube oil consumption – Latest piston ring design

Service experience & field test results

HFO

New bush for rocker arm

New oil scraper ring

-> **Consumption within range**

Low Sulphur

Problem: LSMDO/LSMGO or

**HFO and <-> LSMDO/MGO:
Cylinder liner lacquering**

-> **Consumption very high**

Countermeasure:

- **New 3rd piston ring**



Cylinder liner lacquering

Results

Engines operated on LSMDO/MGO or switching between HFO and LSMDO/LSMGO

New 3rd ring. Lube oil consumption 4-8 litres pr. Day.

L23/30H Connecting Rod – Assembly face

Service Experience

Correct machined and assembled connecting rods:
3 main overhauls -> 36.000 – 48.000 operating hours.

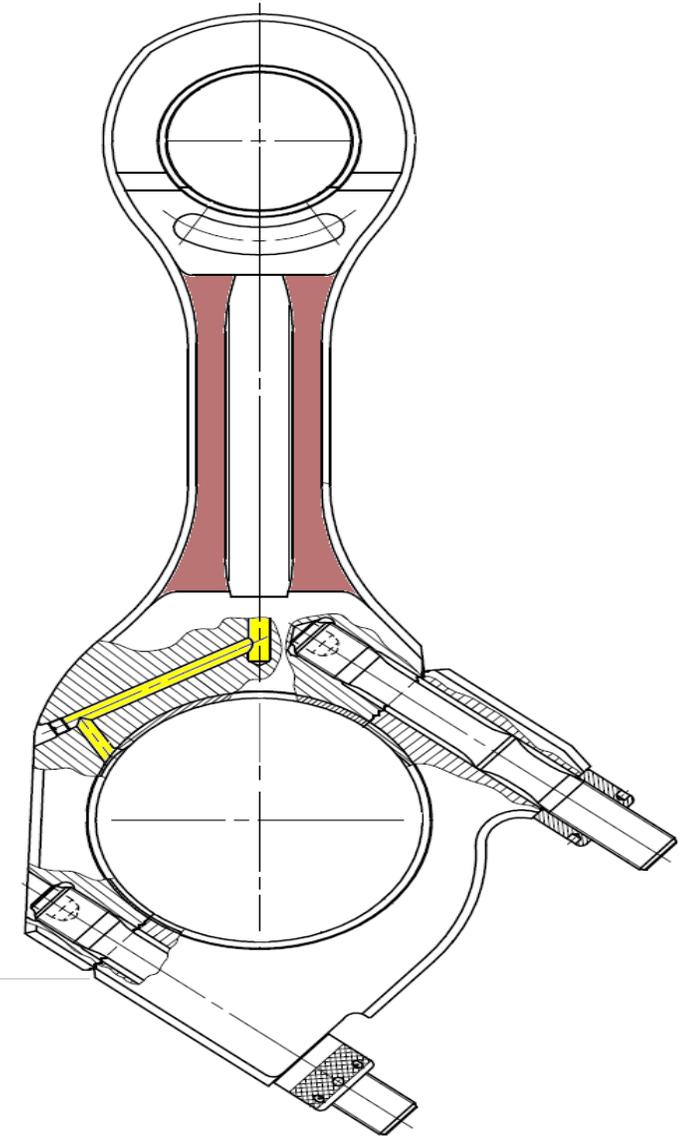
Re-toothing possible 2-3 times

First Overhaul:

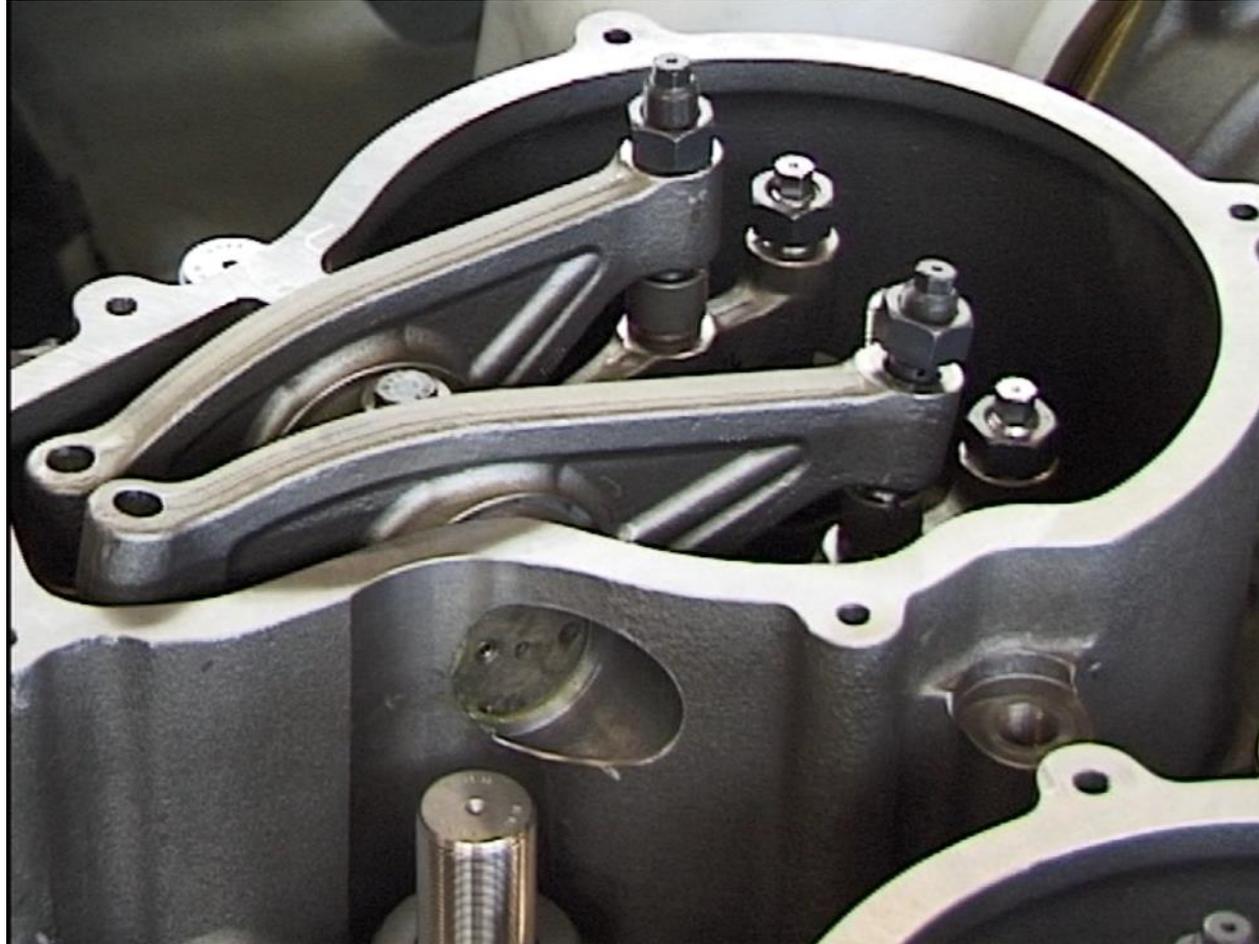
High ovality and/or cracks in serration
-> incorrect machining from maker

Following Overhauls

High ovality and/or cracks in serration
-> failure during last assembly



Cylinder Heads

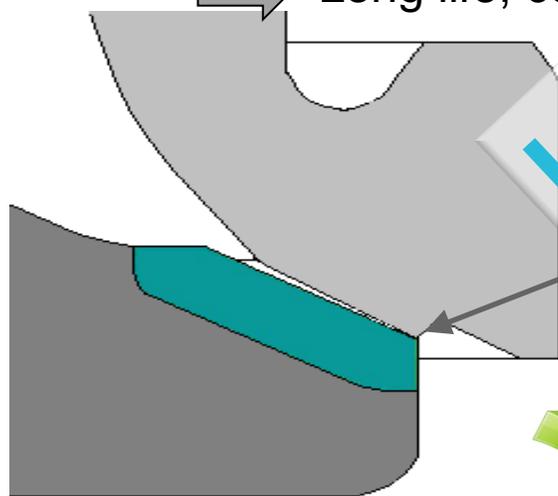


Valve Seats

Machining...

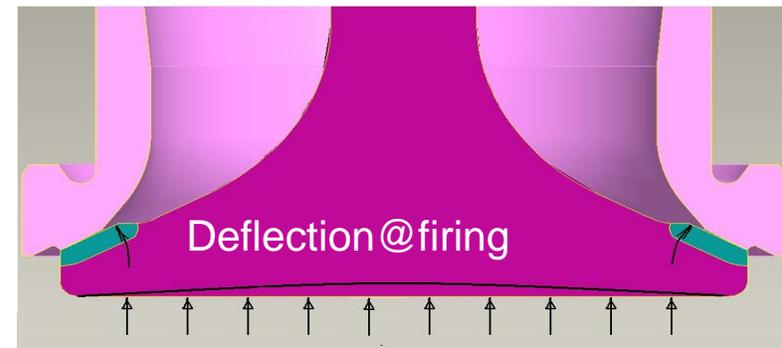
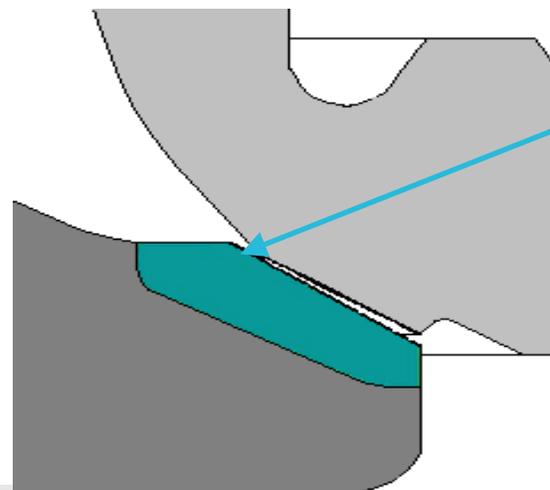
Correct seat Angel

- Inner gap closes
- Full contact
- Good cooling
- Long life, cone and seat



Wrong Seat Angle

- Outer gab increase
- Deposits on seat
- Insufficient cooling
- Burned cones, dented seats

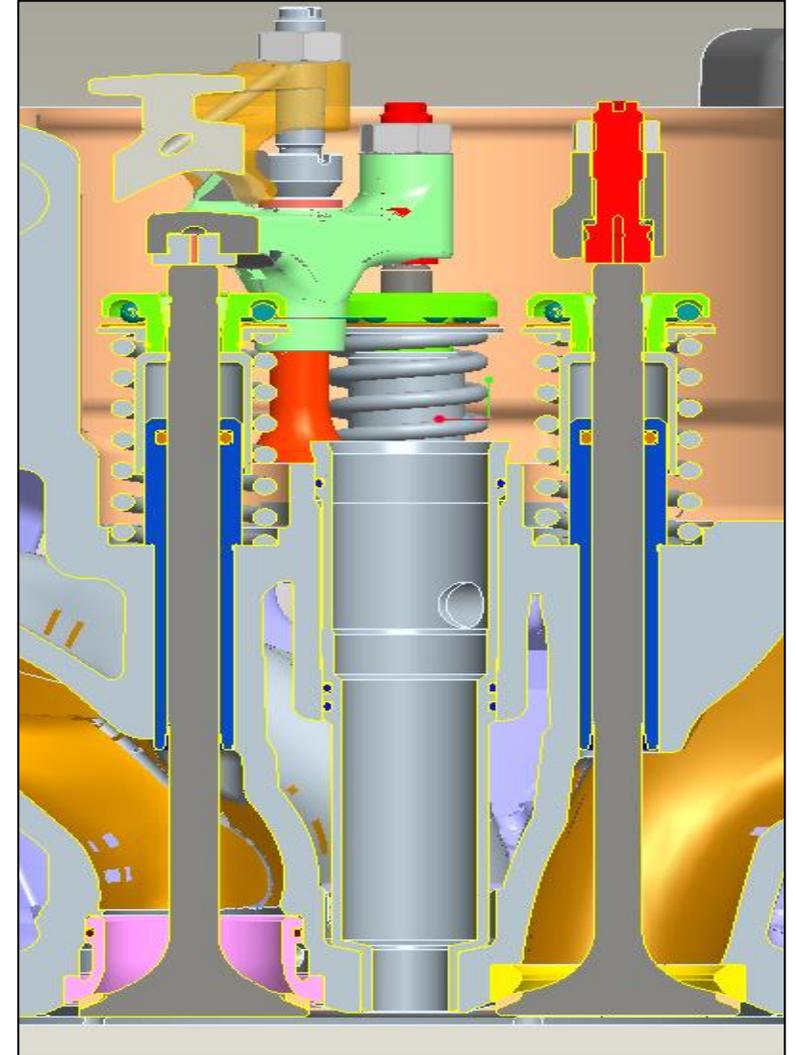
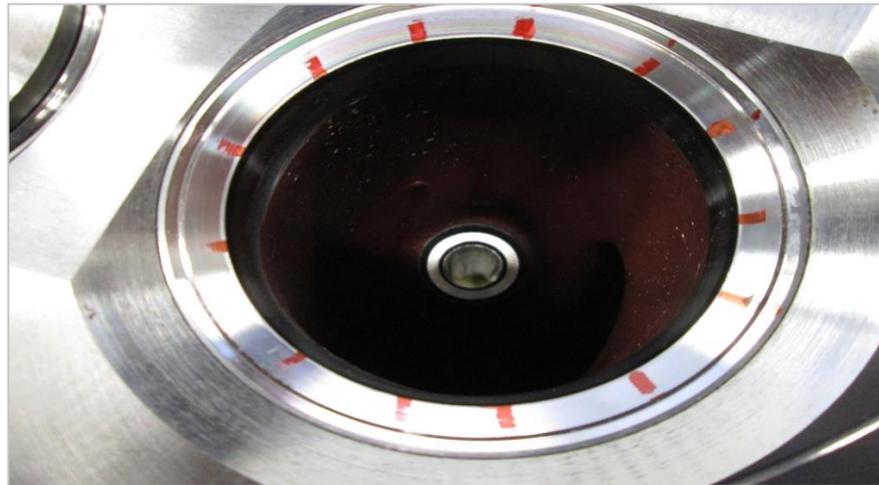


Lapping is not allowed

Overhaul of top cover

On-board or workshop?

1. New valve guide Mounted carefully by cooling (nitrogen)
2. Seat rings mounted carefully by cooling (freezer)
3. Valve guides MUST be reamed after mounting
4. Valve seat MUST be machined by 'Hunger' or 'Chris Marine'
5. Spindle/seat contact MUST be checked with colour paste



Replacement of Valve Seat and guide



Valve seat MUST be machined after replacement of Valve guide and/or Seat ring to ensure good contact



No machining



Poor contact



Burned valves



When to replace the seat ring?

Poor looking seat? – Cut first...

Criteria for replacement

Seat edge disappear (R)?

What to consider

Do not replace until criteria is meet.

Tools available? (Hunger, reamer, oversize cutting)

Cooling available? (Valve guide, seat ring)

Oversize seat ring available?

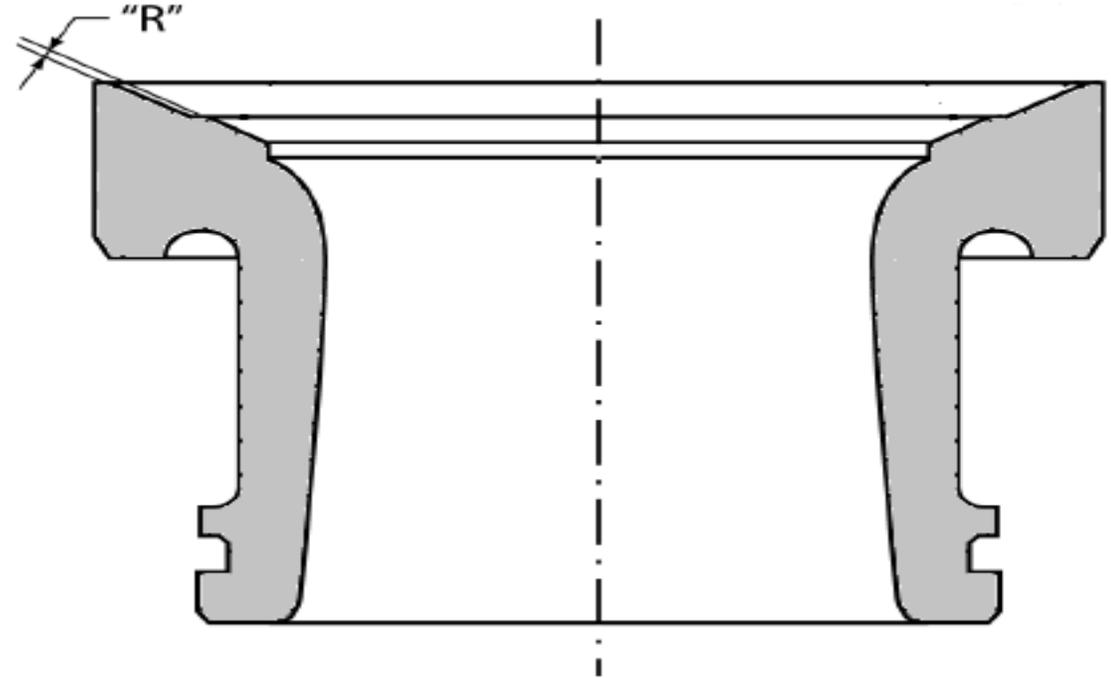
Leading indicators

Cooling water condition (Low inhibitor level, high chloride)

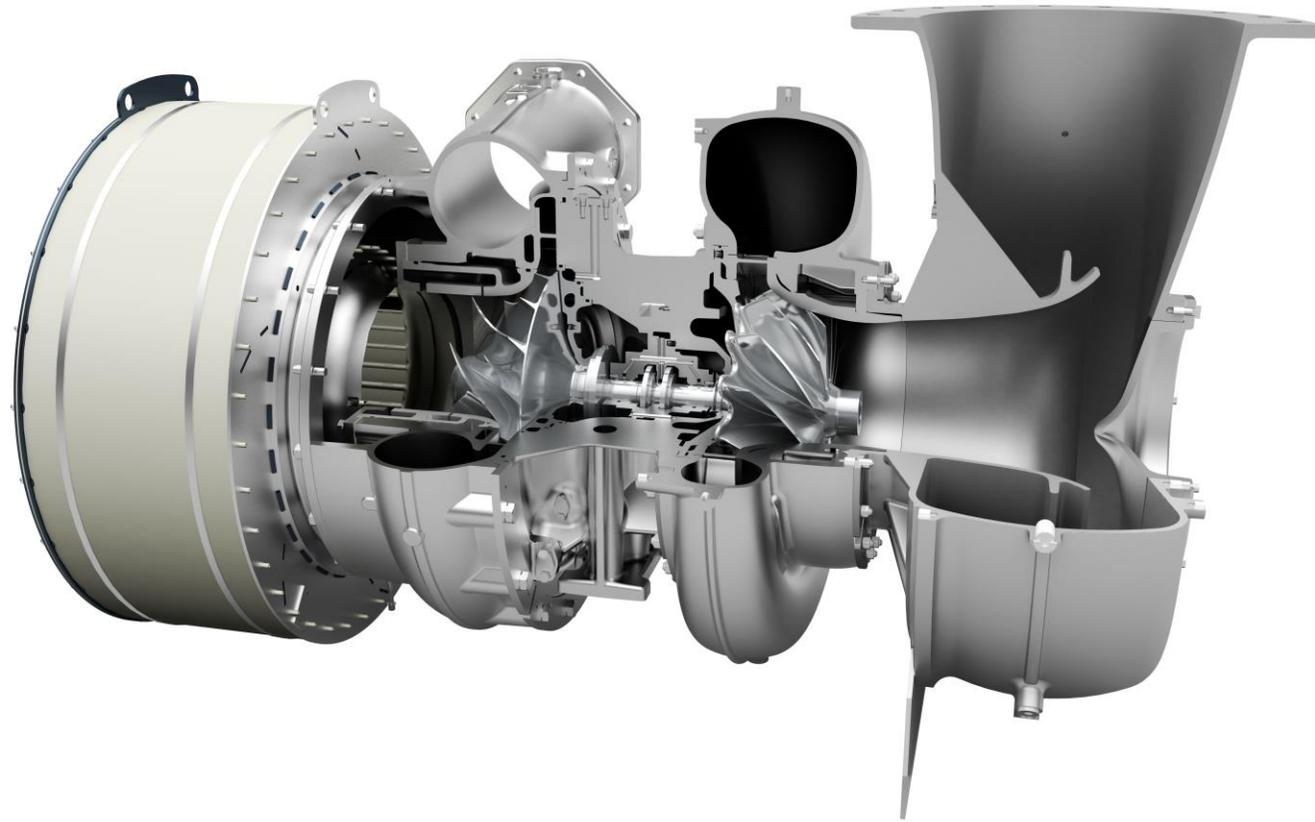
Poor fuel bunker (catfines)

Poor fuel cleaning (separator flow and temperature. Filter backflush frequency)

Poor performance (low Pscav, high exhaust temp) Remember ISO correction

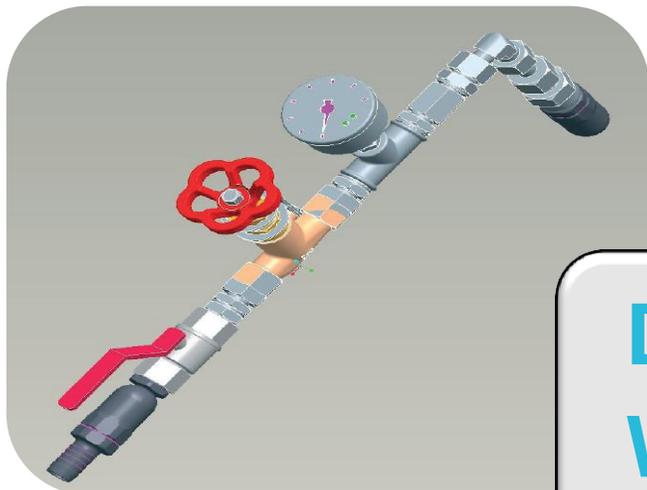


Turbocharger



Dry cleaning and Wet cleaning - Necessary

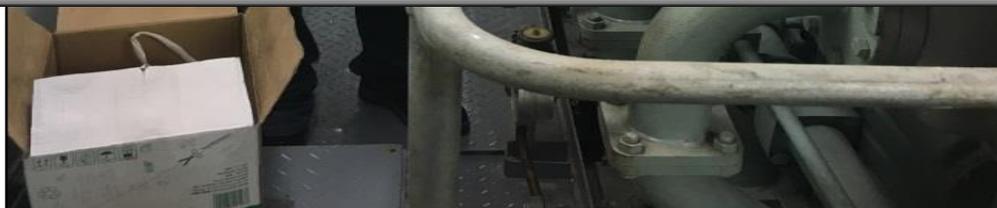
Turbine cleaning



Tool
Wet cleaning



Daily: Dry cleaning
Weekly: Wet cleaning



Tool
Dry cleaning

Are tools available?

Are crew trained to know when and how to clean?

Service Experience- the effect of turbine cleaning

Nozzle ring – NR12/S



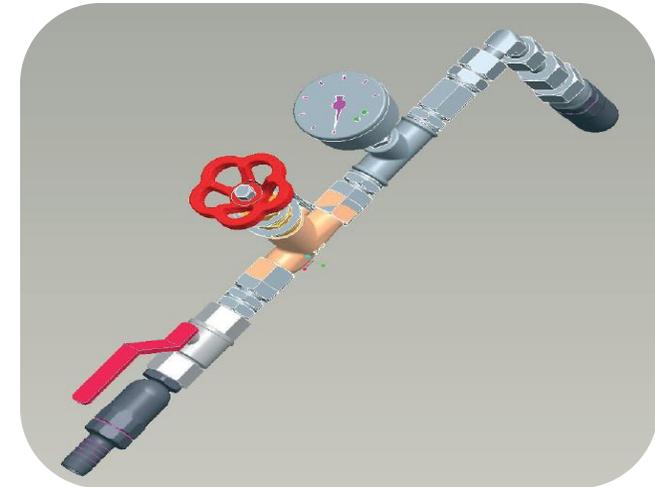
2,000 running hours
No cleaning of TC,
neither water nor dry

Worn out

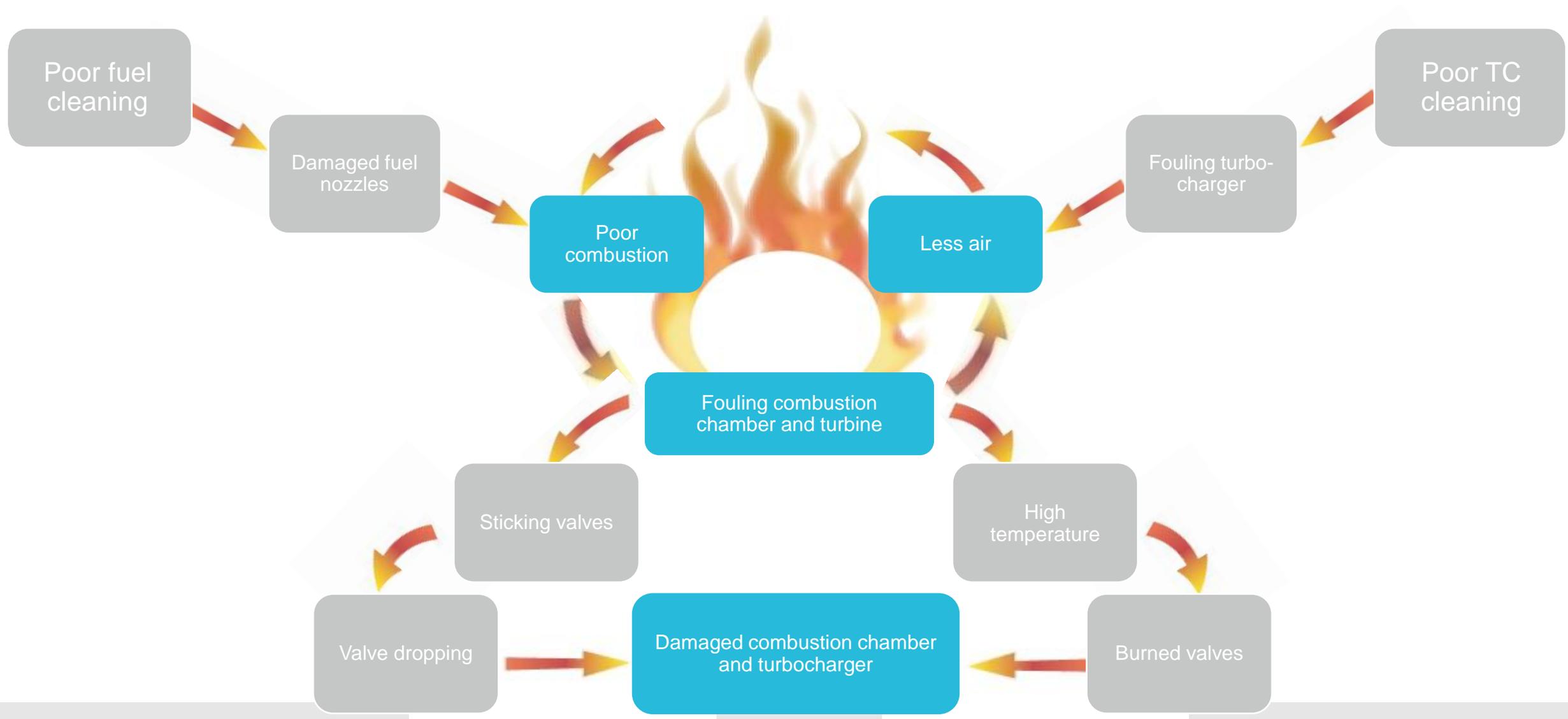


9,000 running hours
Daily dry cleaning
Weekly water washing
Surface-coated nozzle ring
Good fuel treatment

Expected lifetime
16,000+ hrs.



The Vicious Circle

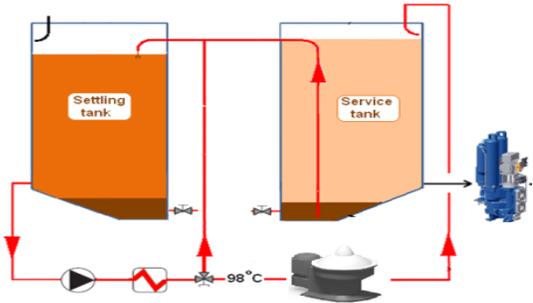


External systems – source of trouble



The root causes are often found in the external systems

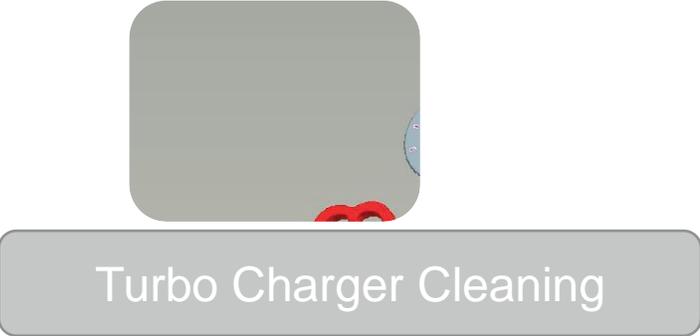
Fuel Cleaning system



Lube oil Cleaning system



Cooling water treatment



Turbo Charger Cleaning

Thank you
very much!

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Depending on the subsequent specific individual projects, the relevant data may be subject to changes and will be assessed and determined individually for each project. This will depend on the particular characteristics of each individual project, especially specific site and operational conditions.