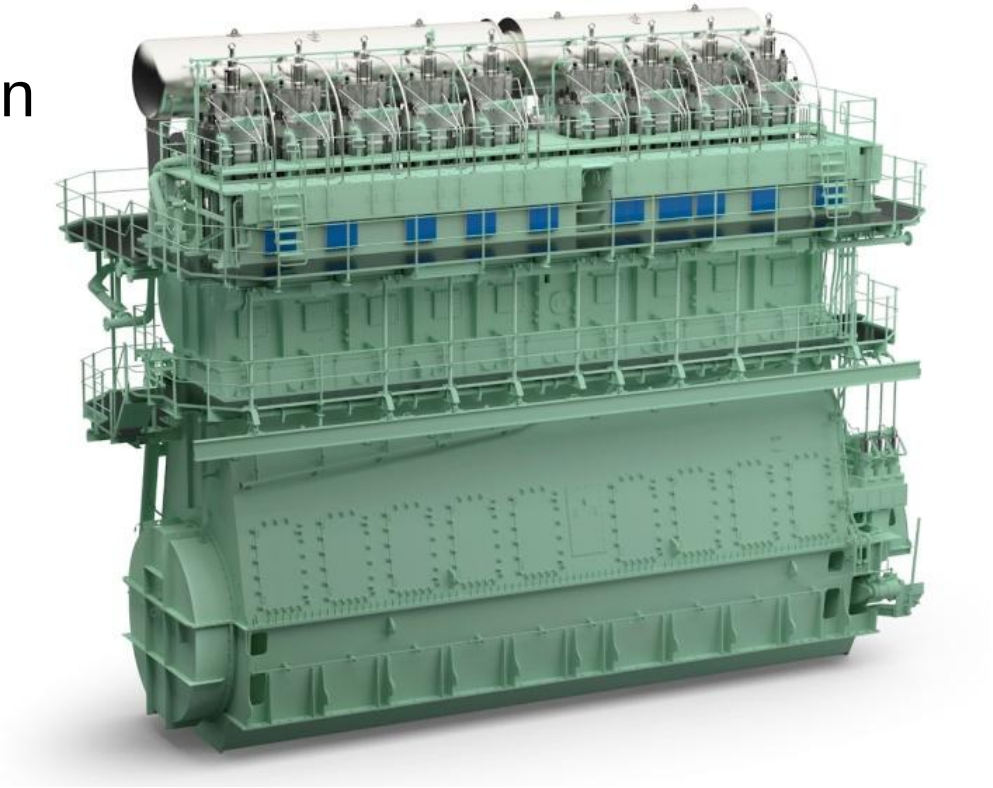

# W-X82 & W-X82-B

*The most modern Engine for VLCC, VLOC & Panamax CV*

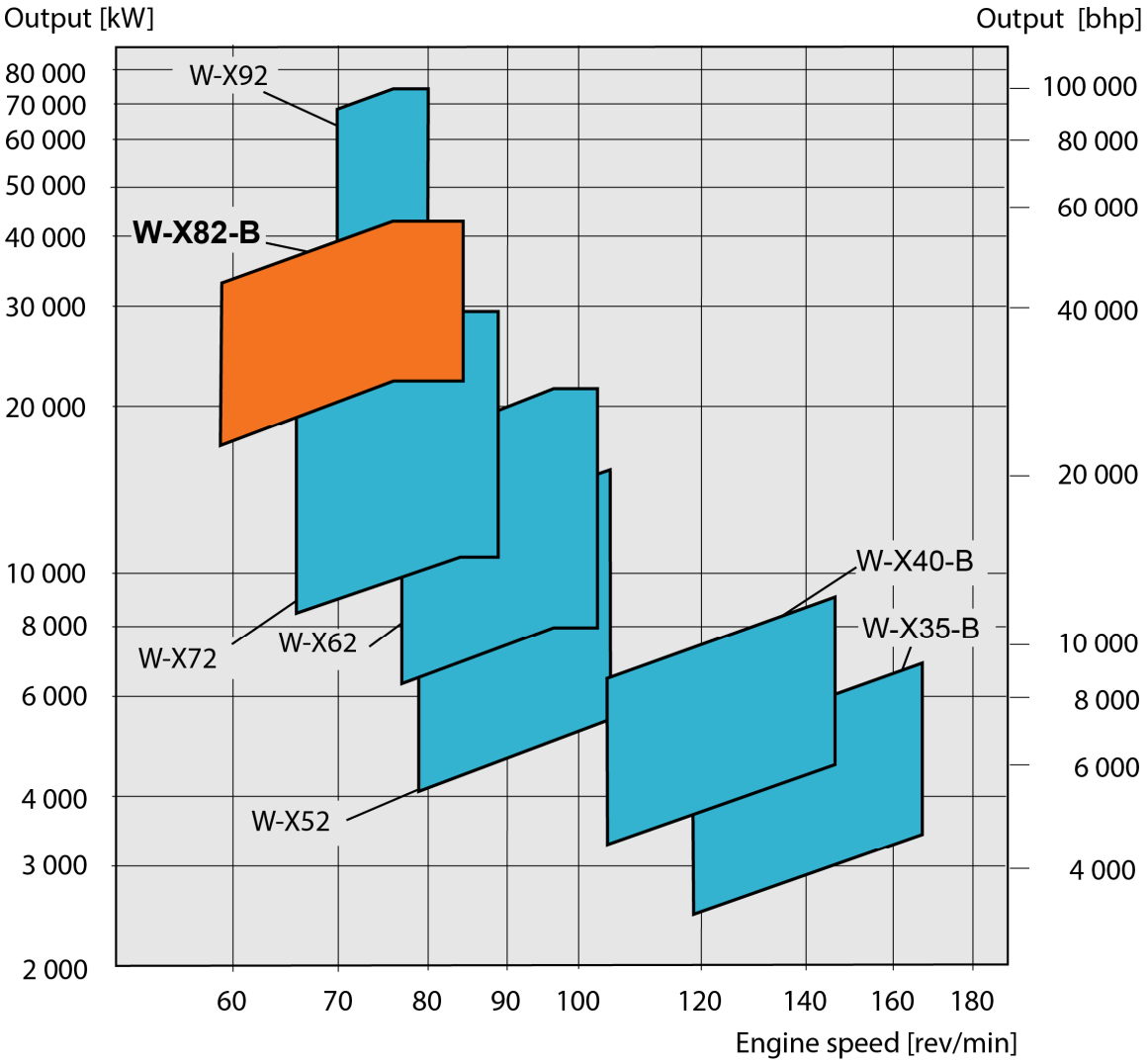
# *W-X82-B Engine*

## Contents

- Engine Rating Field and Main Parameters
- Engine Design Features
- Engines on Order and in Service
- Service Experience
- Conclusion

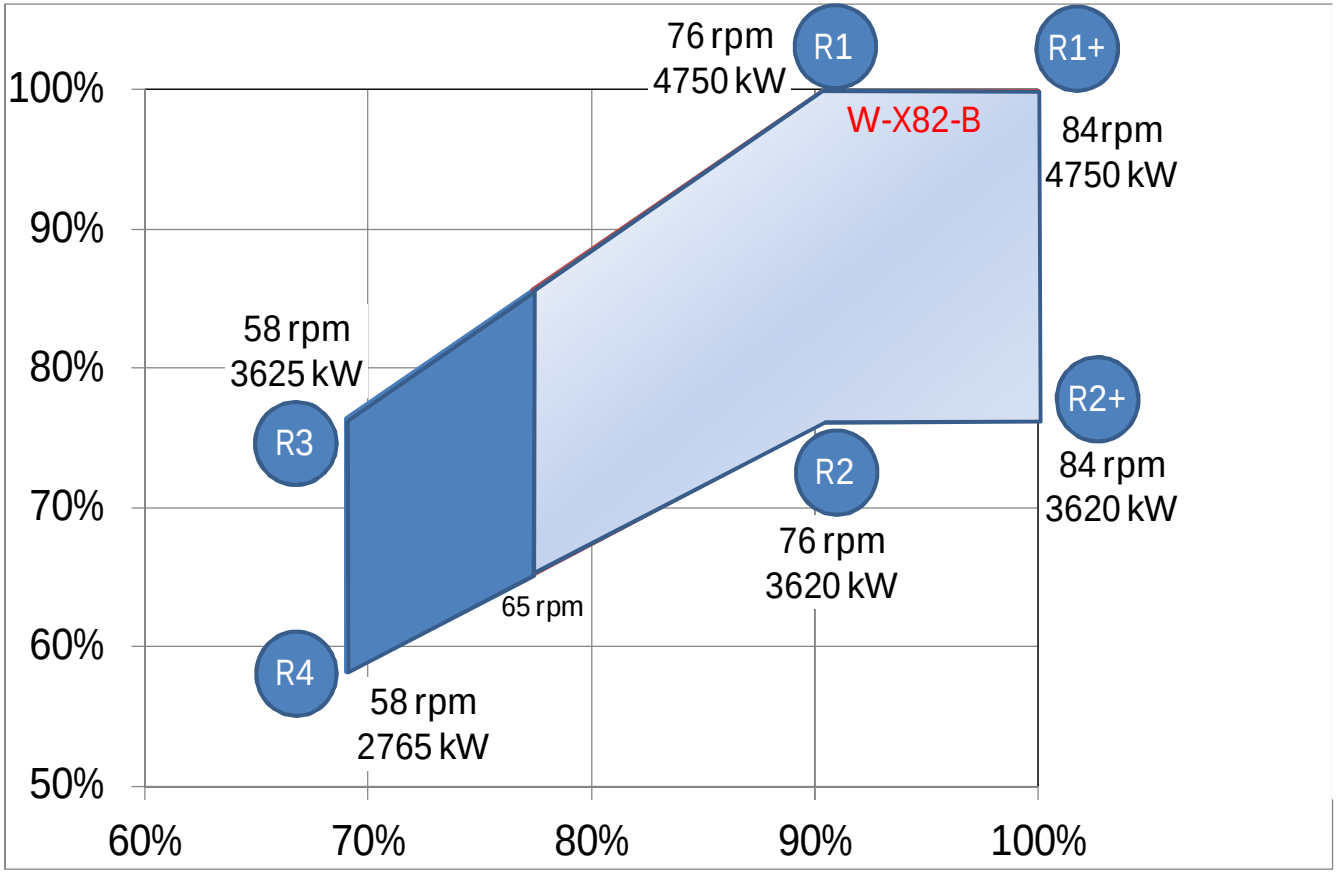


# W-X82-B – Extended Rating Field




Extended rating field has been introduced as new standard
for W-X82-B due to market requirements.

# W-X82-B – Extended Rating Field




## W-X82-B

- R3 & R4 speed reduced to 58 rpm

➔ Wider lay-out field

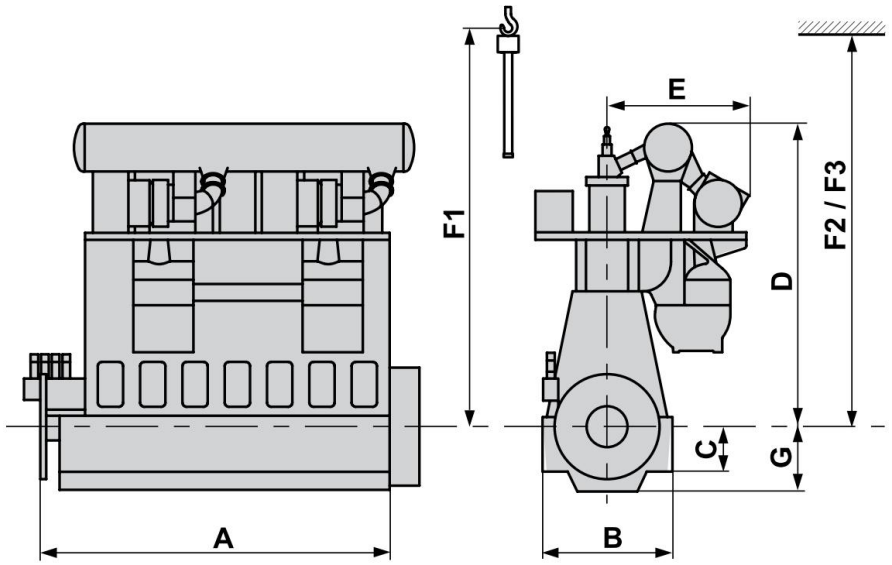
➔ optimum propeller selection

➔ market requirements

# *W-X82-B – Main Parameters*

| | | | RT-flex82T | W-X82 | W-X82-B |
|---|---|---|---|---|---|
| Bore | | mm | 820 | 820 | 820 |
| Stroke | | mm | 3375 | 3375 | 3375 |
| Stroke / bore | | | 4.11 | 4.11 | 4.11 |
| Number of cylinders | | | 6 - 9 | 6 - 9 | 6 - 9 |
| R1 / R1 + | Speed (R3)/R1/R1+ | rpm | 68 / 76 / 80 | 65 / 76 / 84 | 58 / 76 / 84 |
| | Mean piston speed | m/s | 8.6 / 9.0 | 8.6 / 9.45 | 8.6 / 9.45 |
| | Mean effective pressure | bar | 20 / 19 | 21 / 19 | 21 / 19 |
| | Cylinder pressure | bar | 159 / 159 | 175 / 175 | 175 / 175 |
| | Fuel consumption | g/kWh | 168 / 166 | **165 / 163** | 165 / 163 |
| | Power / cylinder at MCR | bhp | 6150 | 6460 | 6460 |
| | | kW | 4520 | 4750 | 4750 |

# W-X82-B – Main Parameters




One-piece CS | Two-piece CS

| | | 6 cyl. | 7 cyl. | 8 cyl. | 9 cyl. |
|---|---|---|---|---|---|
| **A** | mm | 11‘045 | 12‘550 | 14‘055 | 16‘500 |
| **B** | mm | 5‘320 | | | |
| **C** | mm | 1‘800 | | | |
| **D** | mm | 12‘250 | | | |
| **E** | mm | 5’400 | | | |
| **F** | mm | 14’820 | | | |
| **G** | mm | 2‘700 | | | |
| **Weight** | t | 805 | 910 | 1020 | 1160 |

## Piston and cylinder liner dismantling height

F1 Normal vertical lifting
(crankshaft center to crane hook)
F2 Reduced height, vertical lifting with double jib crane
(crankshaft center to deck beam)
F3 Reduced height, tilted lifting with double jib crane
(crankshaft center to deck beam)

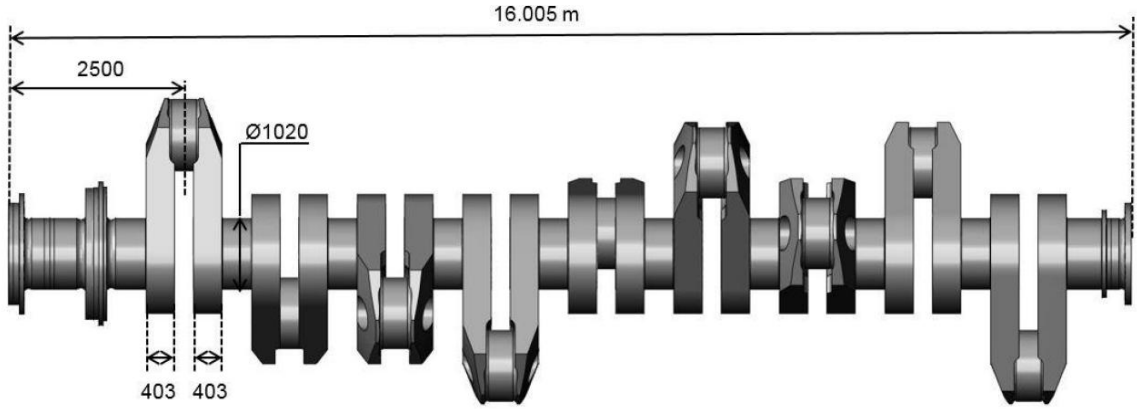
| | | |
|---|---|---|
| F1 | mm | 14‘820 |
| F2 | mm | 14‘800 |
| F3 | mm | 13‘800 |

# *W9X82-B – Main Parameters*

## One-piece crankshaft production is now possible

- Engine length and weight reduced

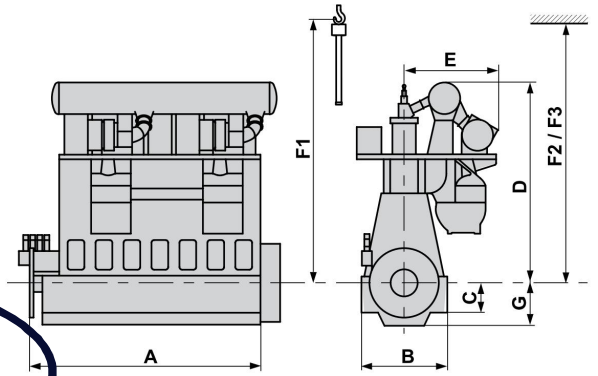
| | | Two-piece C/S | One-piece C/S | Advantage |
|---|---|---|---|---|
| C/S length | mm | 16’945 | 16’005 | -940 |
| C/S weight | t | 292 | 270 | -22 |
| Engine length A | mm | 16’500 | 15’560 | -940 |
| Engine weight | t | 1’160 | 1’130 | -30 |



# W-X82-B – Main Parameters

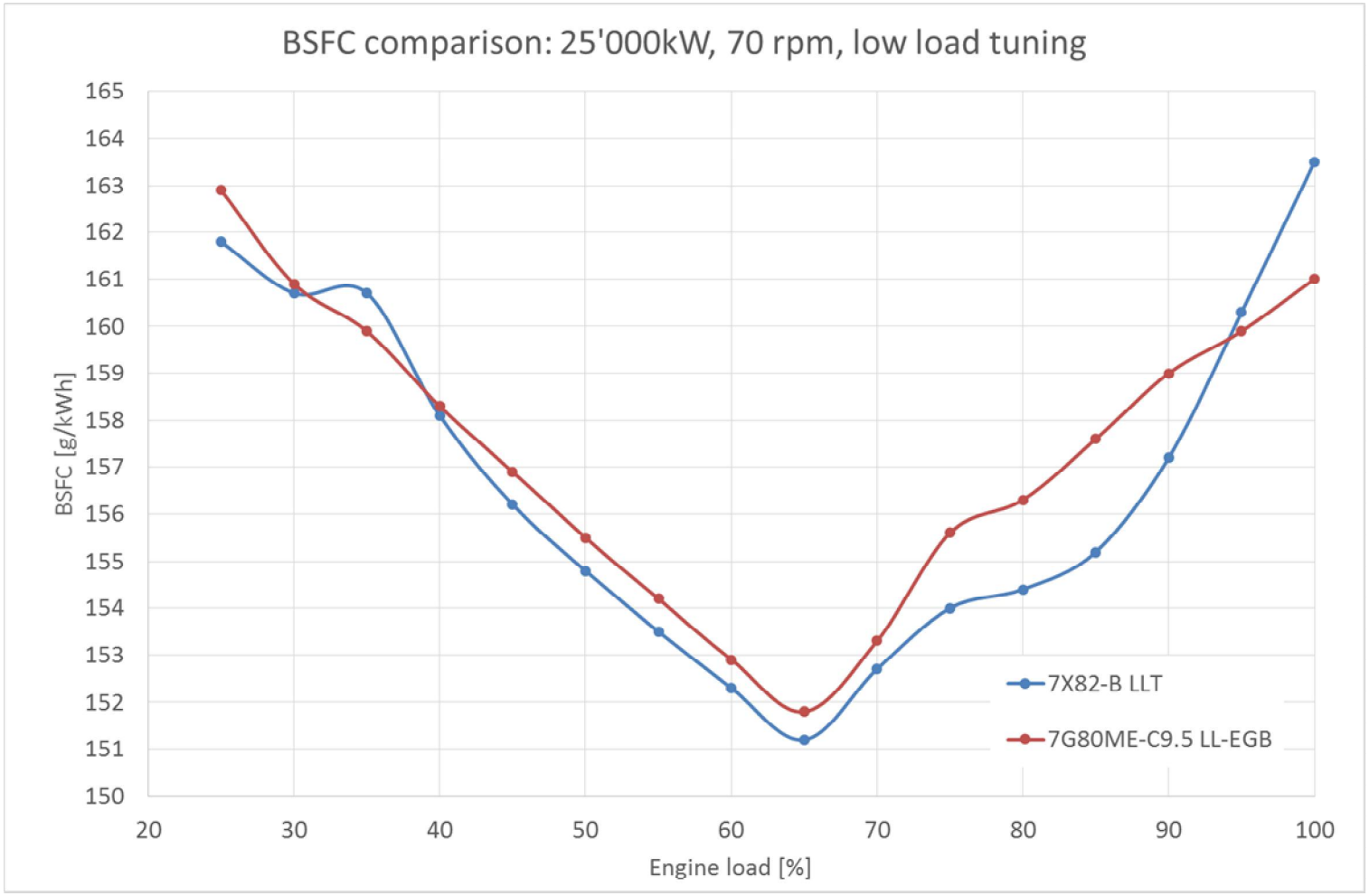
*Main dimensions W-X82 vs. competition*

| | | 7X82-B | 7G80ME-C9 | 7S80ME-C9 | 6S90ME-C9 |
|---|---|---|---|---|---|
| **Stroke** | mm | 3,375 | 3,720 | 3,450 | 3,260 |
| **A** | mm | 12,550 | 12,135 | 11,434 | 12,802 |
| **B** | mm | 5,320 | 5,320 | 5,280 | 5,160 |
| **C** | mm | 1,800 | 1,960 | 1,890 | 1,900 |
| **F** | mm | 14,820<br>13,800 | 16,100<br>14,525 | 15,050<br>13,500 | 15,000<br>14,500 |
| **Weight** | t | 910 | 1,055 | 933 | 1’100 |




Engine weight and dismantling height lower for X82-B engine

# W-X82-B – BSFC Comparison




X82-B BSFC values very competitive over the whole load range

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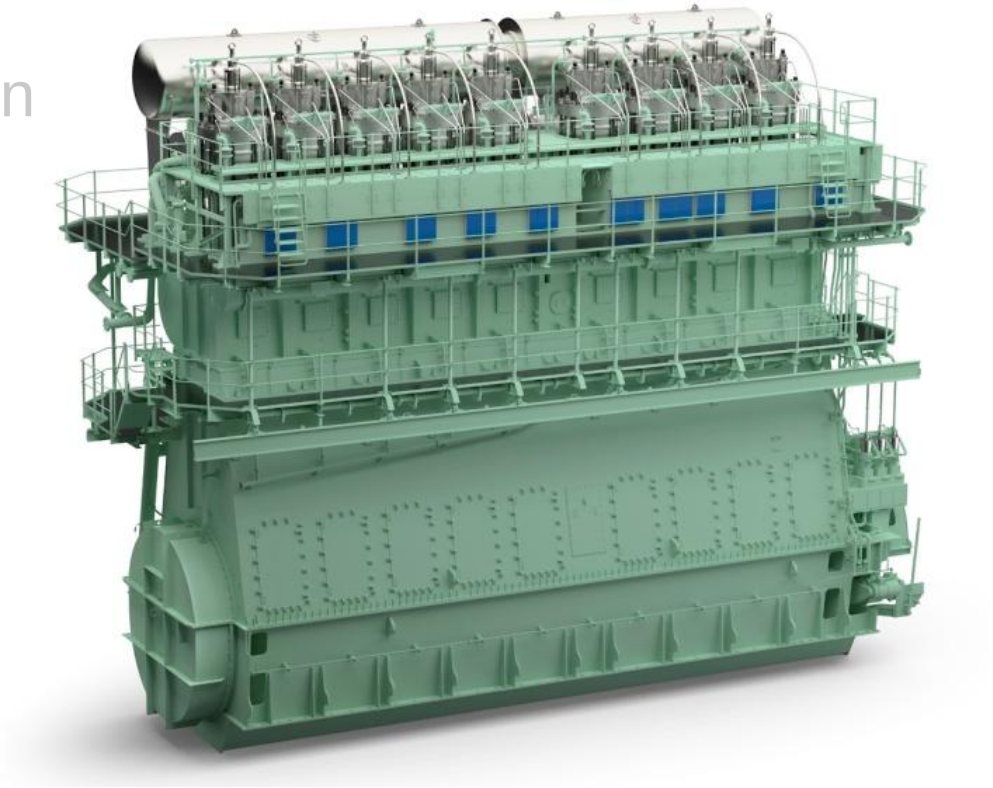
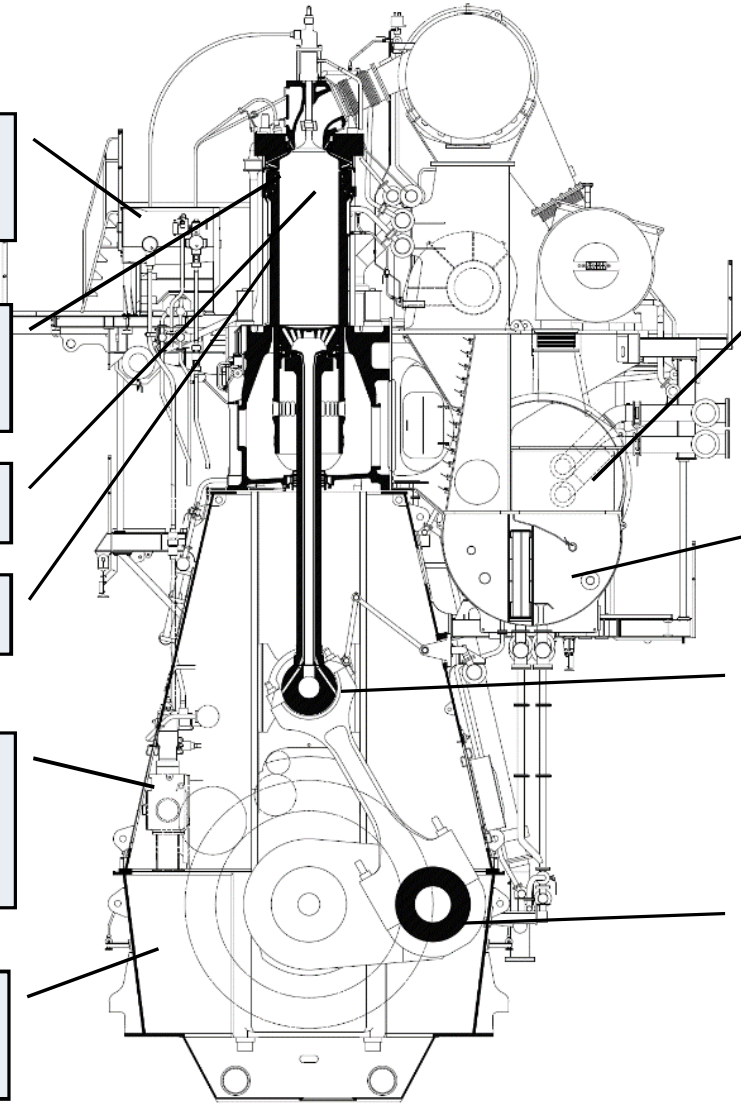


# *RT-flex82T / X82 – Design Features*



RT-flex system
- Rail Unit

Bore cooled combustion chamber components

Piston running features

Pulse Lubricating System

RT-flex system
- Fuel Pump Unit
  Servo Pump Unit

Column & bedplate in double wall design

Compact scavenge air coolers

Underslung receiver

Low pressure oil supply for cross head bearing

White-metal bearings

# RT-flex82T / X82 – Design Features

## Computer Aided Engineering areas

*Finite Elements (stress & strain, temperature)*

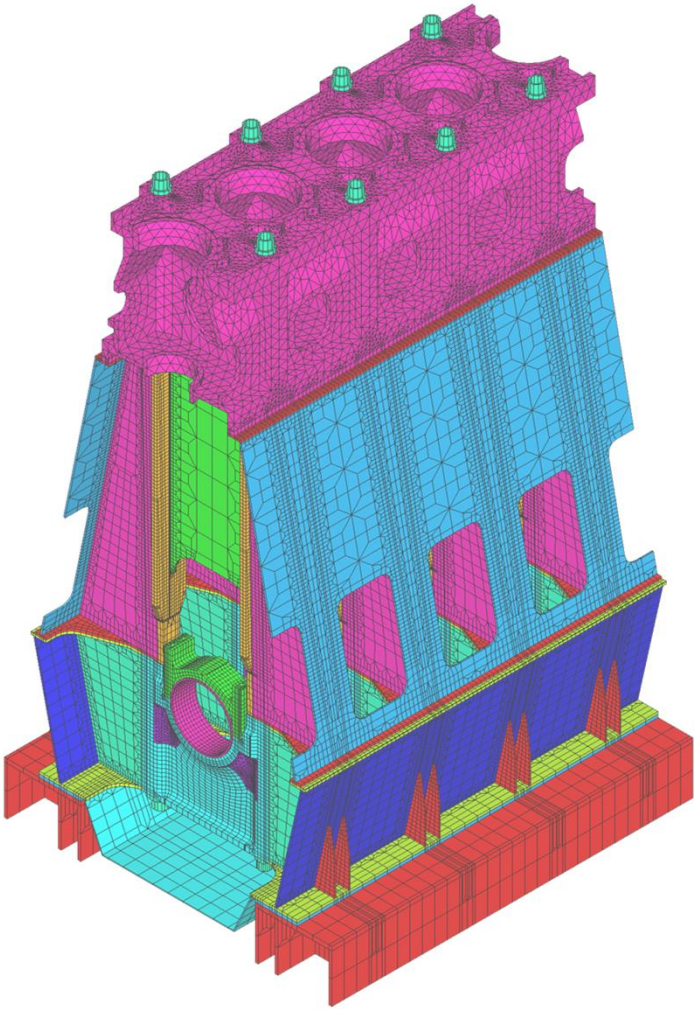
- *Engine structure (column / bedplate)*
- *Air receiver / exhaust pipe*
- *Hot parts, cylinder block*
- *Running gears*
- *Rail unit / supply unit*
- *Girder casting and solidification simulation*

*Hydrodynamics*

- *Elasto Hydro Dynamic main bearing calculation*
- *Supply and rail unit specific hydraulics*

*Vibrations*

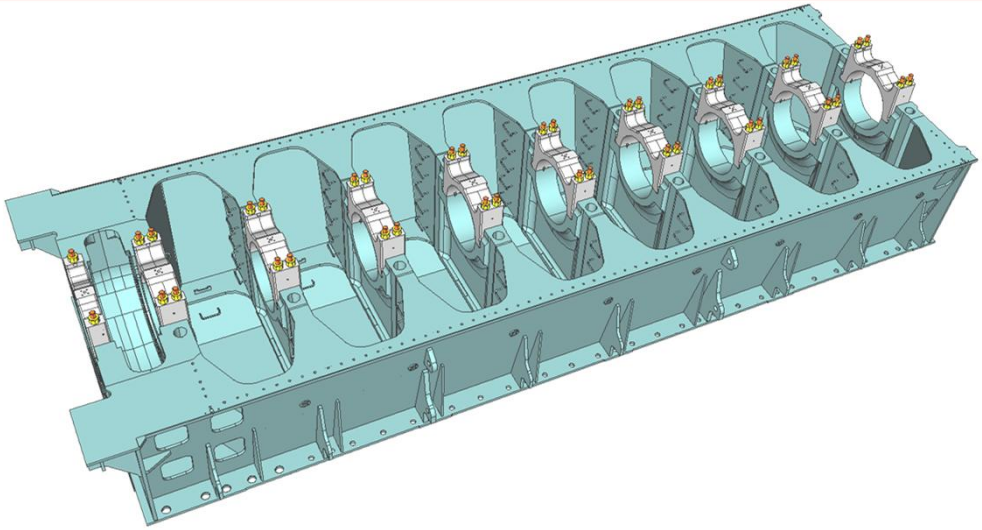
- *Torsional and axial shaft vibrations*



# RT-flex82T / X82 – Design Features

## Bedplate

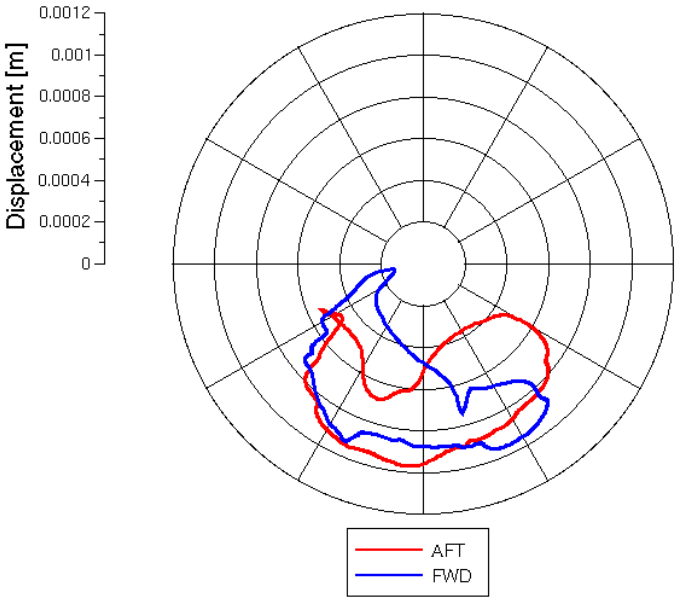
- *Compact double wall design*
- *No side box as on RT-flex50*
- *Integrated thrust bearing*
- *Proven main bearing technology*
- *Girders optimized for thinner tie rods*

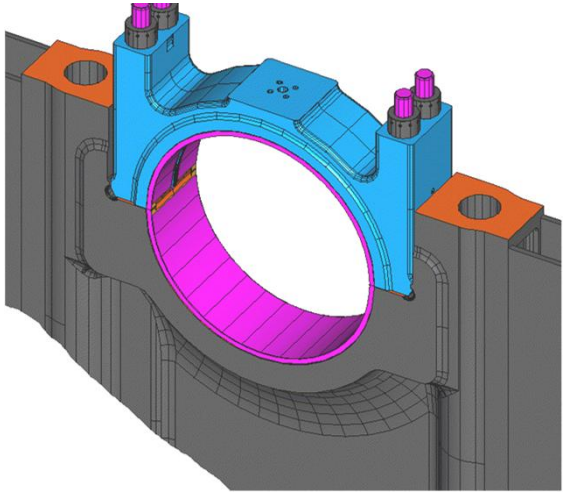


# RT-flex82T / X82 – Design Features

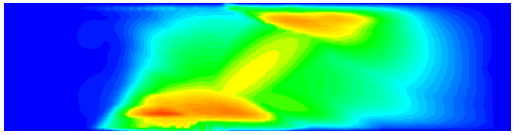
***Main bearings***

- *Two thin shell bearing design with thick white metal layer*
- *Design is chosen to assure reliable main bearing operation*
- *Layout checked by Elasto Hydro Dynamic calculation*



EHD



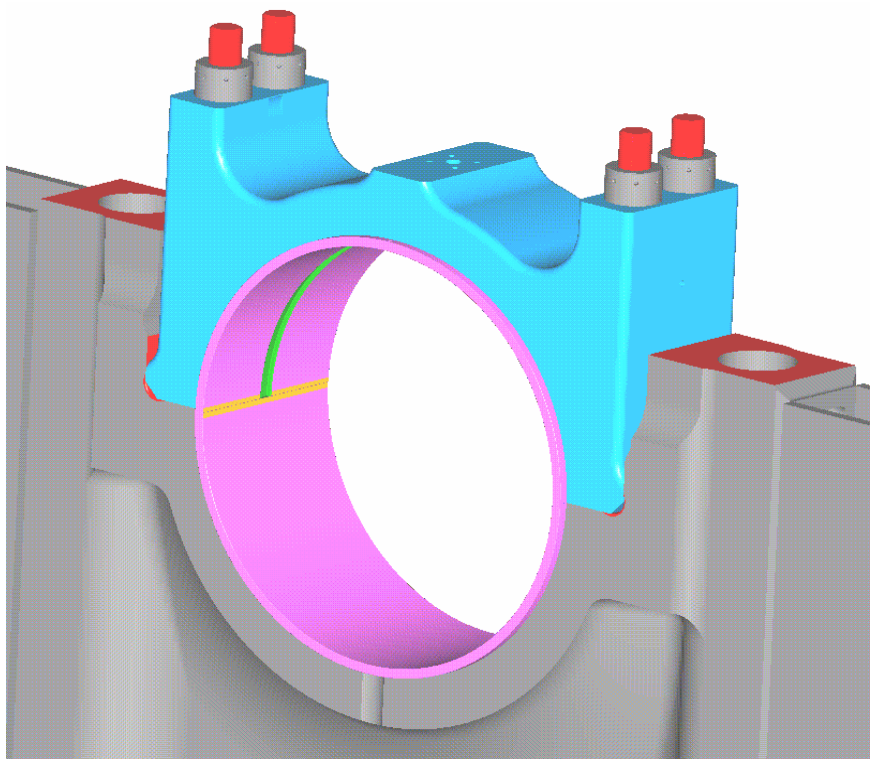


WIN GD
Winterthur Gas & Diesel

# *RT-flex82T / X82 – Design Features*

**Main bearing**

- Two thin shells
- Cover and bedplate machined together



# *RT-flex82T / X82 – Design Features*

## Risk after a main bearing failure

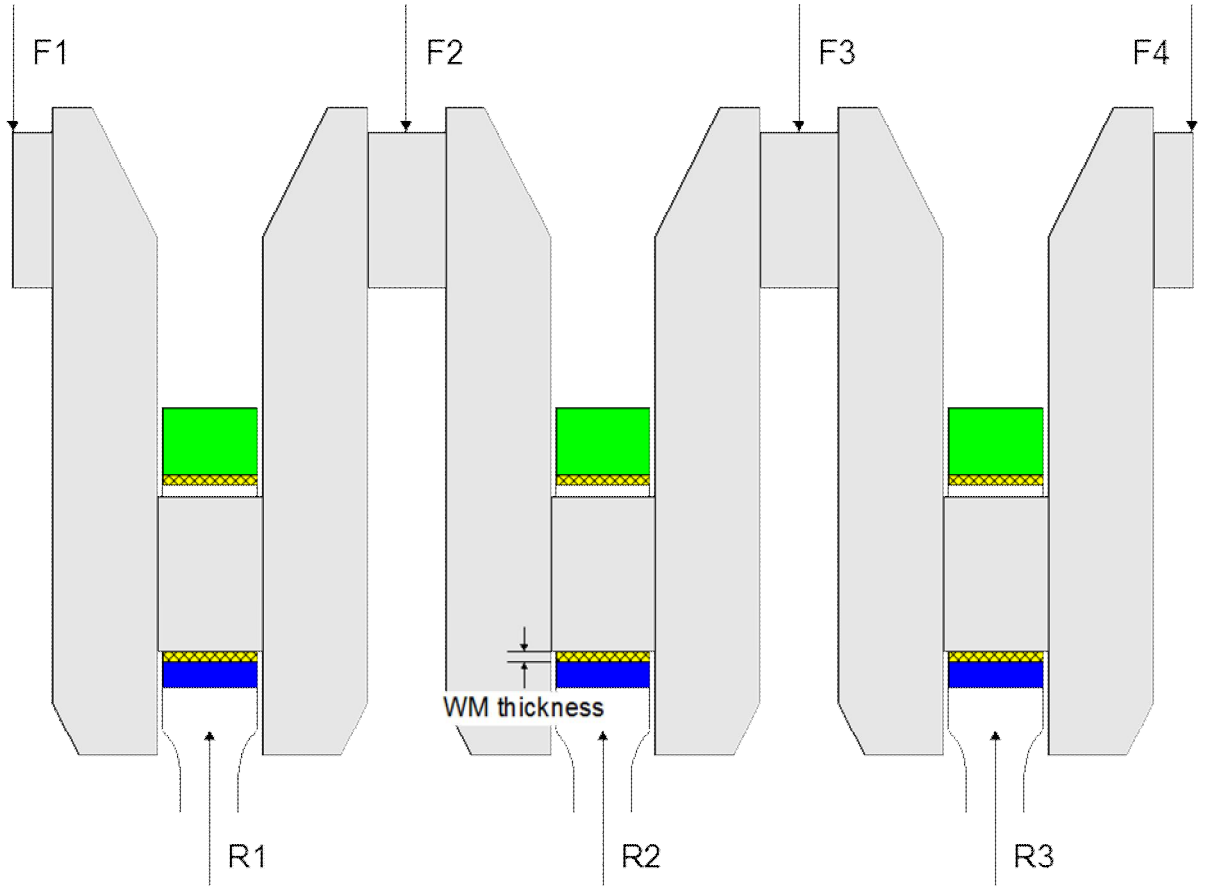
- What should be avoided
  - Main engine breakdown
  - Contact between crankshaft and back metal of main bearing shell

- Preventive measure
  - White metal layer thicker than bending of crankshaft

- Service experience
  - No main engine breakdown after a main bearing failure in WinGD engines
  - Extreme low risk to damage the crankshaft journal
  - Main bearing shell exchanged at next port and trip continued
  - Proven design

# RT-flex82T / X82 – Design Features

## Crankshaft with main bearings

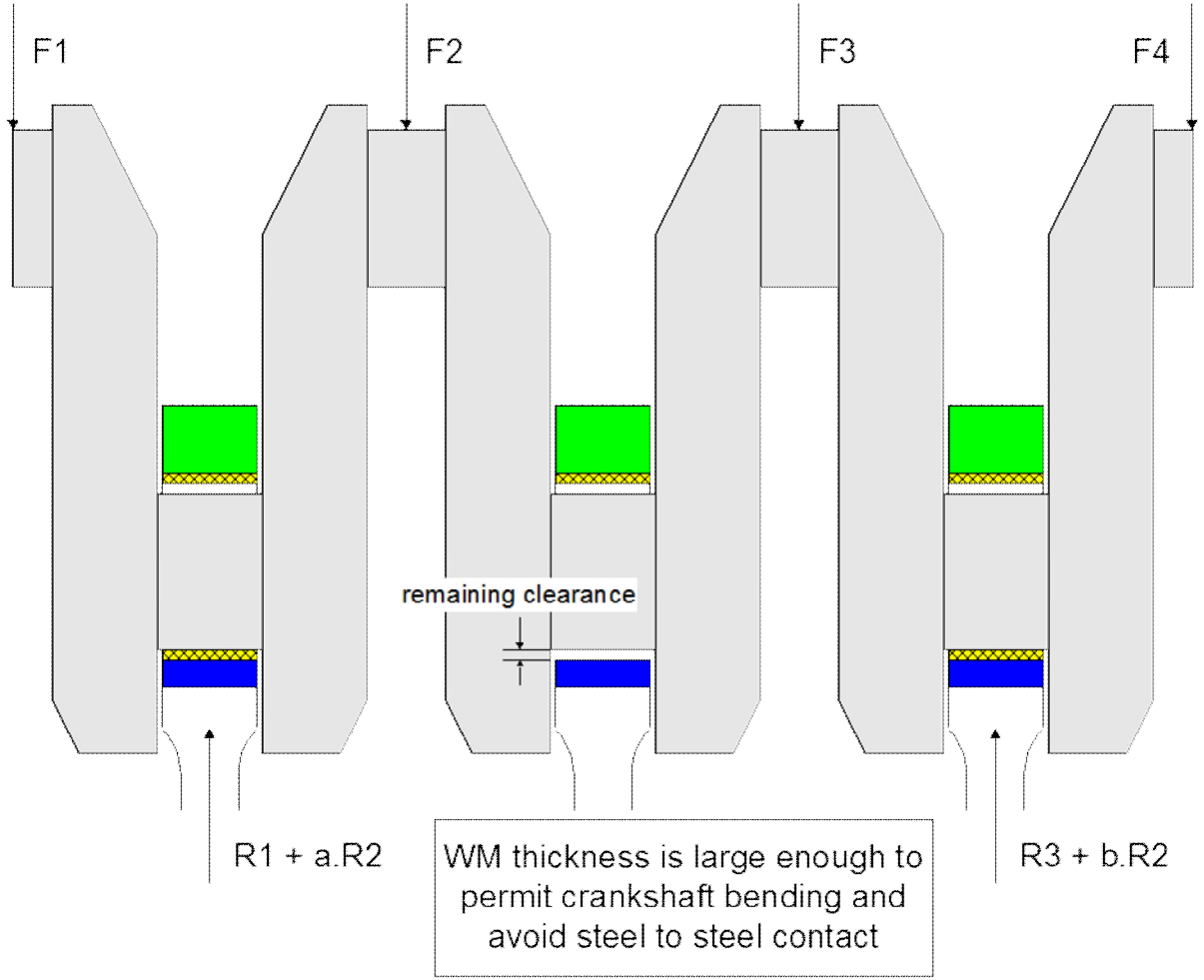





WIN GD
Winterthur Gas & Diesel

# *RT-flex82T / X82 – Design Features*

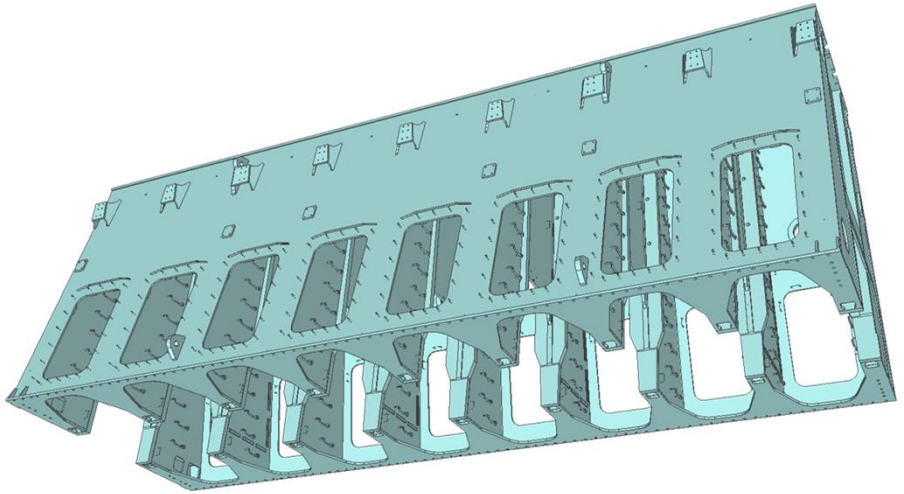
## One main bearing shell without white metal



# RT-flex82T / X82 – Design Features

## Column

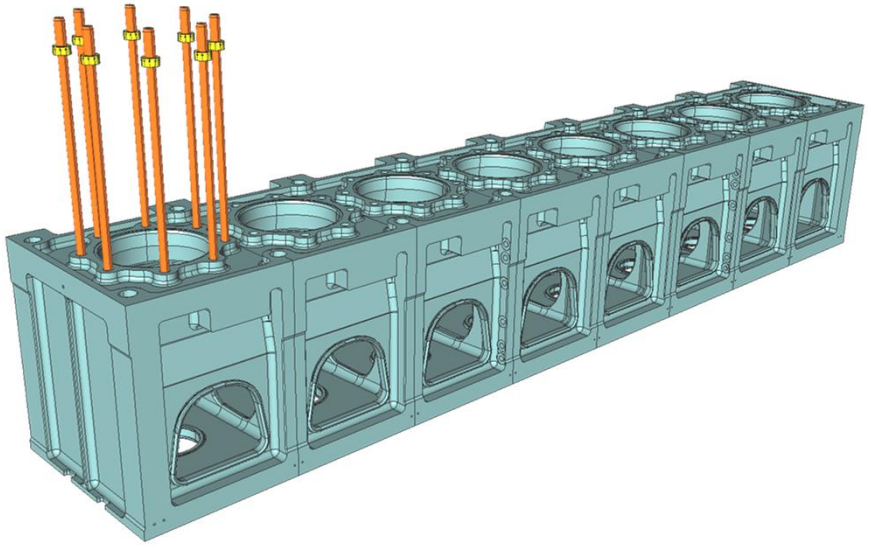
- *Sturdy double wall design*
- *Mid-sheets are executed as single walls*
- *Thick guide rails to reduce deformation and stress under guide shoe forces*
- *Thin sections for ease of welding*
- *Design optimised for ease of manufacturing and allowing strong quality assurance*



# RT-flex82T / X82 – Design Features

## Cylinder block

- *Grey cast iron*
- *Optimized for stress distribution and weight*
- *Reduced machining surface*
- *Mono block design and split execution are available*
- *Dry block*
- *Inspection door on fuel side*
- *Easy access to piston underside*



# RT-flex82T / X82 – Design Features

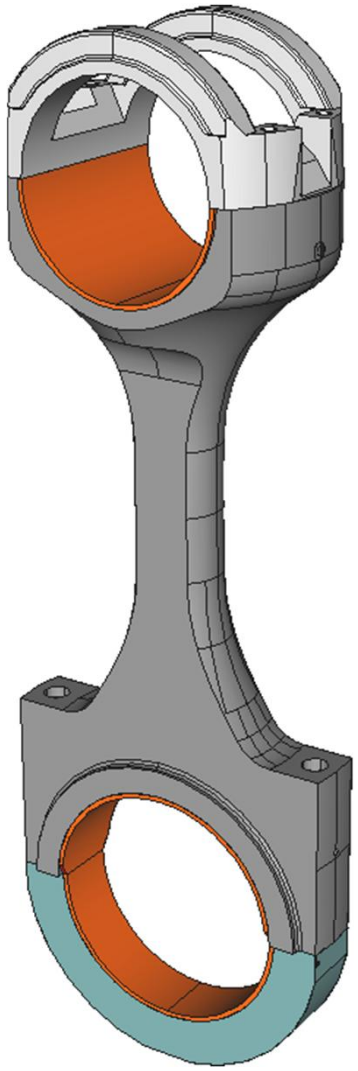
## Connecting rod

### Cross head bearing

- Lubricating and piston cooling oil access by knee lever
- White metal running surface
- Proven low pressure lubrication

### Bottom end bearing

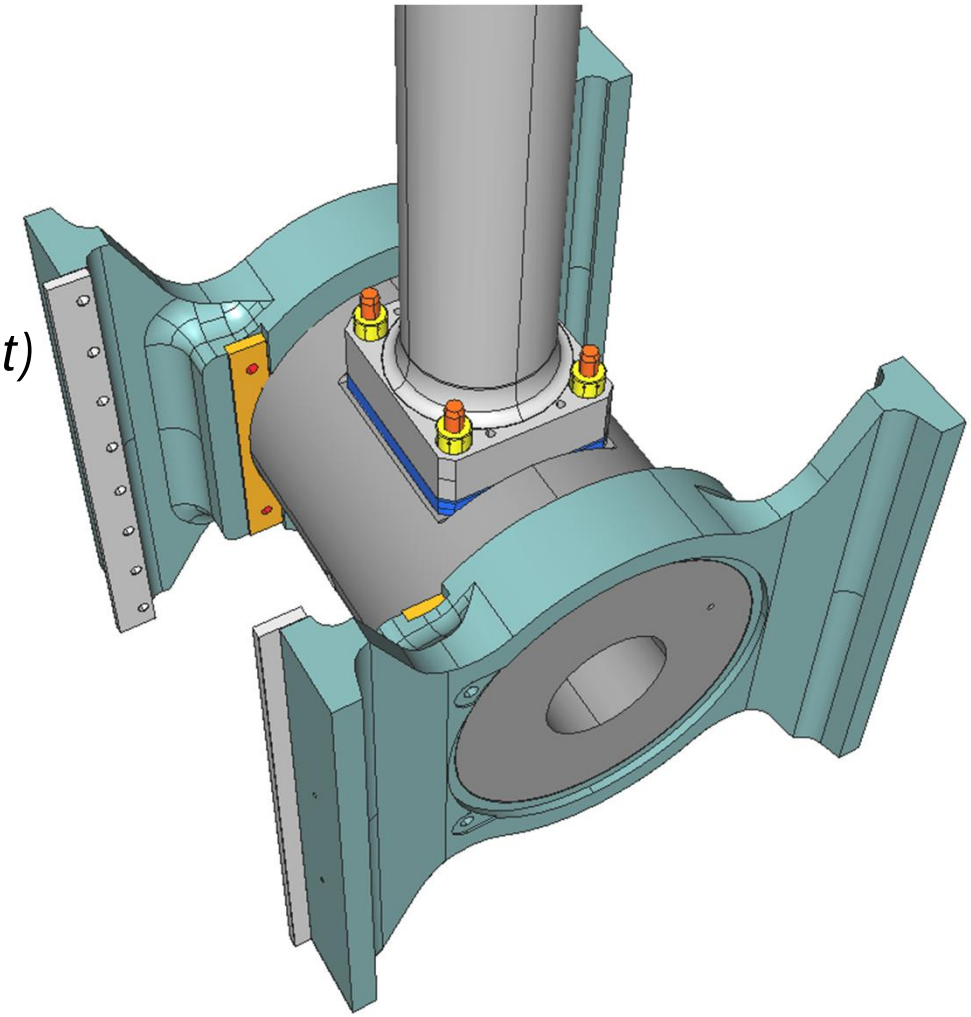
- Two thin shell bearings design with white metal layer



# RT-flex82T / X82 – Design Features

## Crosshead

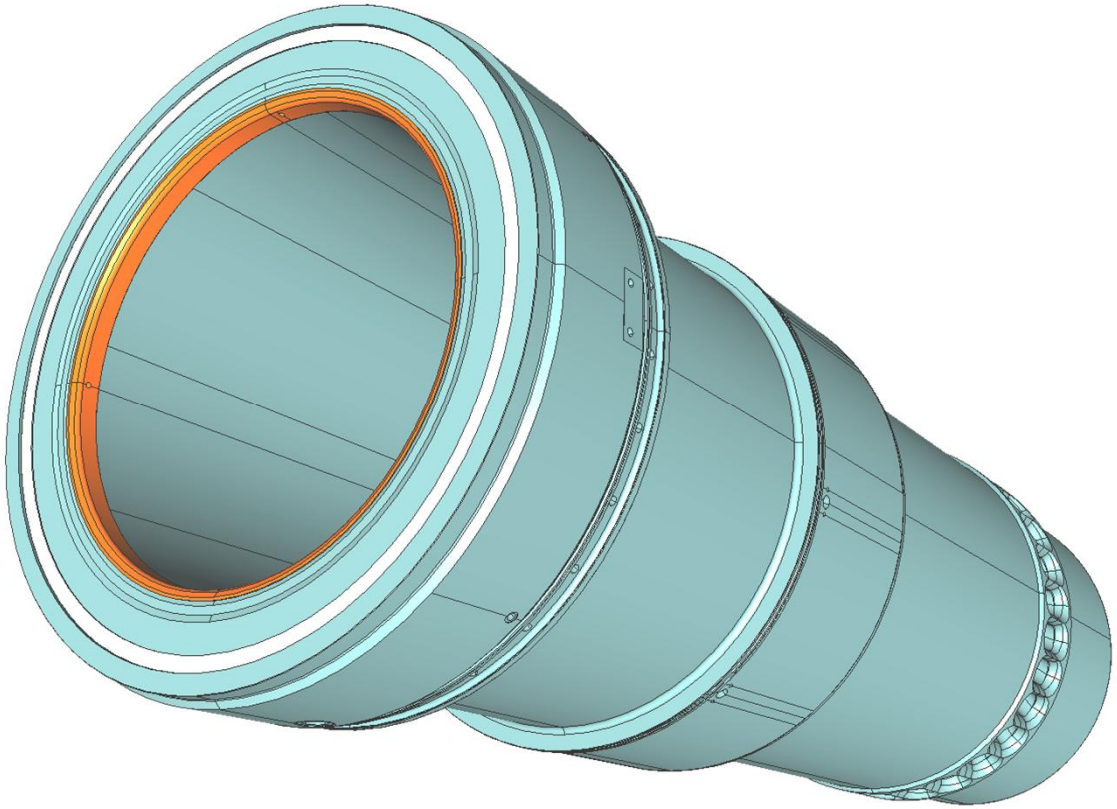
- *Deformations of guide shoe optimized by FE calculations*
- *Guide shoe in one piece (steel cast) with white-metal lining*
- *Optimized force transmission for lowest load on engine structure*
- *Large contact surface between guide shoe and guide rail at bottom dead centre*



# RT-flex82T / X82 – Design Features

## Cylinder liner

- Grey cast iron with optimal hard-phase content
- Stress and temperature optimized by FE calculation
- Bore cooled collar
- Supporting ring omitted
- Cooled O-rings
- Anti polishing ring



# RT-flex82T / X82 – Design Features

***Combustion chamber***

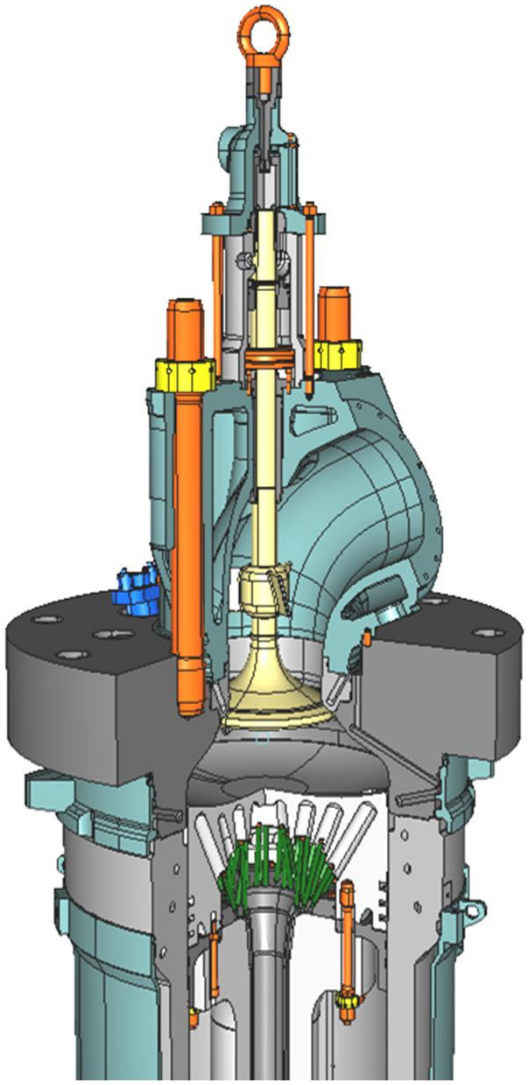
*Bore cooled components*

- *Piston*
- *Cylinder liner*
- *Cylinder cover*
- *Exhaust valve seat*

*Exhaust valve spindle is made of Nimonic 80A*

*Grey cast valve cage, water cooled*

*Anti polishing ring*



# RT-flex82T / X82 – Design Features

***Piston***

*Proven jet-shaker oil cooling*

*Stress and temperature optimized by FE calculation*

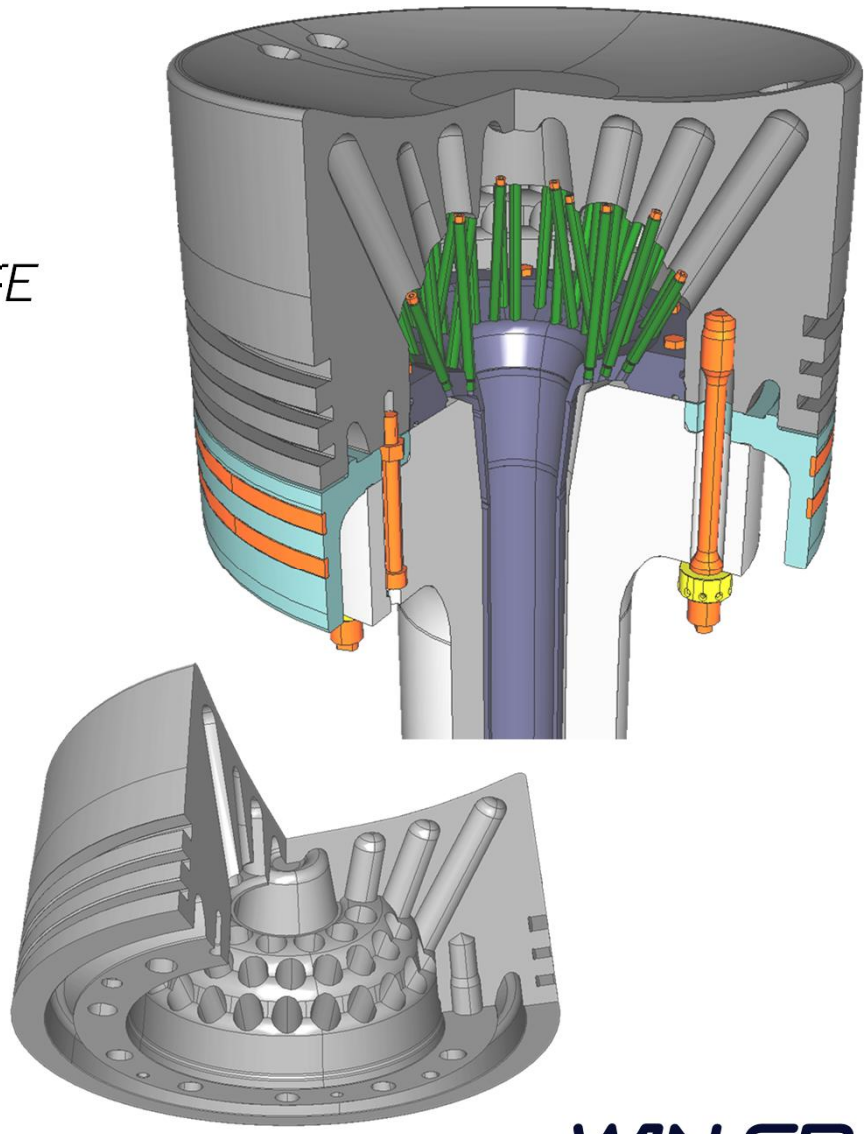
- *Position and number of cooling bores optimized for even temperature distribution on piston crown*

*3 piston rings will be applied*

- *Top ring gas tight, 24 mm high*
- *Lower rings standard, 16 mm high*

*High top land*

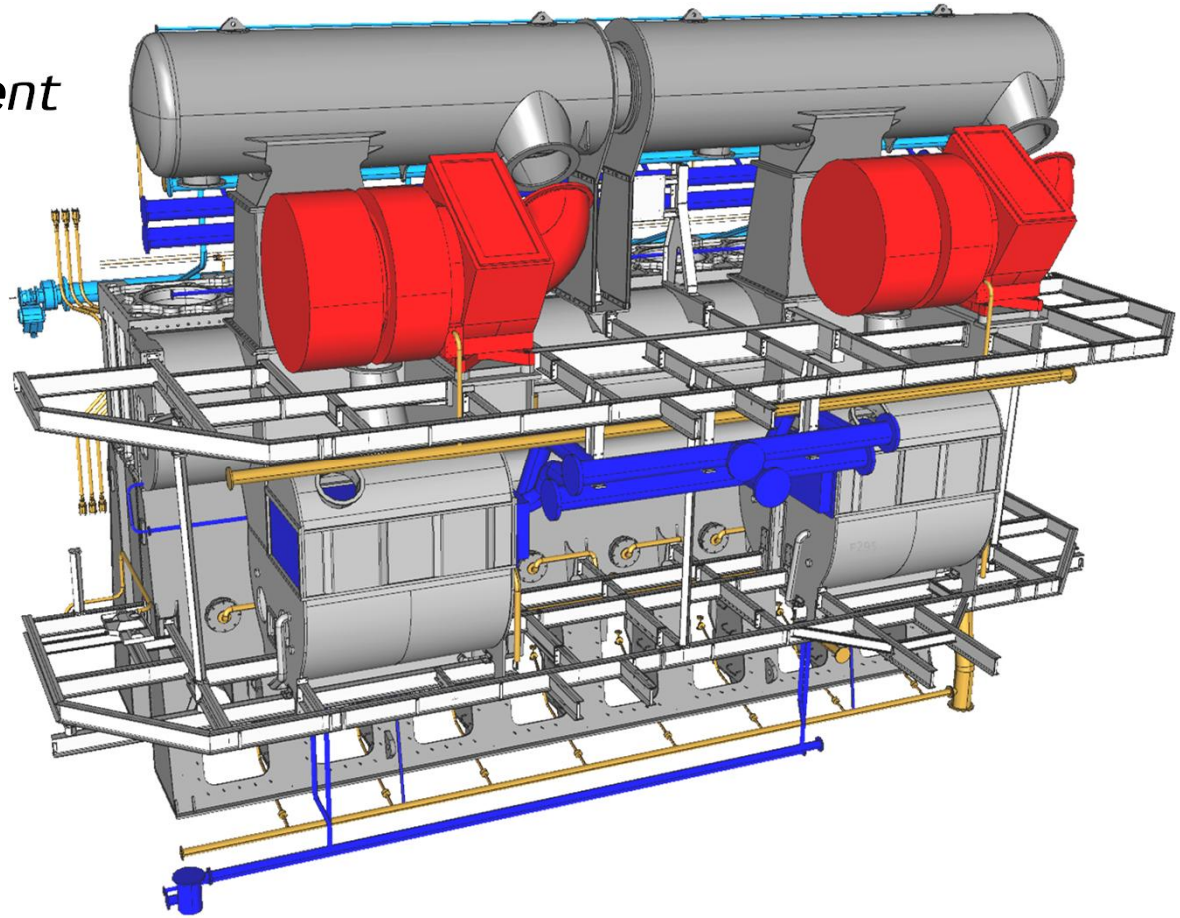
*Simplified cooling nozzles*



# RT-flex82T / X82 – Design Features

***Turbo charging arrangement***

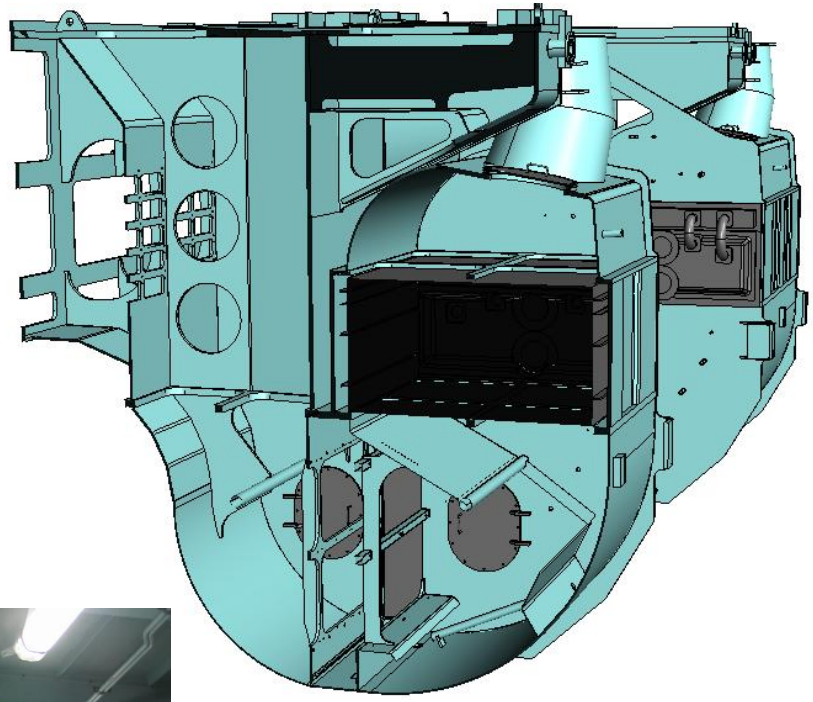
- *Very stiff T/C support design*
- *Compact scavenge air coolers*



# RT-flex82T / X82 – Design Features

***Receiver arrangement***

- *Highly efficient water separation with underslung receiver and separator*
- *Efficient condense water drain system*
- *Horizontal cooler dismantling*
- *High performance cooler for fresh water*

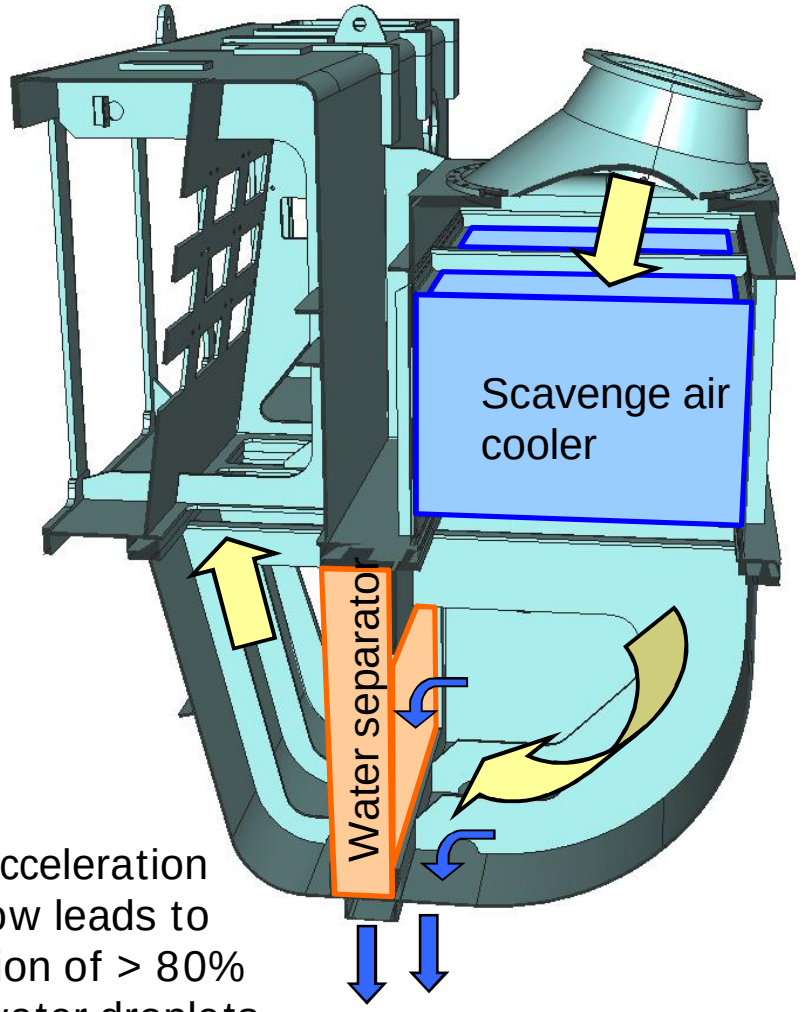


# RT-flex82T / X82 – Design Features

## Water separation

*Underslung design for efficient natural water separation*

- *Air swirl supported water droplet separation*
- *Additional water separator element for high efficiency*
- *Effective drain (pressure balanced)*




Radial acceleration of air flow leads to separation of > 80% of the water droplets

# RT-flex82T / X82 – Design Features

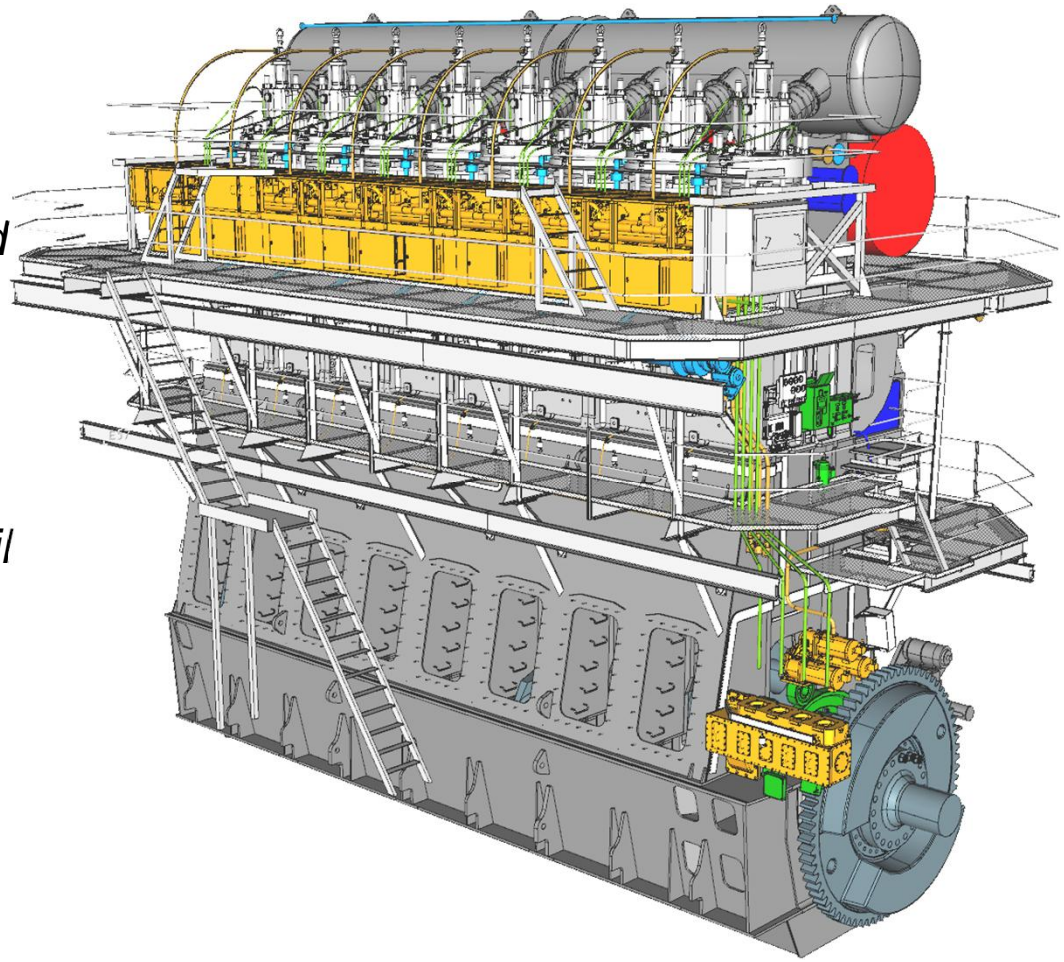
## Common Rail System

*Rail unit*

- *Activation of fuel and exhaust valve by electronically controlled rail valves*

*Supply unit*

- *Pressurizing of fuel and servo oil*
- *The servo oil is fine filtered*
- *Redundant piping for fuel and servo oil between Supply Unit and Rail Unit*



# RT-flex82T / X82 – Design Features

***Fuel pump, servo oil pump arrangement for 6 - 8 cylinder version***

*Compact design*

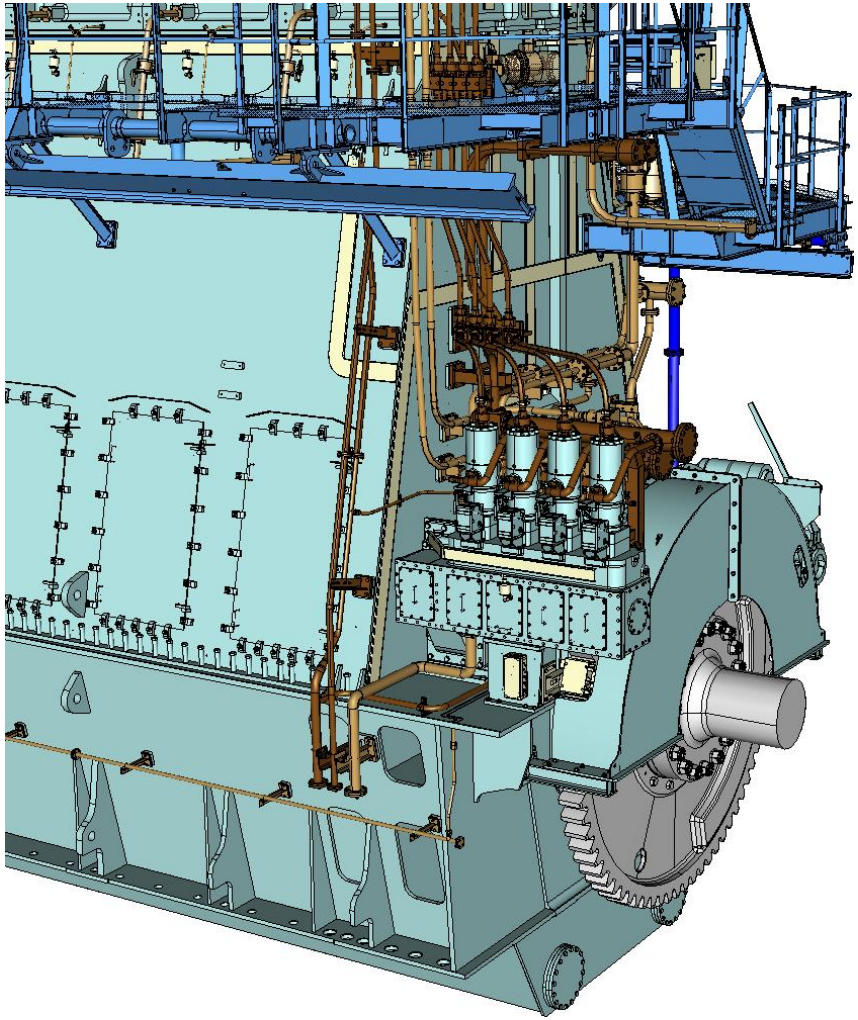
*Split arrangement of heavy fuel oil and servo oil supply*

*Heavy fuel oil supply*

- *Pressure up to 900 bar*
- *4 fuel pumps*

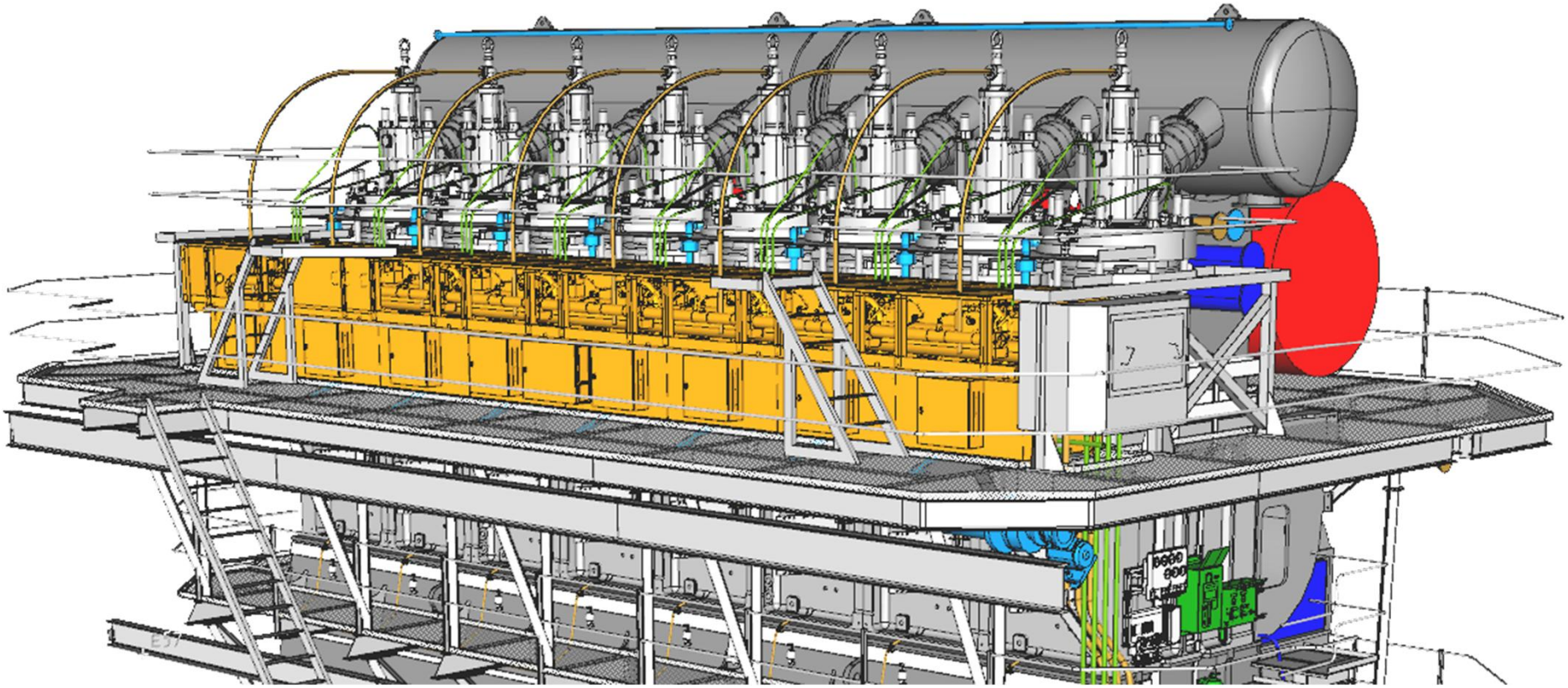
*Servo oil supply*

- *Pressure up to 200 bar*
- *Axial piston type oil pumps*
- *2 pumps (6 - 8 cylinder)*
- *3 pumps (9 cylinder)*



# RT-flex82T / X82 – Design Features

***Rail unit arrangement***



# RT-flex82T / X82 – Design Features

## RT-flex system

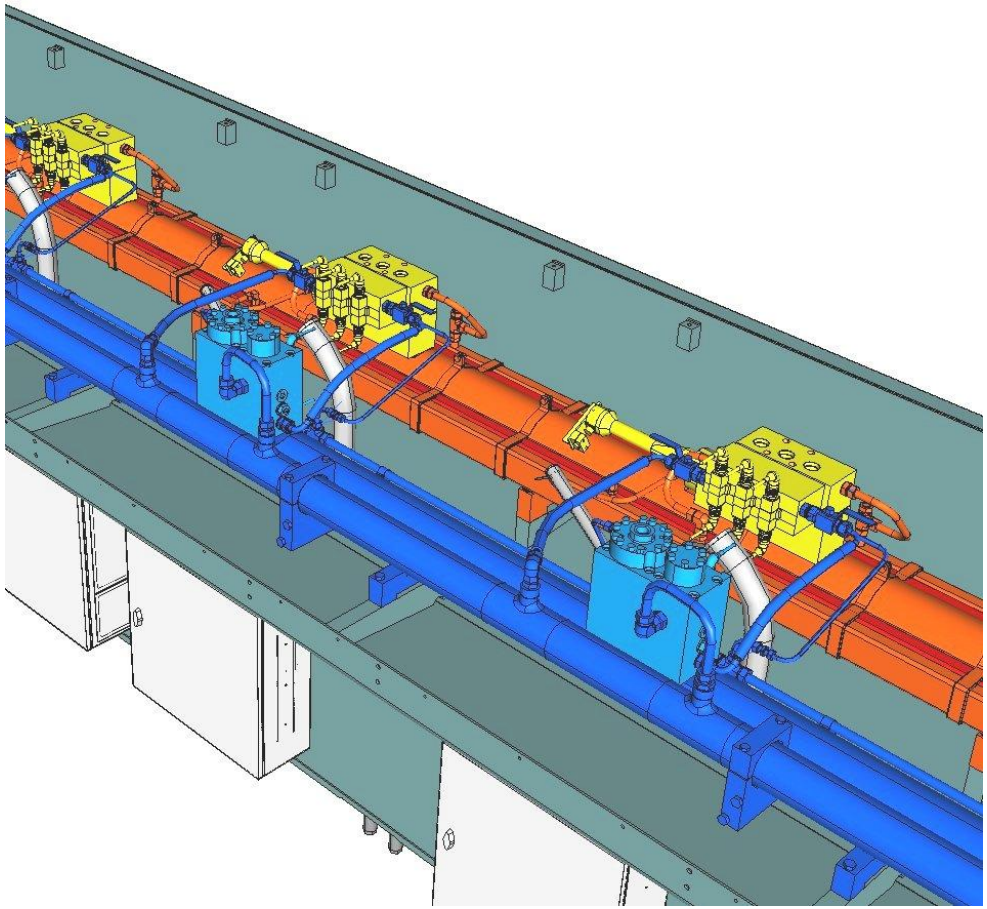
*4th execution re-dimensioned and optimized for RT-flex82T engine*

- *Fuel rail*

*Injection control units*
*Fuel injection pressure up to 900 bar*
*Fuel pipe in one piece*

- *Servo oil rail*

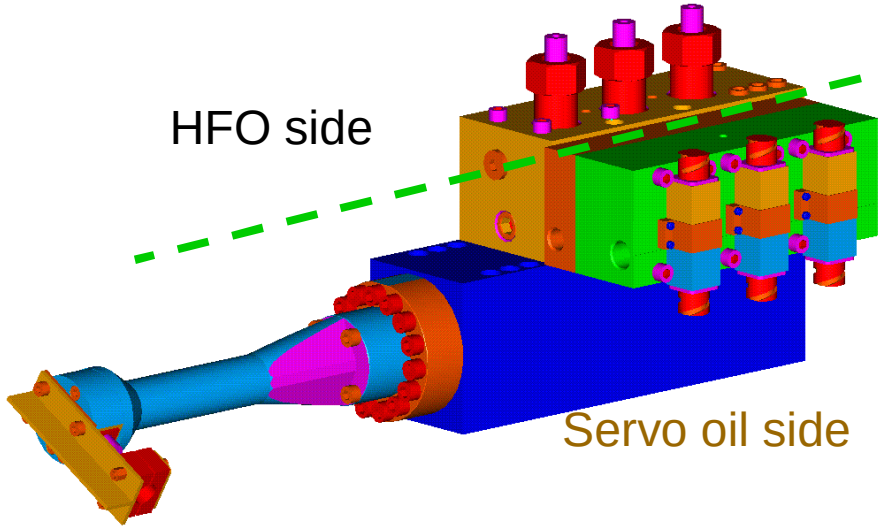
*Hydraulic exhaust valve drive*
*Pressure up to 200 bar*



# RT-flex82T / X82 – Design Features

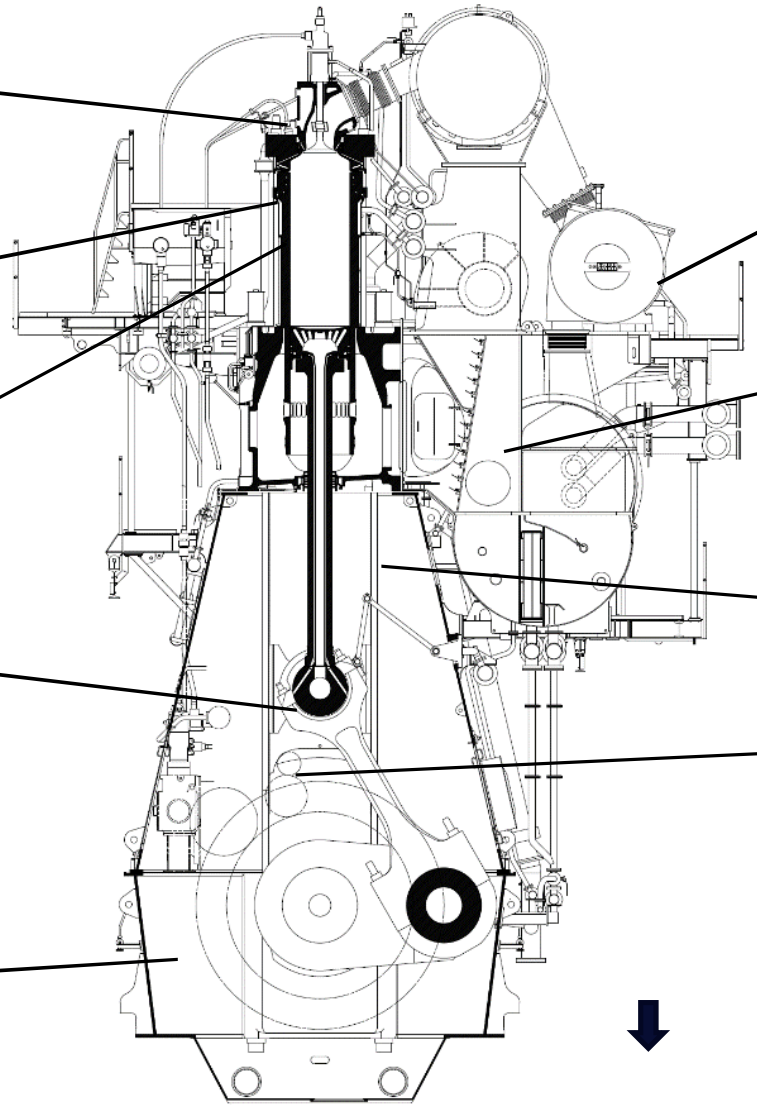
***Injection control unit***

- *Wärtsilä rail valves are electronically controlled*
- *They hydraulically activate the individual injection valves per cylinder*
- *A dosage piston stands for an exact volumetric control of the fuel oil*




Test rig in DTC

# *RT-flex82T ➔ X82 – Design Modification*



FAST nozzles

Cylinder liner, temperature adaptation

Pulse Jet Lubricating System

Crosshead bearing shell with oil pocket

Bedplate, side plates changed 28 ⇨ 32 mm

TC and CAC adaptation

Receiver strengthening

Tie rod: Pre-tensioning jacks

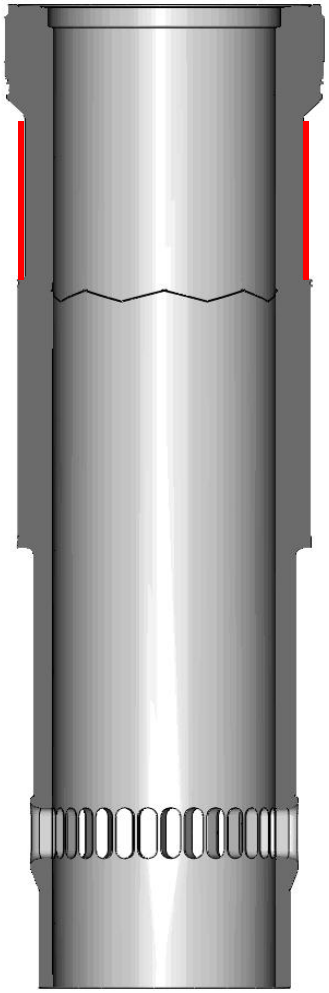
SU drive speed adaptation

# W-X82 – Piston Running Concept

RT-flex82T
PLS Feed

Cylinder liner arrangement

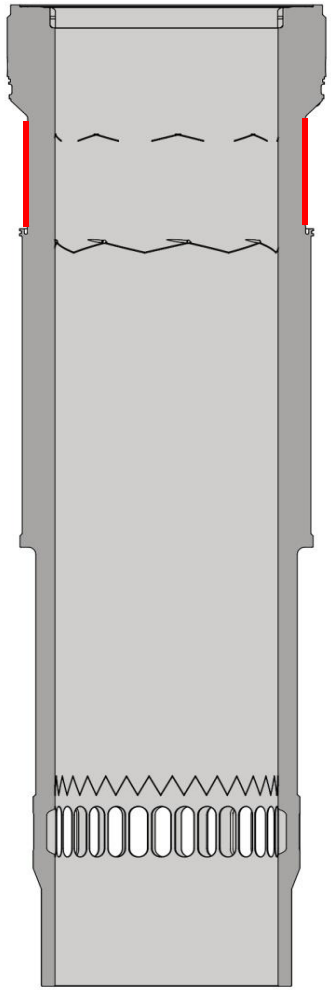
W-X82
PLS Jet



Umbrella grooves
- Improve corrosion resistance at DTC

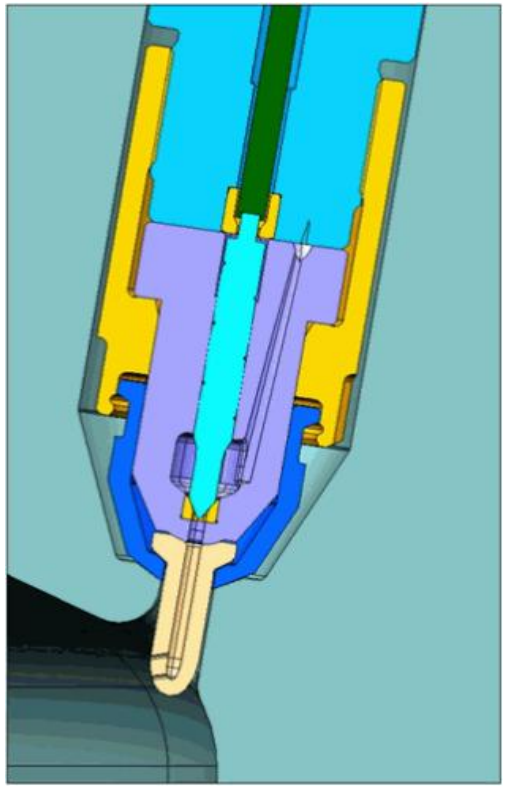
Zigzag grooves
- Enhanced lube oil distribution
- Pulse Jet system

Collection grooves
- Reduced lube oil losses through inlet ports to piston underside

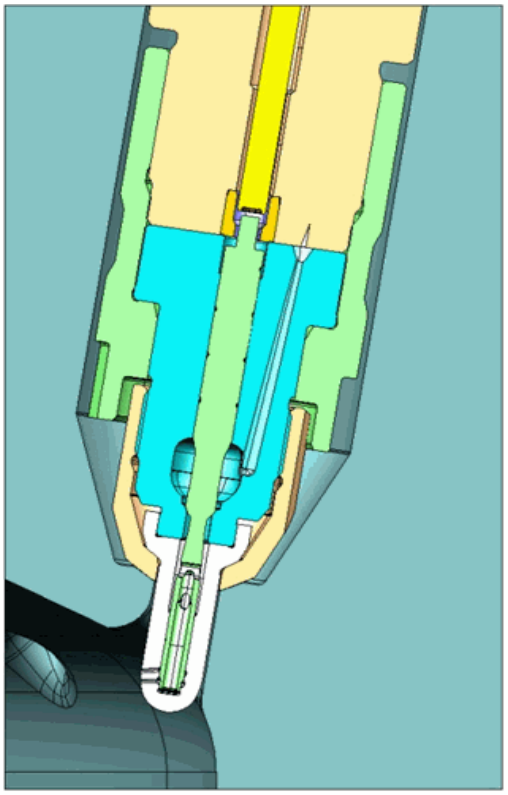


# *W-X82 – FAST Injection Nozzle*

**FAST** = Fuel Actuated Sacless Technology



**Standard nozzle nozzle**

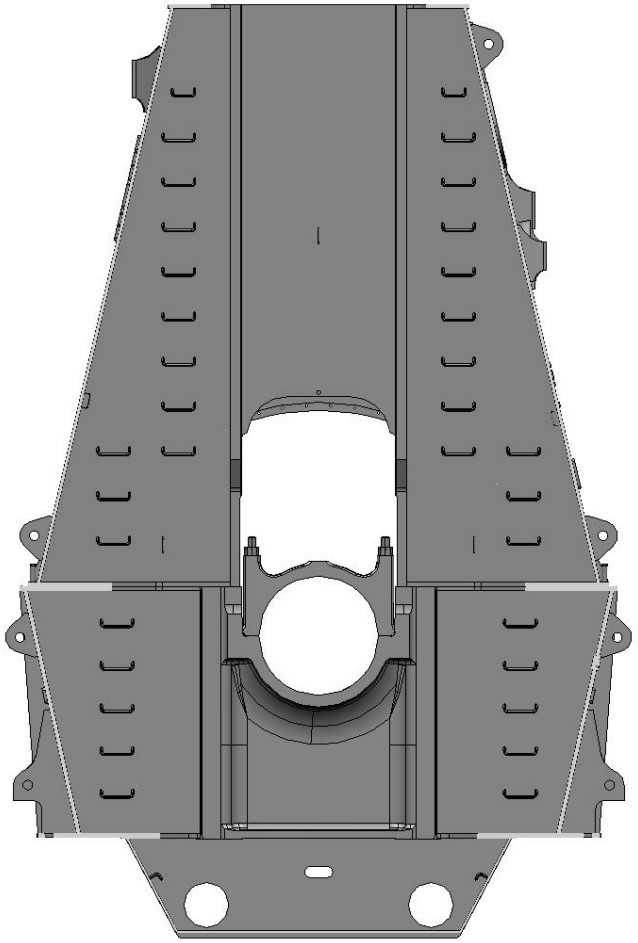


**FAST**

- Reduced HC emissions
- Reduced BSFC, especially at part load
- Cleaner combustion chamber
- Cleaner exhaust gas after exhaust valve → fouling reduction of the receiver and turbine parts
- Reduced smoke formation
- Reduced CO emissions

# W-X82 – Engine Structure

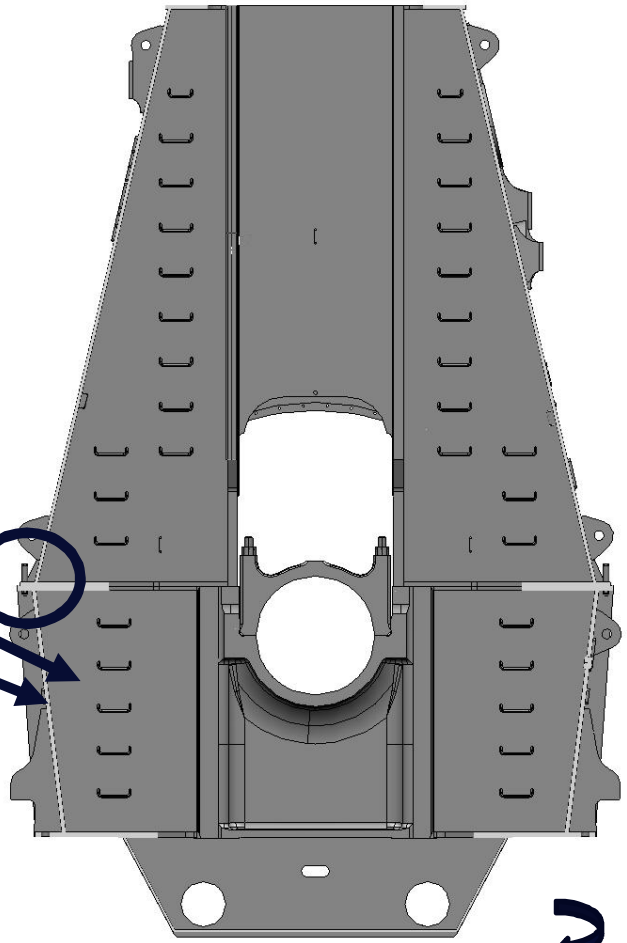
RT-flex82T



- Bolts outside
- Thicker plate
- Side sloping plate

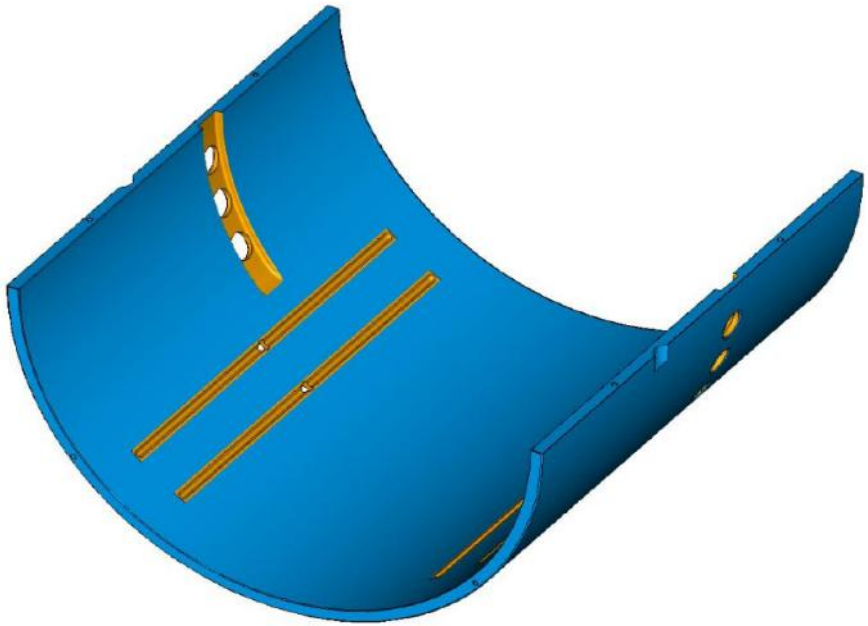
➔ Stress reduction in bedplate

W-X82

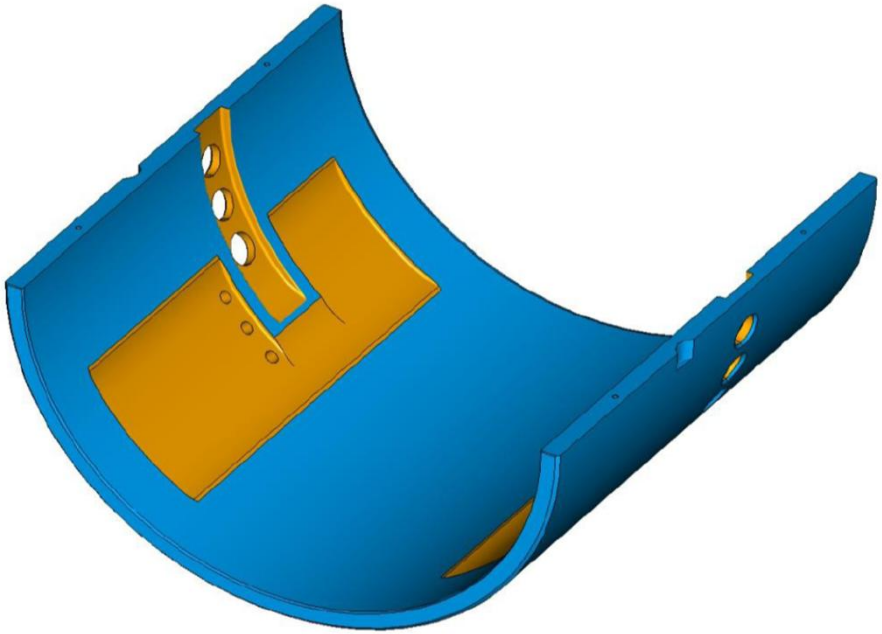


# W-X82 – Crosshead Bearing Shell

RT-flex82T



W-X82



- Oil pockets to increase safety margin
- Needed for T/C cut off operation

# *W-X82 – SU Drive Speed*

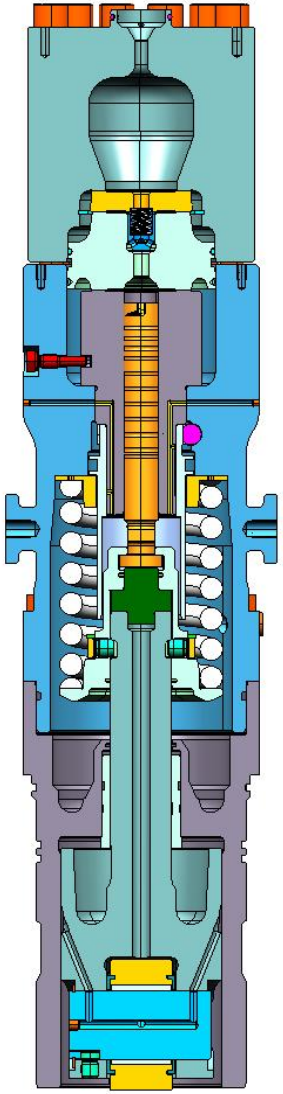
**W-X82**

- **Fuel pump plunger speed**

The plunger speed is reduced improving lifetime of parts (NRV, plunger etc.) + dynamic impact reduced by 15%.

- **Fuel pump plunger diameter optimised**

Compared to RT-flex96C, the plunger diameter is reduced on 6,7&9 cylinders, reducing the static forces.

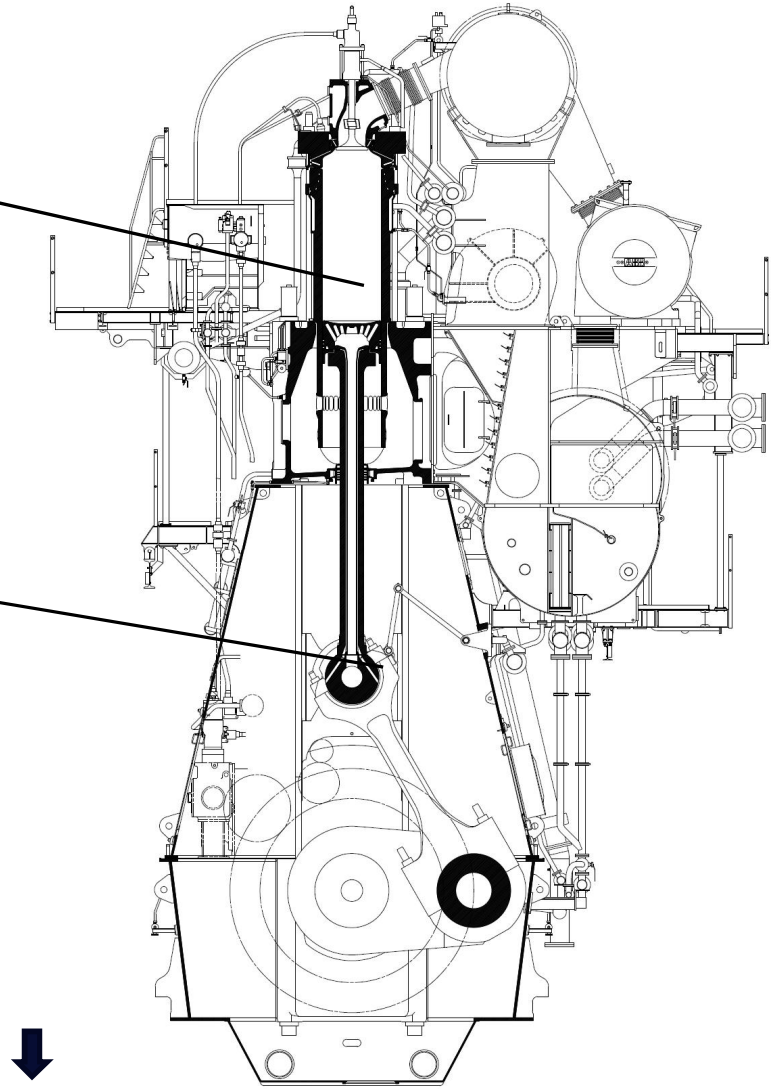


# *W-X82 ➔ W-X82-B – Design Modification*

Cylinder liner cooling with shorter water guide jacket

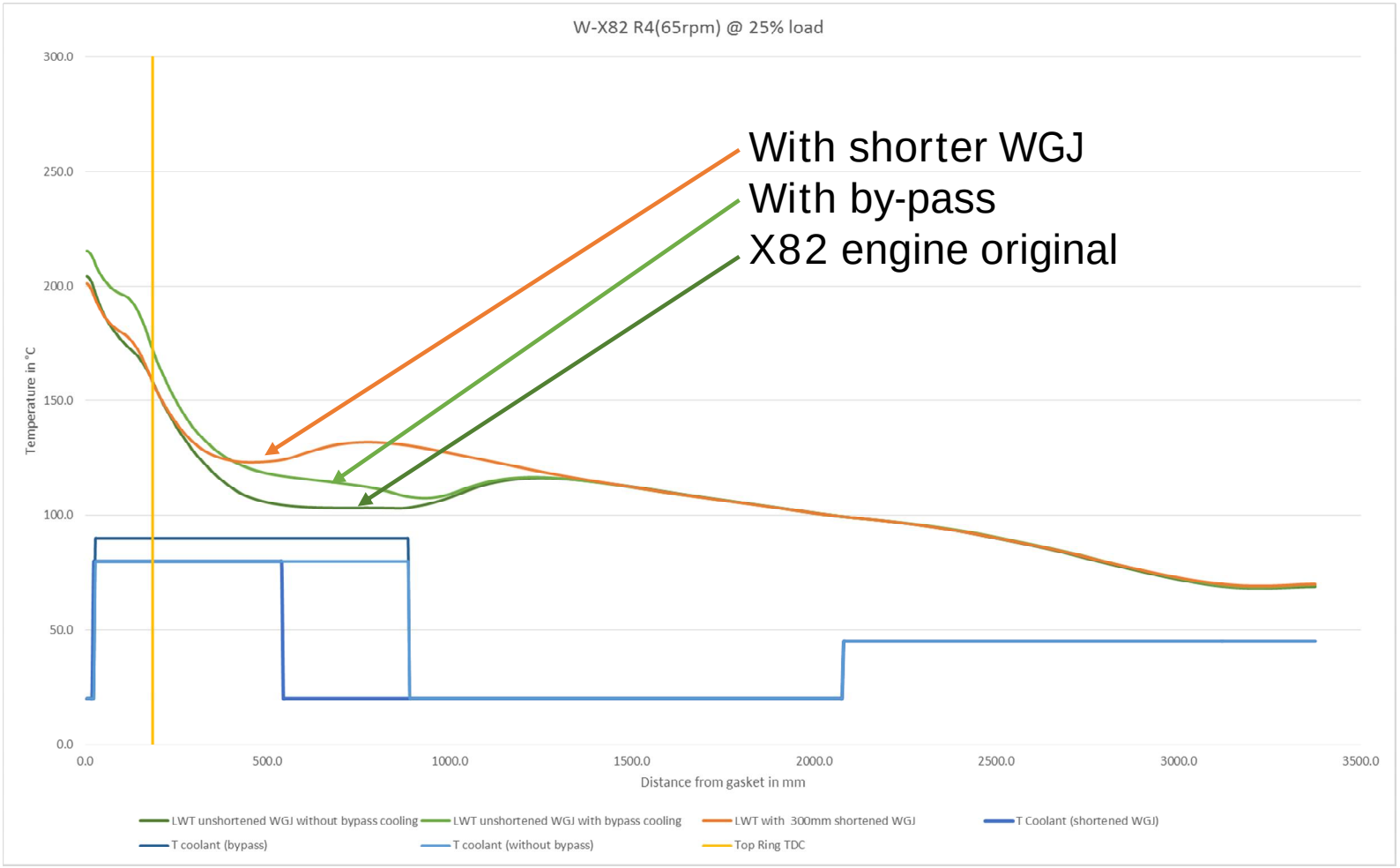
Crosshead bearing with high lube oil pressure below 65 rpm

Introduction of Angela crank angle system



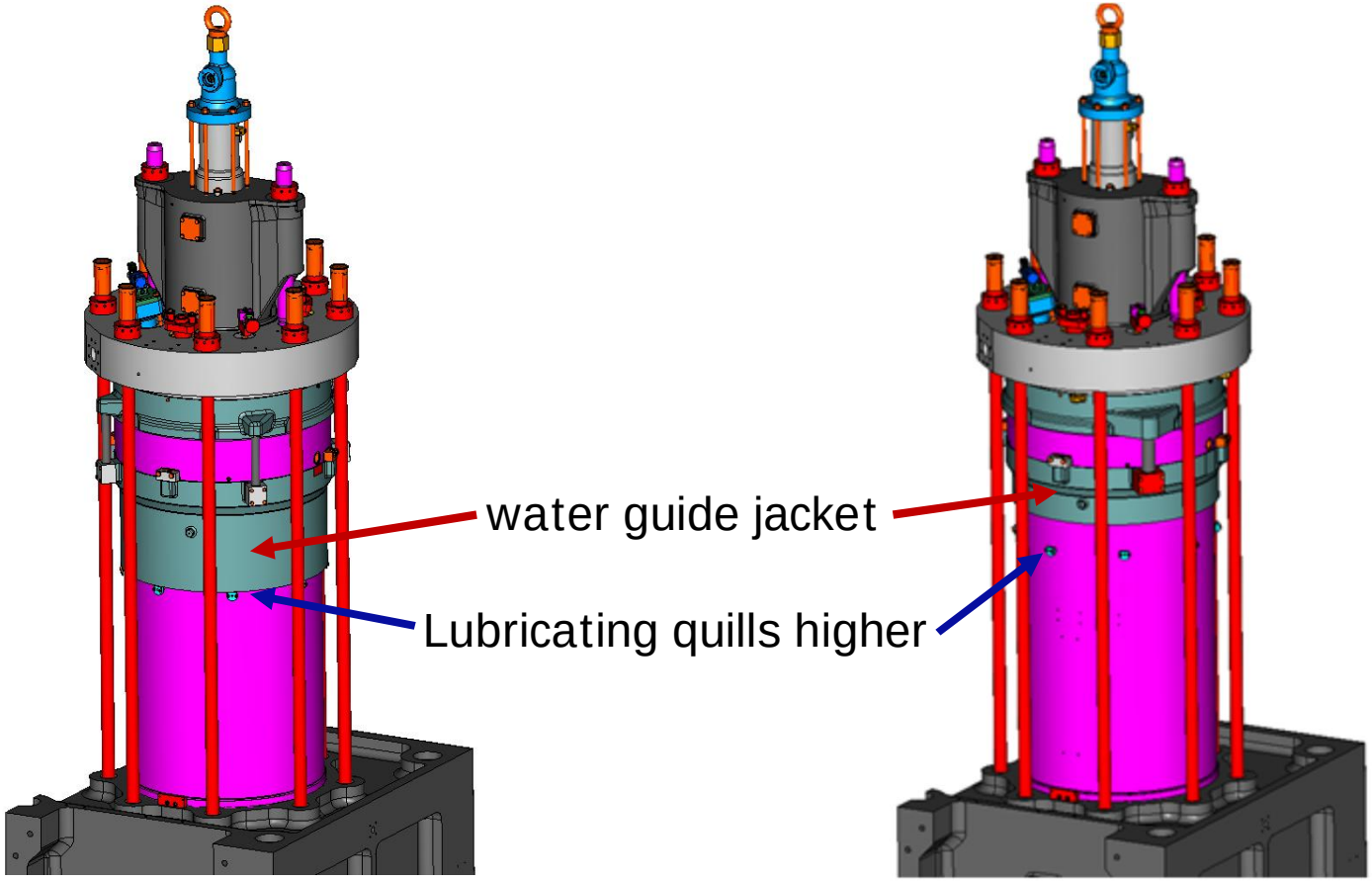
# W-X82-B – Cylinder Cooling System

**Liner with shorter water guide jacket – similar as X52 – gives the best result**



# W-X82-B – Cylinder Cooling System

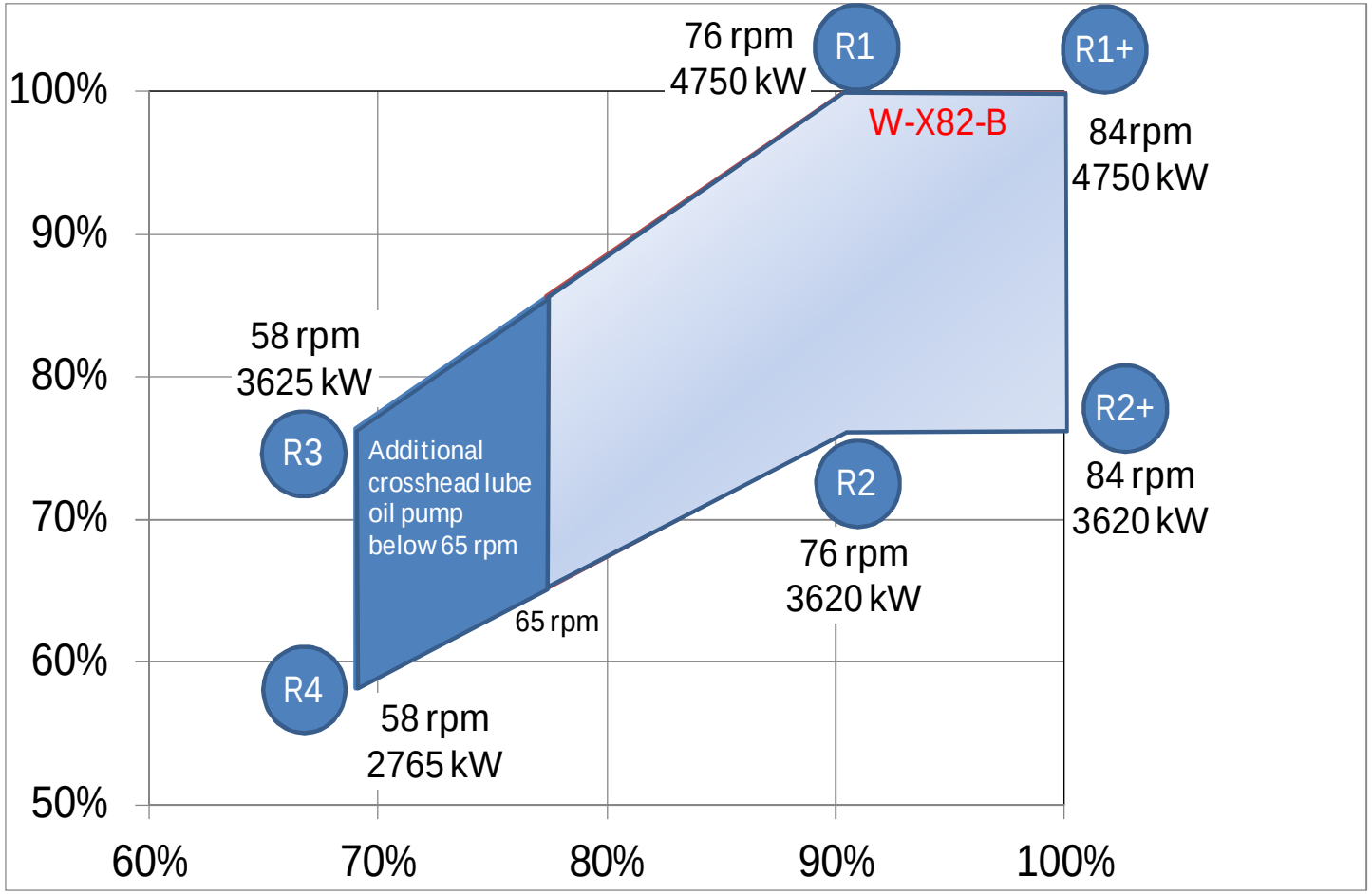
## *Cylinder liner cooling – short water guide solution*




Long water guide jacket

Short water guide jacket

# W-X82-B – Design Modification



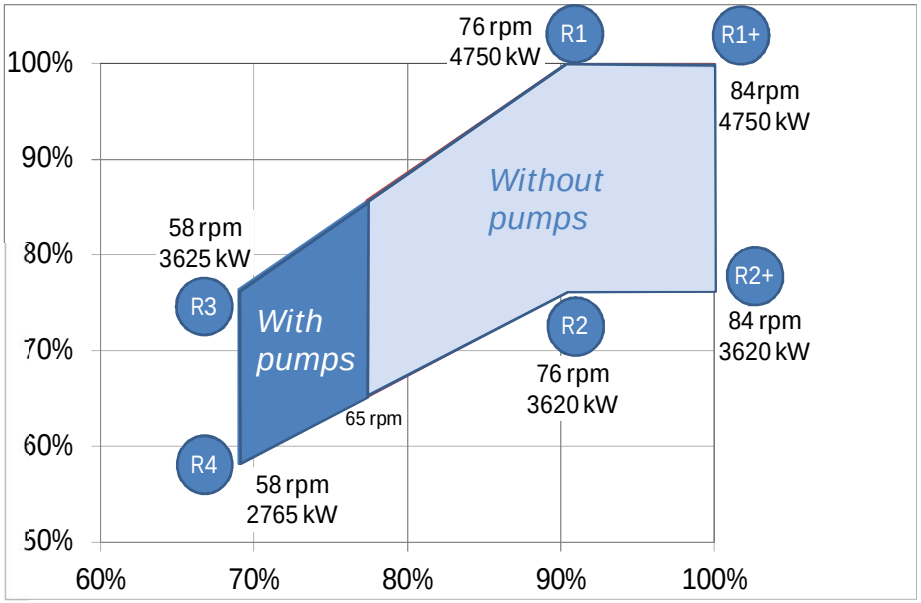

## X-Head pumps

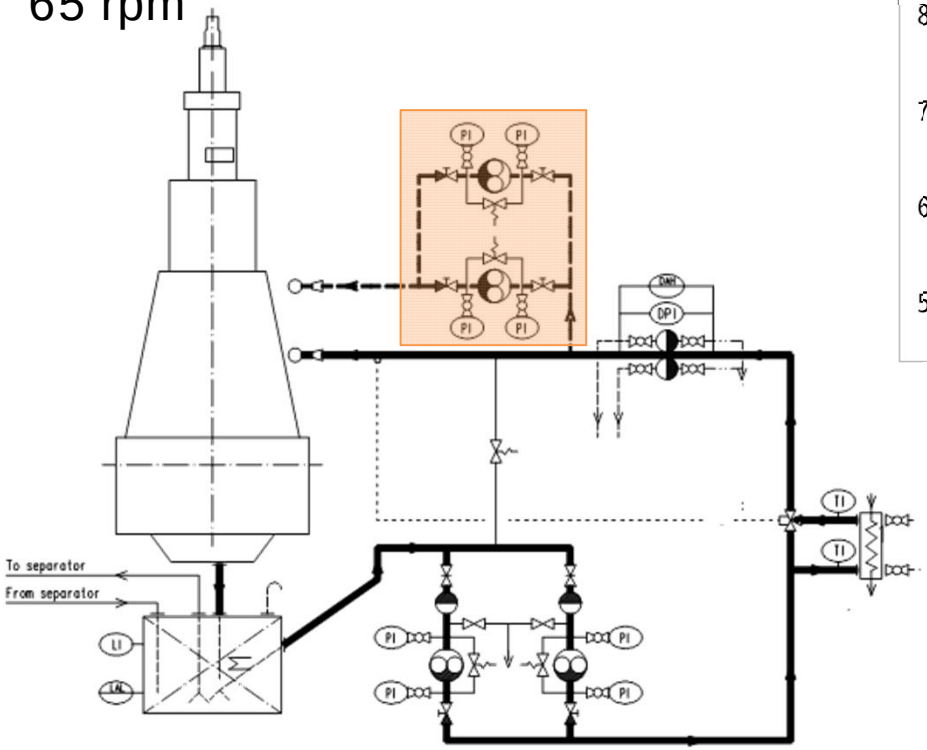
- Needed for engines selected at ratings between 58 and 65 rpm
- X82 engines with 65 rpm and above do not need additional crosshead lube oil pump

# W-X82-B – Design Modification

## Crosshead booster pumps

- Modification for extended rating field
- Only for low CMCR speeds below 65 rpm



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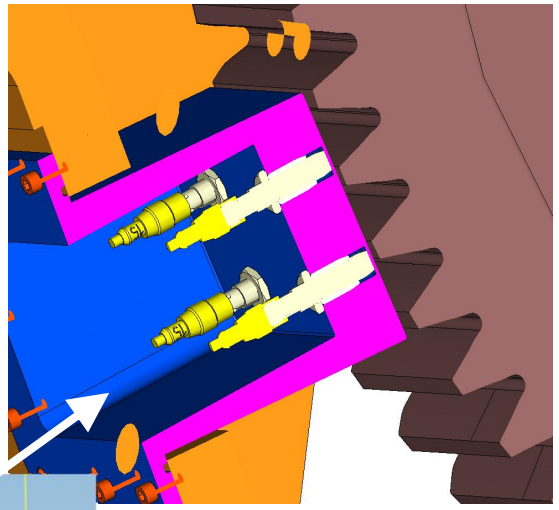
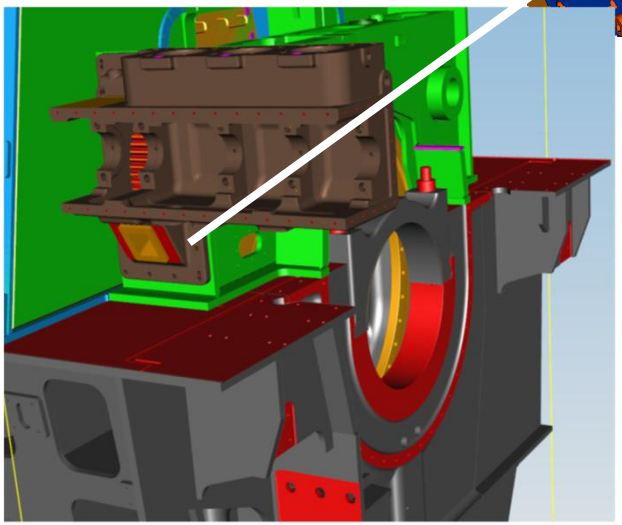
# W-X82-B – Design Modification

## Angela Crank Angle Sensor (CAS)

- Needed for application of PTO at engine free end

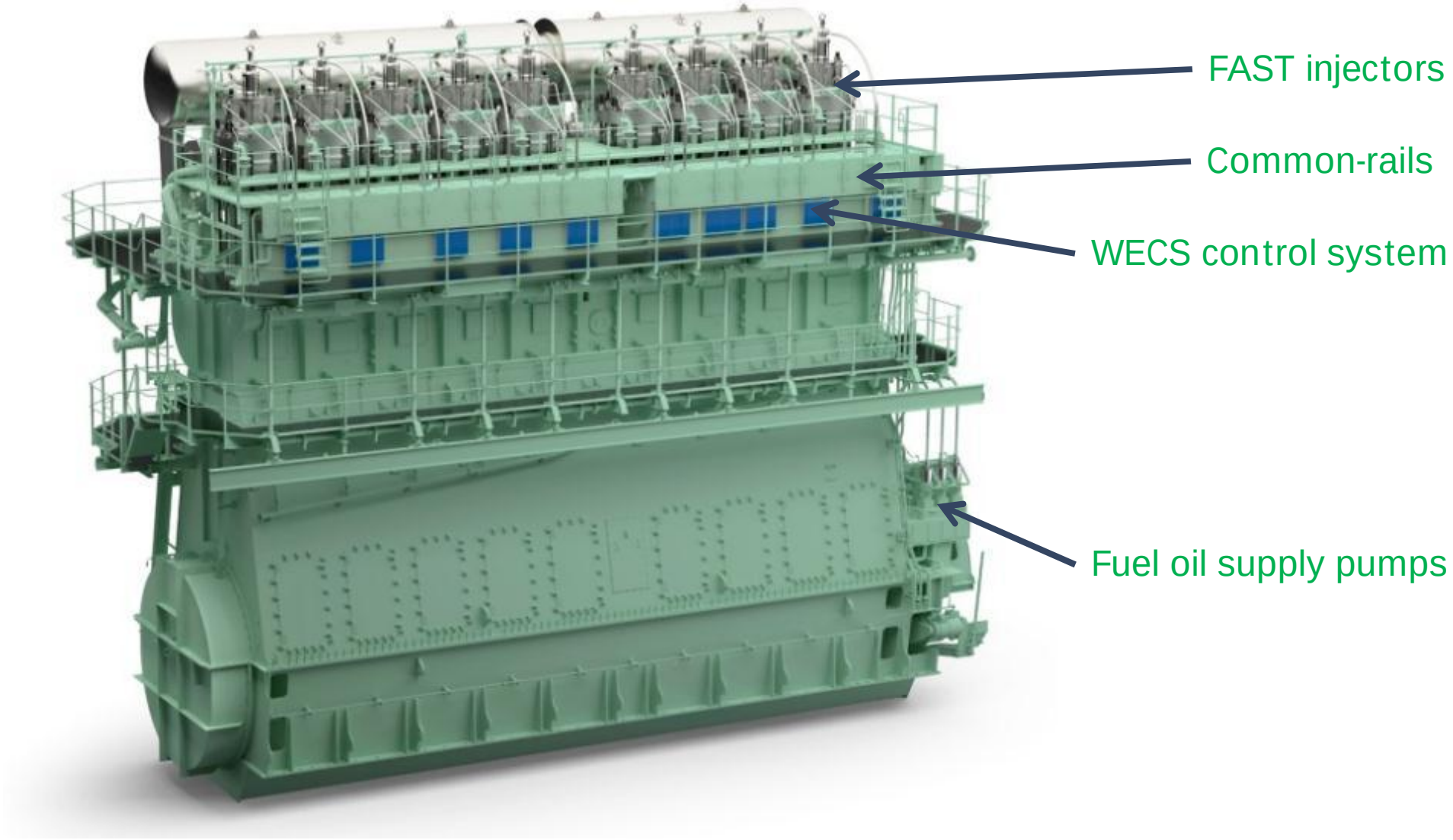




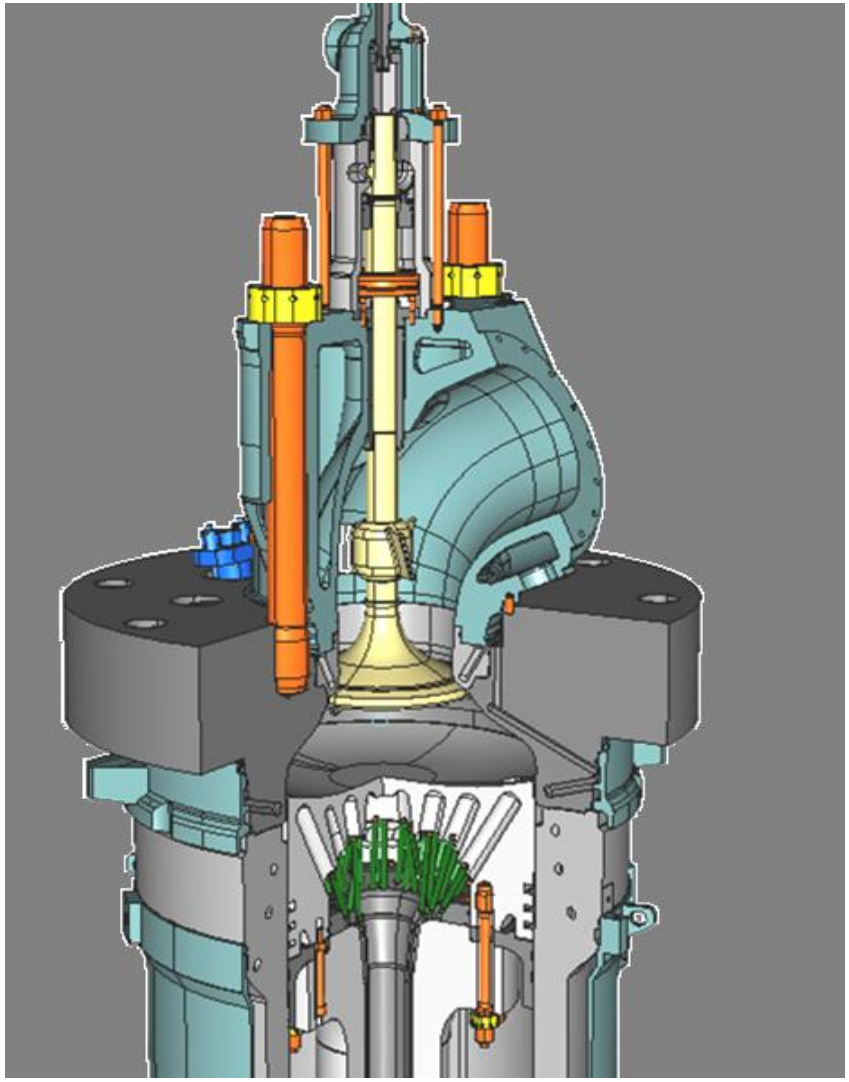
**W-X82** CAS at engine free end

**W-X82-B** Angela CAS at engine driving end
2 + 2 sensors

# W-X82-B – Design Features



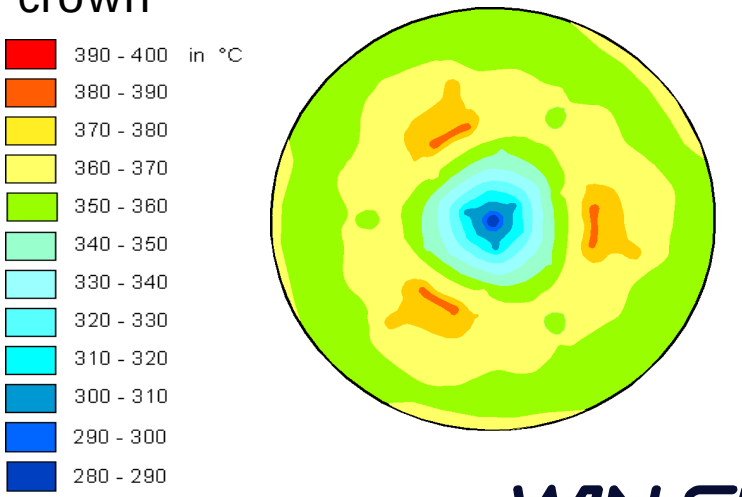
# W-X82-B – Design Features



**Combustion Chamber: bore cooled**

- Exhaust valve seat
- Cylinder cover
- Cylinder liner
- Piston crown with jet-shaker cooling concept

➔ Optimum combustion component temperatures – example of piston crown

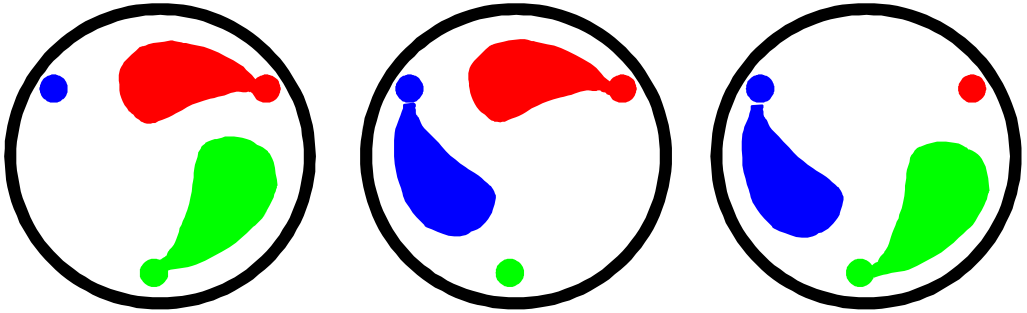


# *W-X82-B – Design Features – Optimum Fuel Injection*

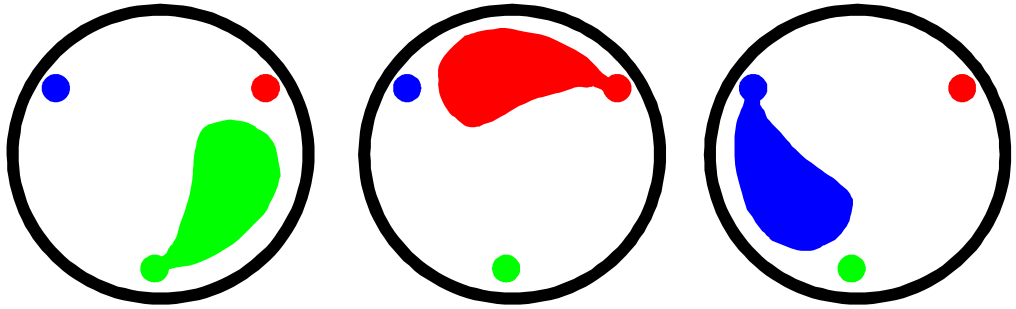
Sequential operation of injection nozzles for smokeless mode and slow steaming

Wärtsilä 2-stroke with Common Rail injection

Available with common rail engine only !!



Low load:
2 nozzle operation

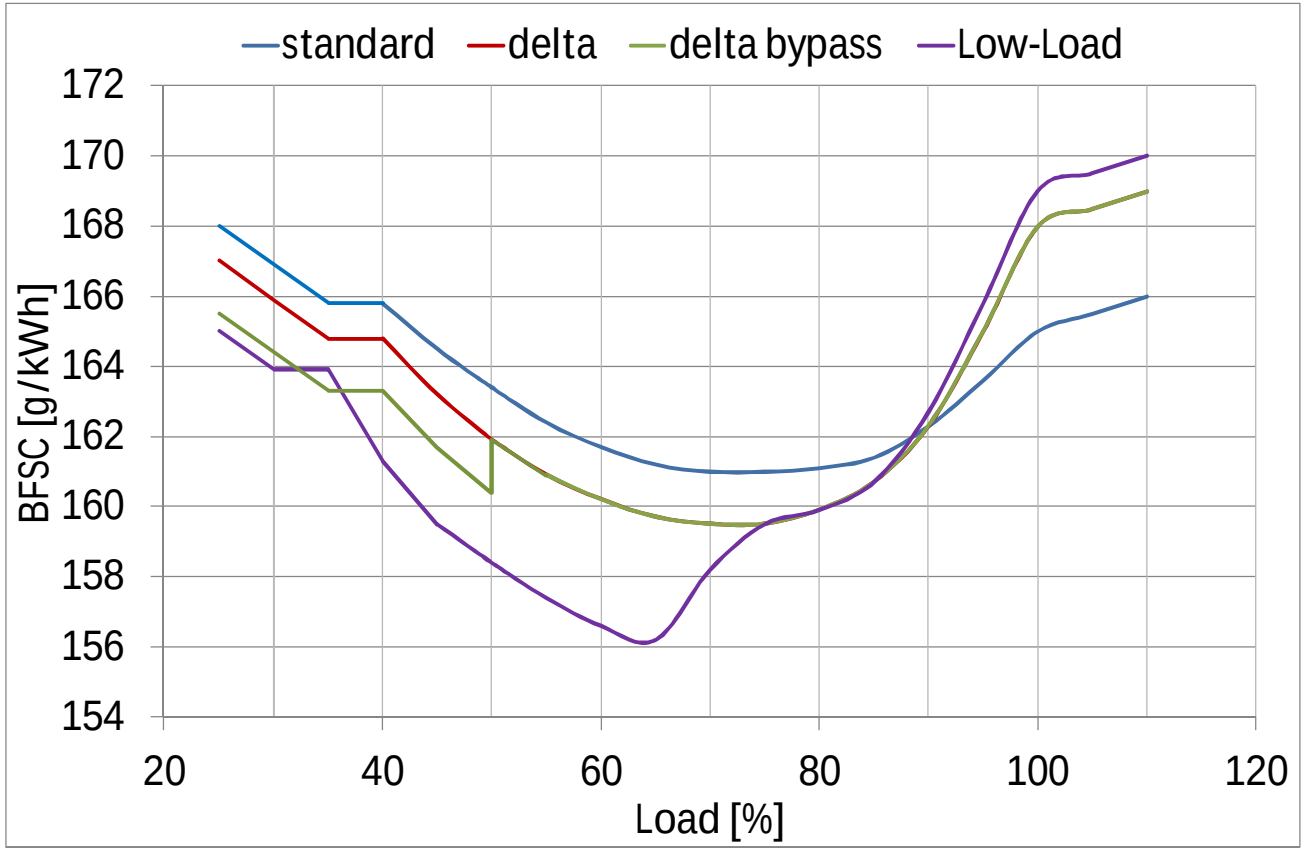


Low load:
1 nozzle operation

**smokeless operation down to 10 to 12% of MCR-speed**

# W-X82-B – Design Features

W-X82-B R1, Tier II



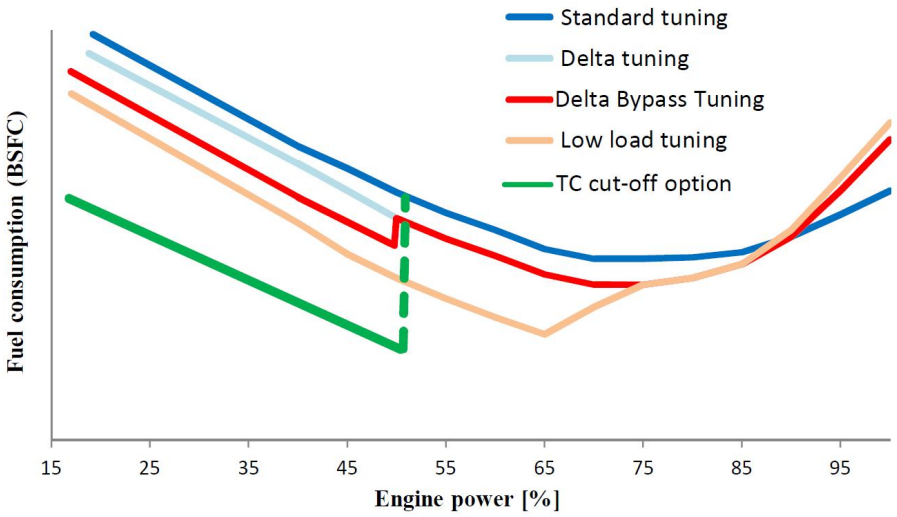

Specific fuel consumption curves

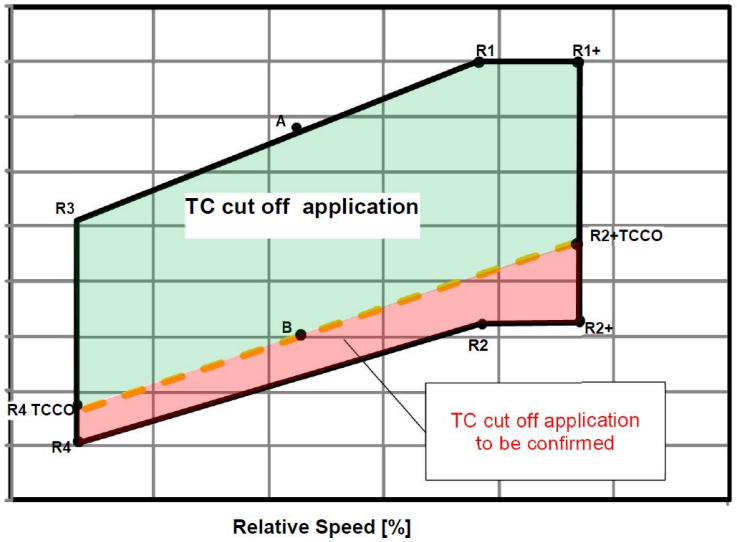
Different Engine Tunings

- Standard Tuning
- DELTA Tuning optimised at 70-80% load
- Low Load Tuning optimised at 40-70% load
- Delta Bypass Tuning for steam production between 50 and 100% engine loads

➔ RT-flex and X-engines offer very low specific fuel consumptions at engine part load

# W-X82-B – Design Features




Optional Turbocharger Cut-Off

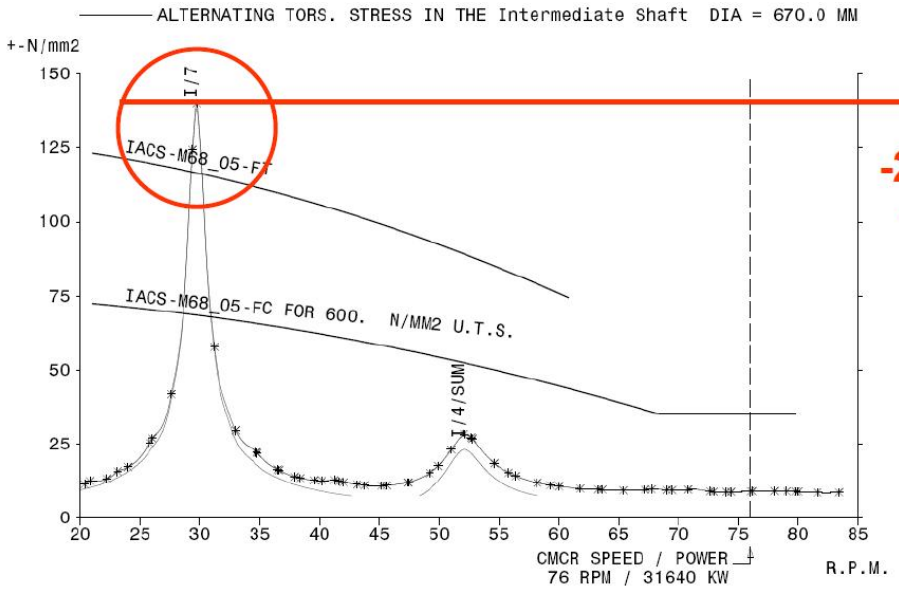
- New built engines with 3 T/C
- Currently only on W9X82
- BFSC savings up to 6 g/kWh

Requirements

- Crosshead pump required
- Possible on the upper part of the rating field
- To be evaluated on the lower part of the rating field

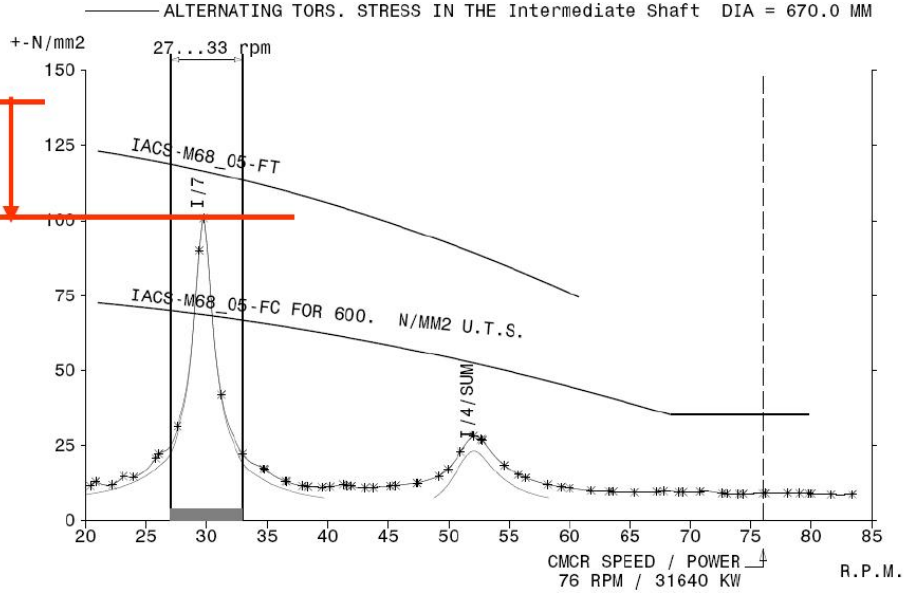
# Theoretical effect of LowTV tuning on 7RT-flex82T / X82-B

## Standard tuning




TV damper needed

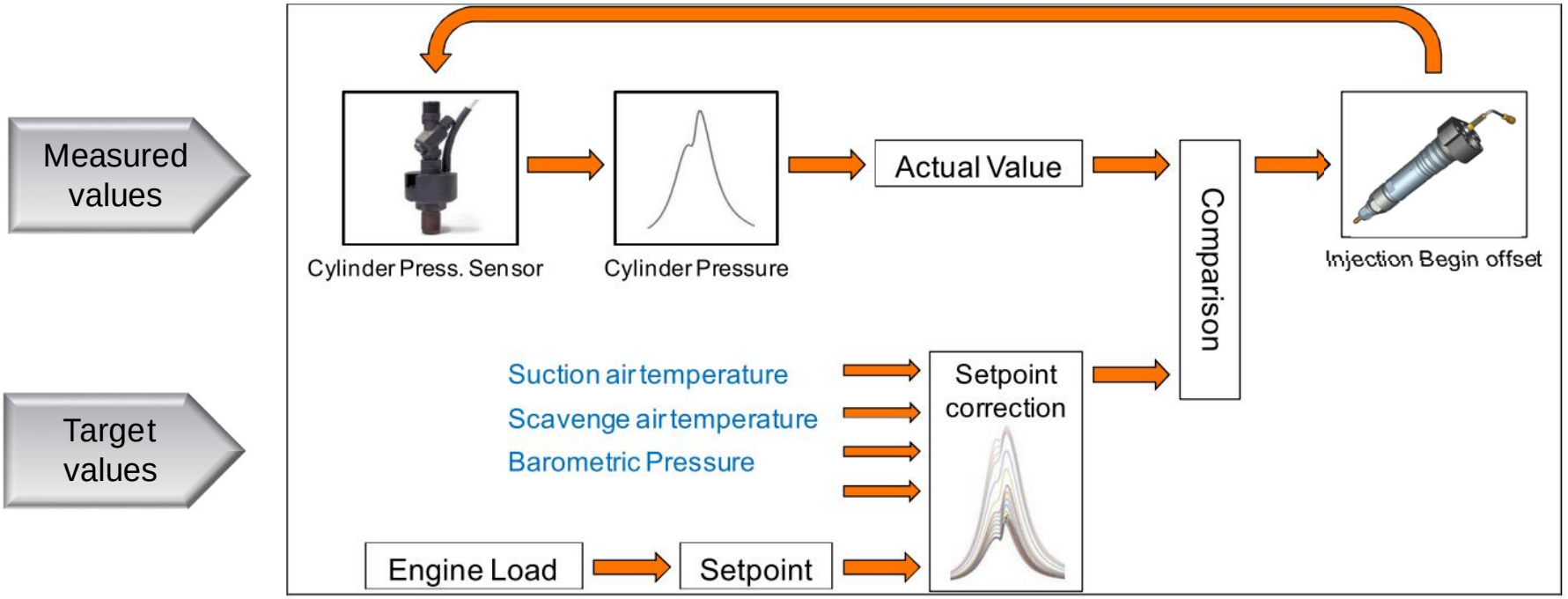
## Standard **LowTV** tuning




No TV damper needed

## ICC – Intelligent Combustion Control principle

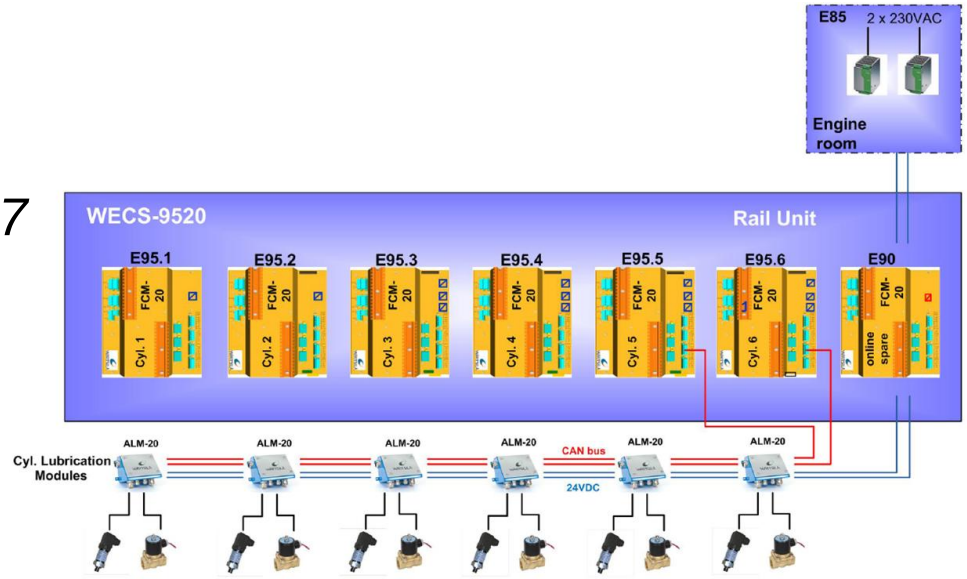
- Measured cylinder pressure is compared to target values
- ICC integrated in WECS control system

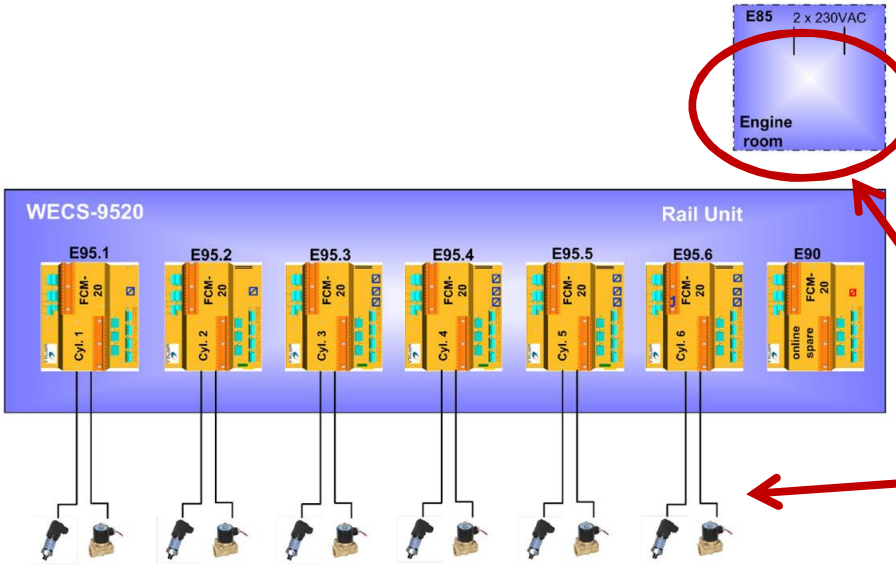


# W-X82-B – Engine Control System

*WECS 9520*

- *Current execution FCM-20 rev. 07*
- *ALM-20 wiring*



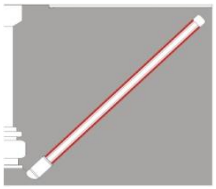

*Introduction of FCM-20 rev. 08*

- *Control of cyl. Lubrication by FCM-20 (integration of ALM-20*
- *No need of additional power supply*
- *Simplification of wiring*

# W-X82-B – Design Features – Piston Running Concept

Optimized liner wall temperatures

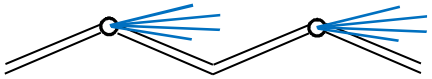
- Cooling bore insulation for low loads



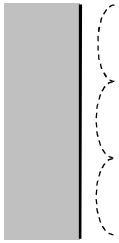
- Mid-stroke insulation

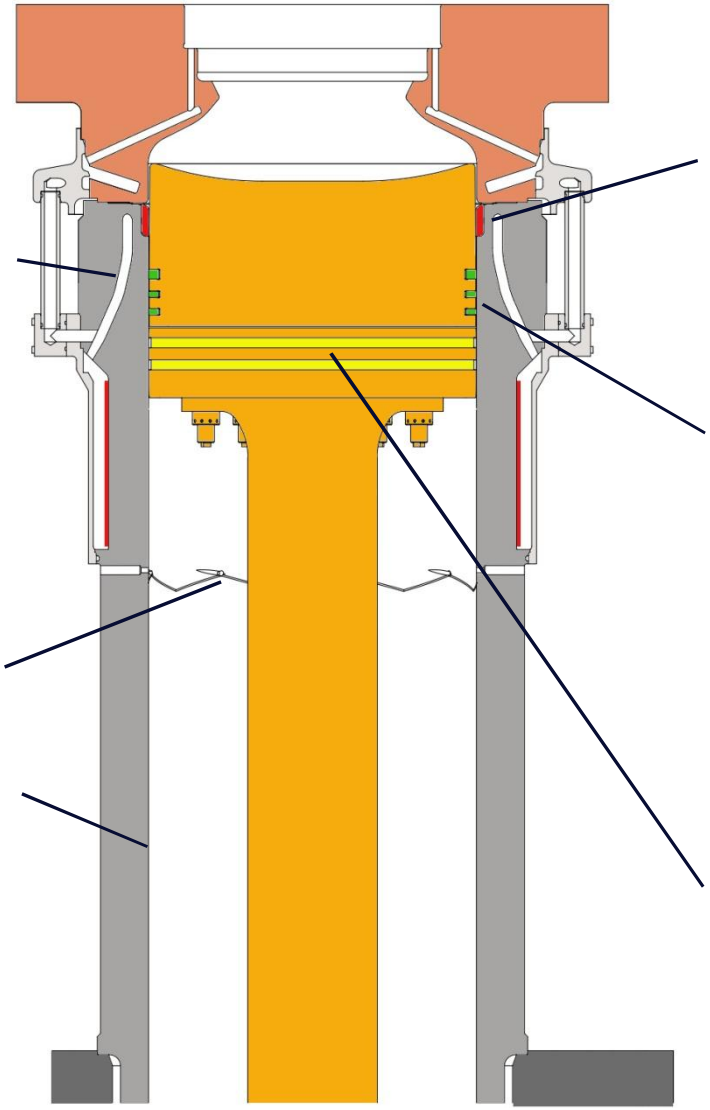
- Shorter water guide jacket

Pulse Jet Lubricating System



Liner plateau honed

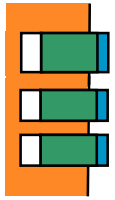




Anti-polishing ring

3 piston rings

- Top ring gas-tight
- Cr-ceramic coated
- Pre-profiled



Piston ring grooves with thick chromium layer

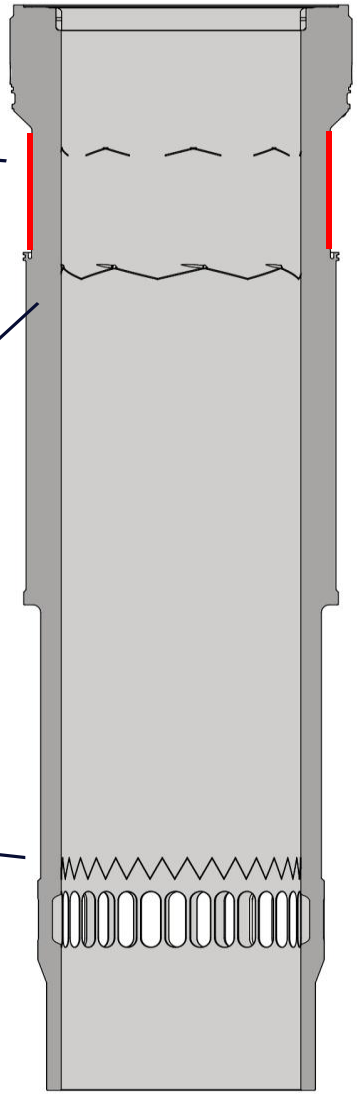
Piston skirt with bandage

# W-X82-B – Design Features – Piston Running Concept

Umbrella grooves
- Improve corrosion resistance at TDC

Zigzag grooves
- Enhanced lube oil distribution
- Pulse Jet system

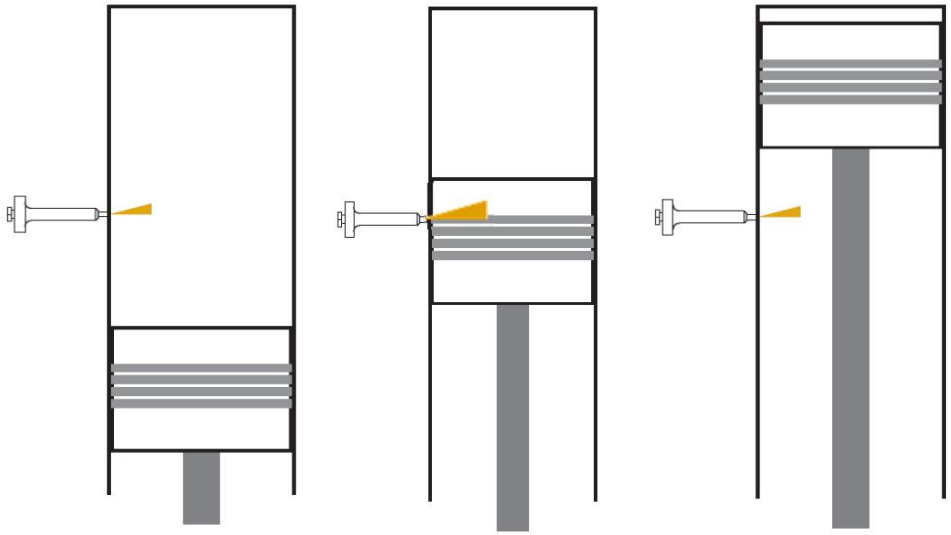
Collection grooves
- Reduced lube oil losses through inlet ports to piston underside

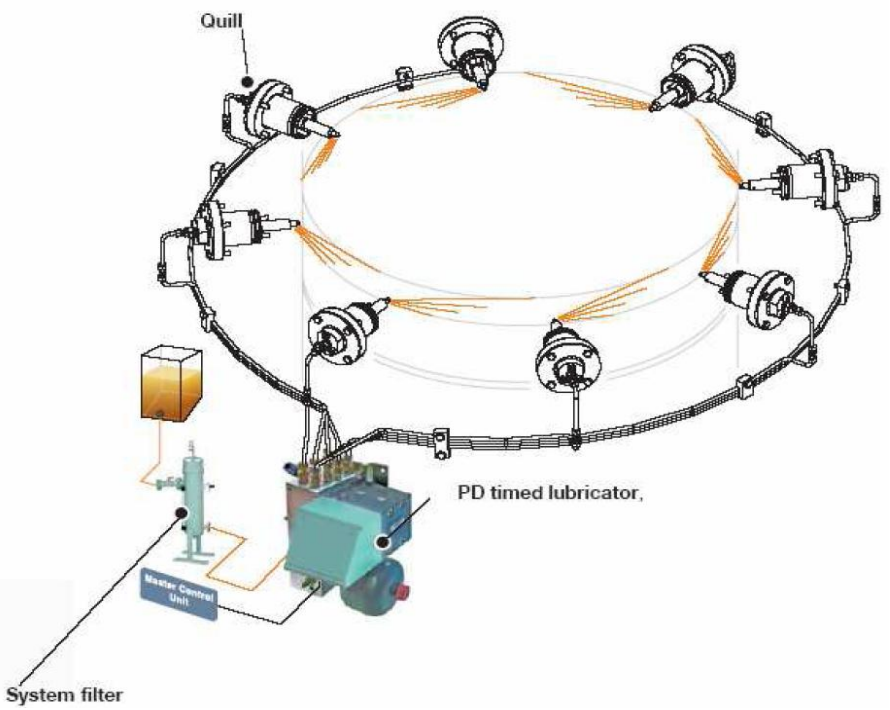


Lube oil grooves arrangement

# W-X82-B – Design Features – Cylinder Lubricating System

- Lube oil distribution into, above and below piston ring packet
- Low cylinder oil consumption
- Efficient oil distribution
- Cylinder liner with oil grooves

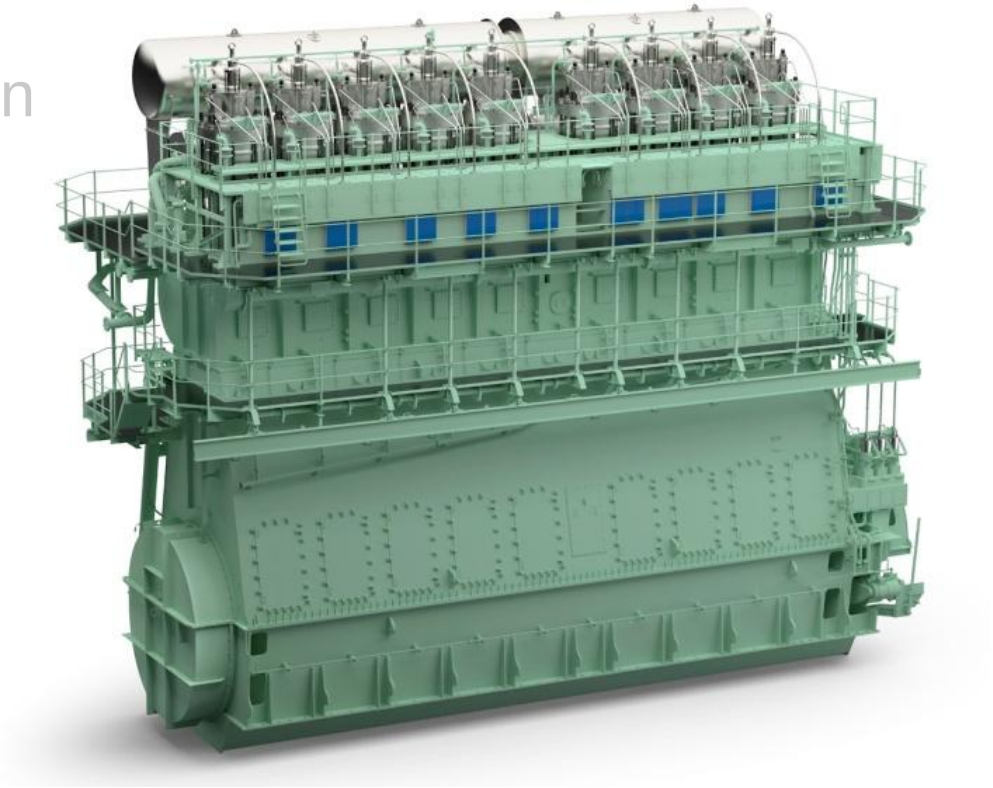




# *W-X82-B Engine*

## Contents

- Engine Rating Field and Main Parameters
- Engine Design Features
- Engines on Order and in Service
- Service Experience
- Conclusion



# *Engines on Order and In Service – Overview*

| Summary | # engines on order | # engines after shop test | # engines in service | Max. running hours | Accumulated running hours |
|---|---|---|---|---|---|
| RTA82C | 18 | | 18 | ~53‘400 | ~802‘800 |
| RT-flex82C | 37 | 1 | 36 | ~46‘700 | ~1’288‘300 |
| RT-flex82T | 92 | | 92 | ~50‘200 | ~2‘465‘300 |
| RTA82T | 5 | | 5 | ~38‘800 | ~163‘900 |
| W-X82 | 74 | 11 | 42 | ~17‘100 | ~366‘500 |
| W-X82-B | 4 | 2 | | | |
| Total | 230 | 14 | 193 | – | ~5‘086‘800 |

**1000th RT-flex engine sold is first W-X82**

**186 engines in service at end 2016**

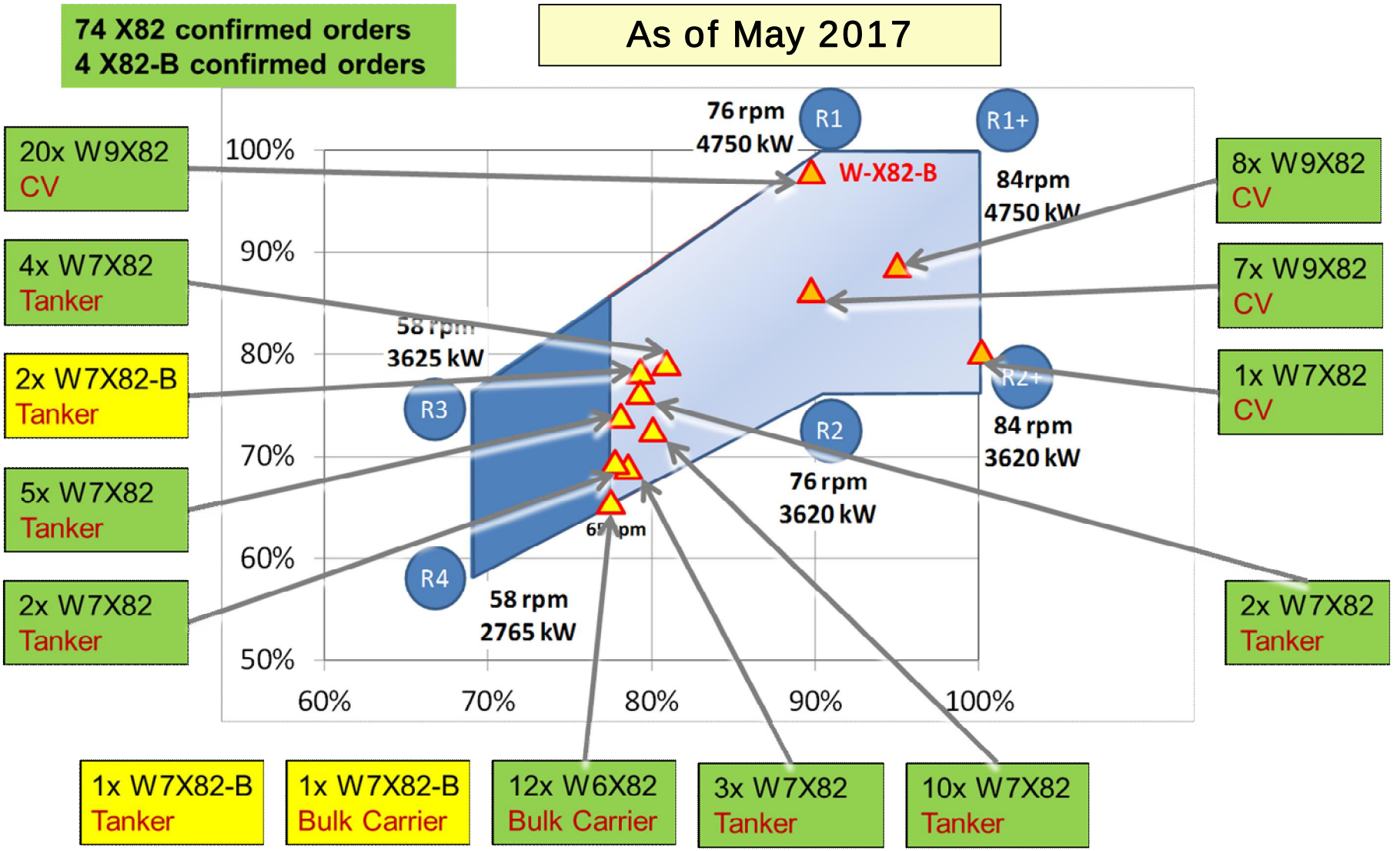
**More than 5 Mio running hours accumulated**

As of May 2017



WIN GD
Winterthur Gas & Diesel

# Engines on Order and In Service – Overview





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# *Engines on Order and in Service – Overview*

## Market share – Engine deliveries

## Engine bore between 75 and 89 cm

| engine series | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 | 2017 | 2018 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 75-89 | 48 | 51 | 59 | 65 | 72 | 80 | 97 | 100 | 85 | 89 | 48 | 81 | 74 | 76 |
| MAN | 38 | 45 | 46 | 50 | 39 | 47 | 57 | 54 | 50 | 60 | 35 | 61 | 60 | 53 |
| Mitsubishi | 2 | 2 | 2 | 2 | 2 | 1 | 4 | 4 | 3 | 1 | | | | 1 |
| WinGD | 8 | 4 | 11 | 13 | 31 | 32 | 36 | 42 | 32 | 28 | 13 | 20 | 14 | 22 |
| WinGD share | 17% | 8% | 19% | 20% | 43% | 40% | 37% | 42% | 38% | 31% | 27% | 25% | 19% | 29% |

Source: Clarkson Research Services

**As of September 2016**

# *Engines in Service – VLCC*


Eneos Spirit, W7X82, VLCC, in service since August 2014
312’000 DWT, 340 x 60 m

**1000th flex engine order**

# *Engines in Service – Container Vessel*


NYK Blue Jay, W9X82, in service since February 2016
14’000 TEU Container Vessel, 364 x 51 m

# *Engines in Service – Container Vessel*


A cargo ship begins to cross the new Agua Clara locks, part of the Panama Canal expansion project, near the port city of Colon in Panama on June 26, 2016. (Moises Castillo / Associated Press)

WinGD is proud to power the 9443 TEU container vessel "COSCO Shipping Panama" which is the first vessel sailing through expanded Panama canal. The vessel was delivered in January 2016 and installed with W9X82 engine.

Picture from Los Angeles Times online

# *Engines in Service – Container*


San Christobal, W9X82, Container Vessel in service since August 2014
9’000 TEU, 112’000 DWT, 300 x 48 m

# *Engines in Service – VLOC*


Ore China, 7RT-flex82T, in service since 24.11.2011
400’000 DWT, 360 x 65 m

# *W-X82-B Engine*

## Contents

- Engine Rating Field and Main Parameters
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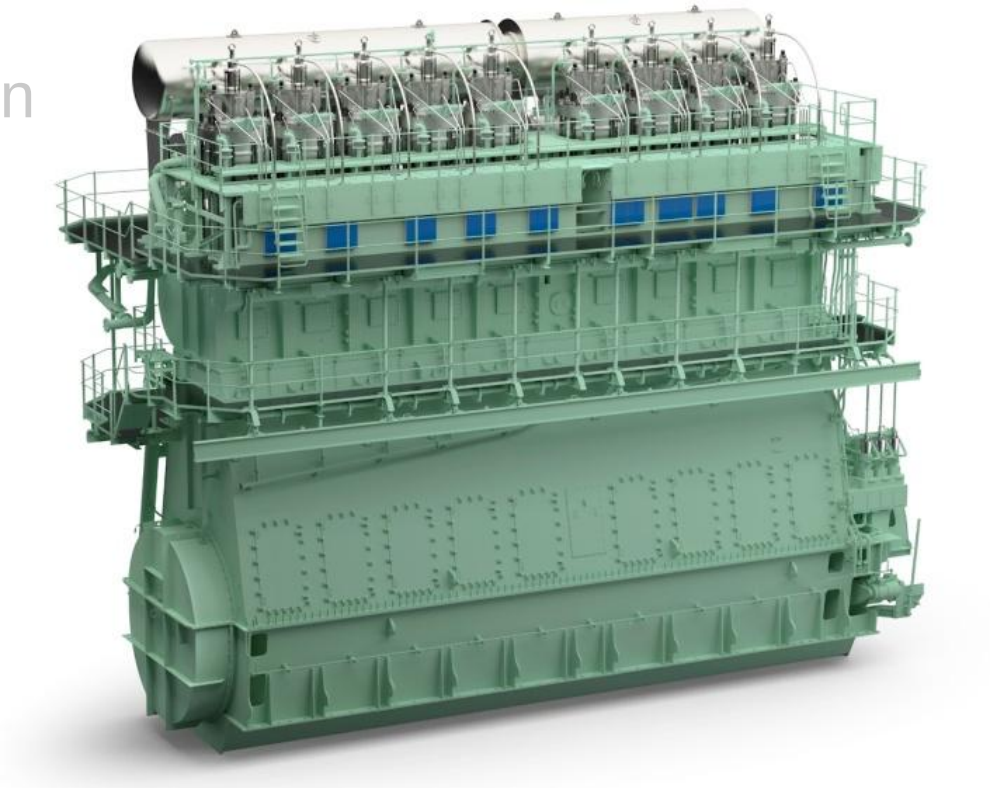


# *Service Experience X82 Engines*

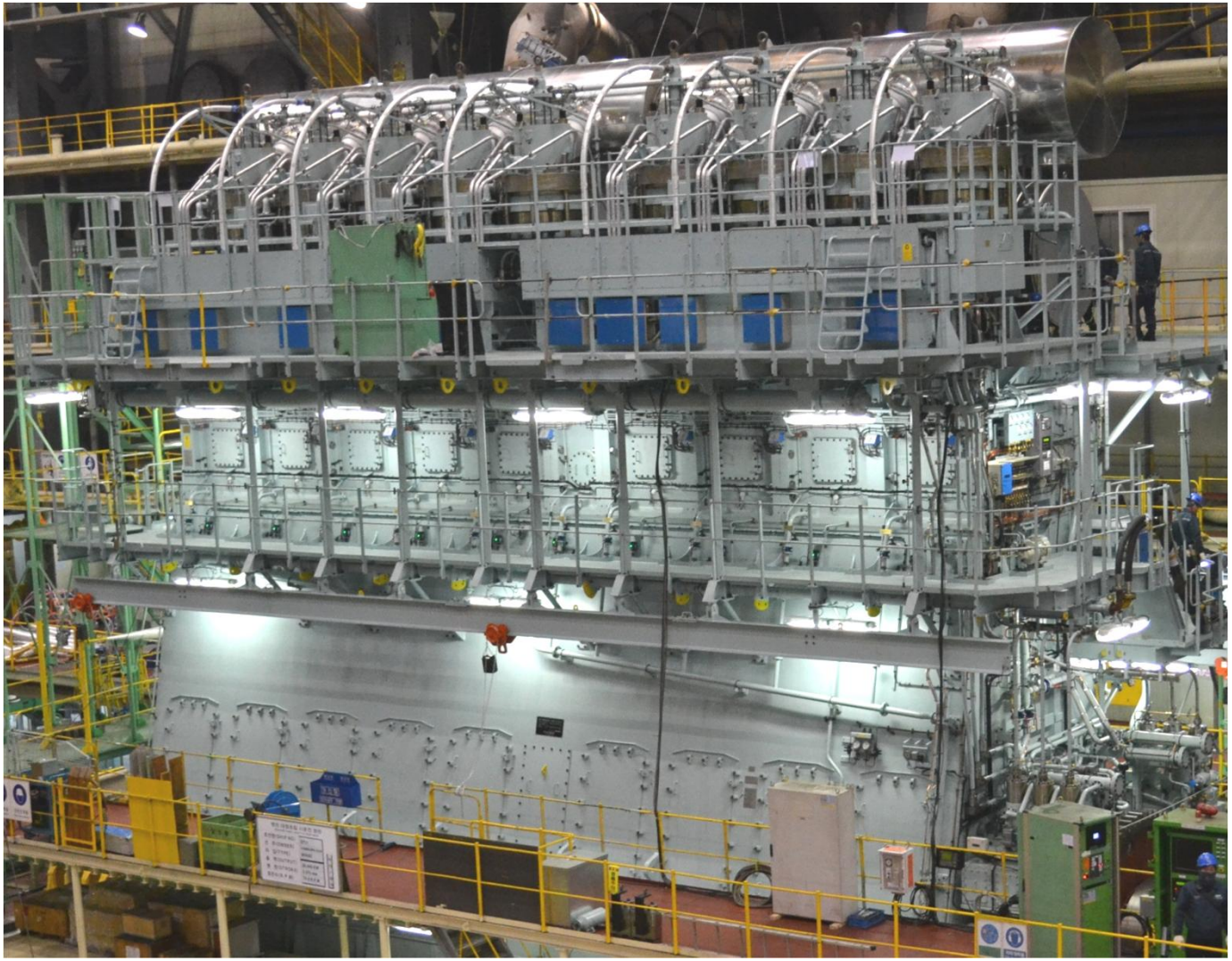
**W7X82**

December 2013
Diesel United

23,620 kW
65 rpm

First X82 on shop test

# *Service Experience X82 Engines*



**W9X82**

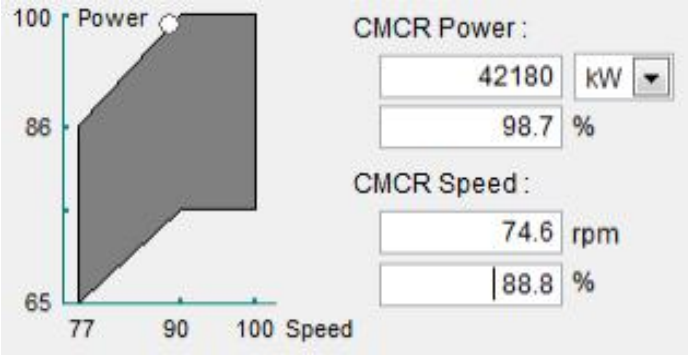
February 2014
HHI, South Korea

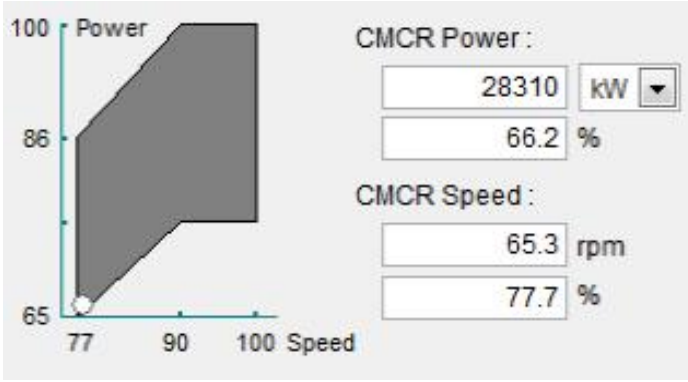
36,440 kW
74.5 rpm

# *Service Experience X82 Engines*

**W9X82 Dual rating**

April 2015
DU Japan



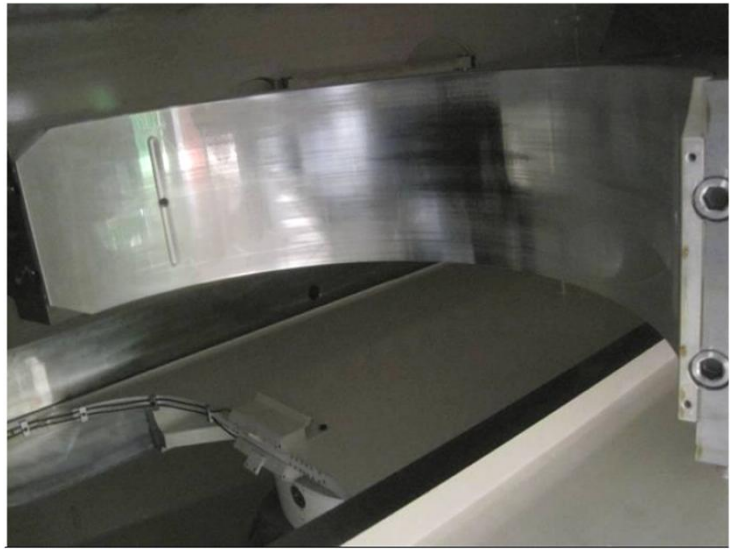
# *Service Experience X82-B Engines*


## W7X82-B

March 2017
HHI South Korea

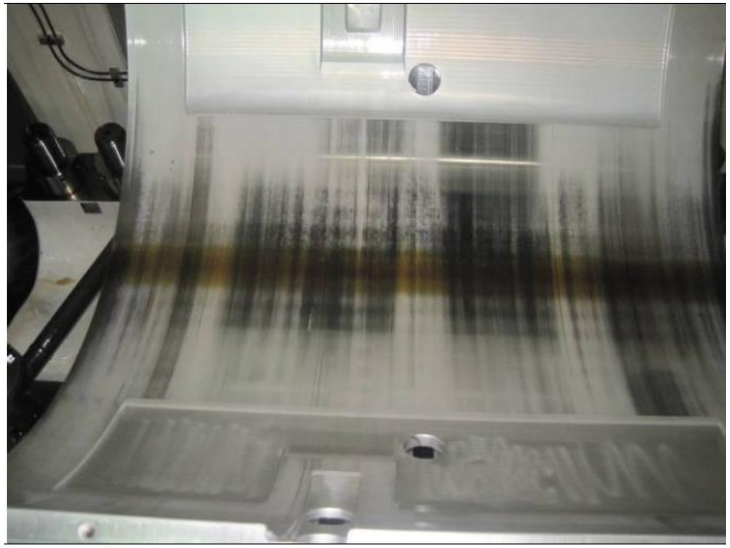
- First W-X82-B on shop test

# *Service Experience X82 Engines*

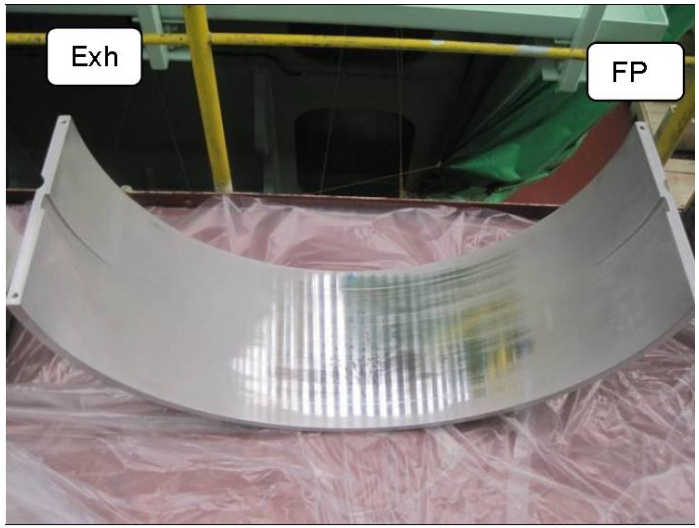


Contact surface of bottom end bearing

**W9X82**
**after shop test**

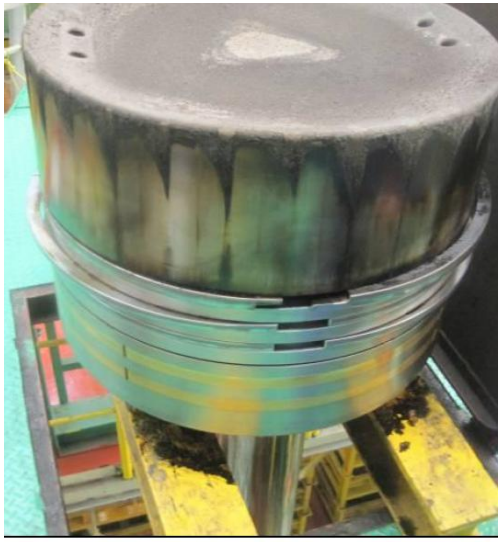


Top end bearing shell

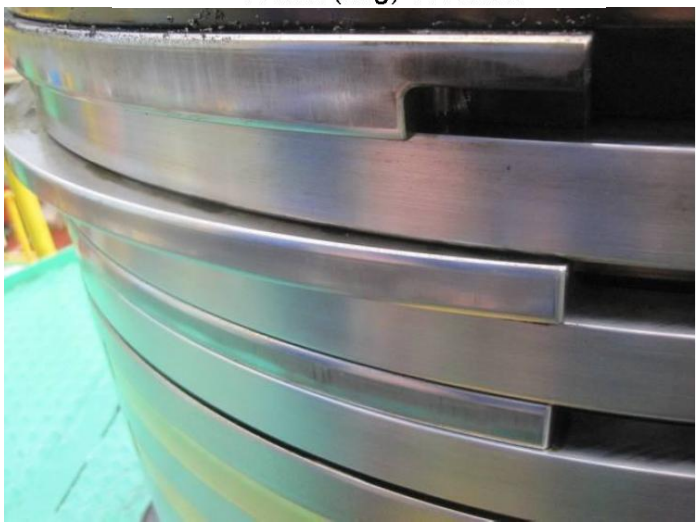



Main bearing lower shell with uneven contact

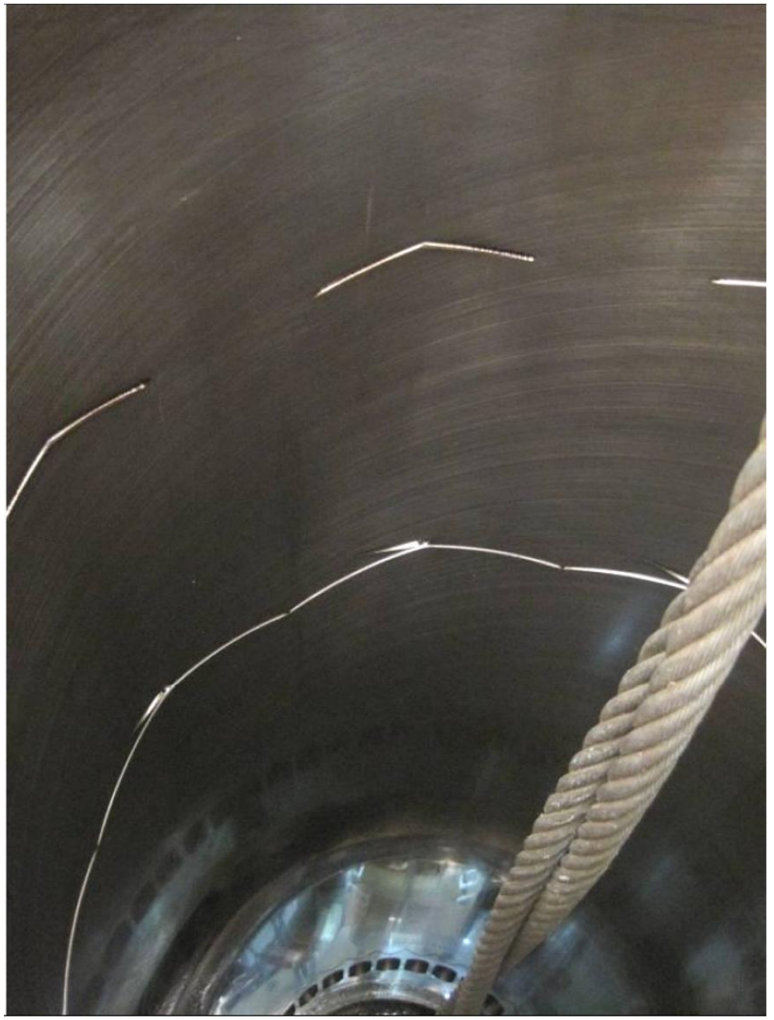
# *Service Experience X82 Engines*



Piston (ring) overview



**W9X82**
**after shop test**



AFT side

# *Service Experience X82 Engines*

**W9X82**
**after shop test**

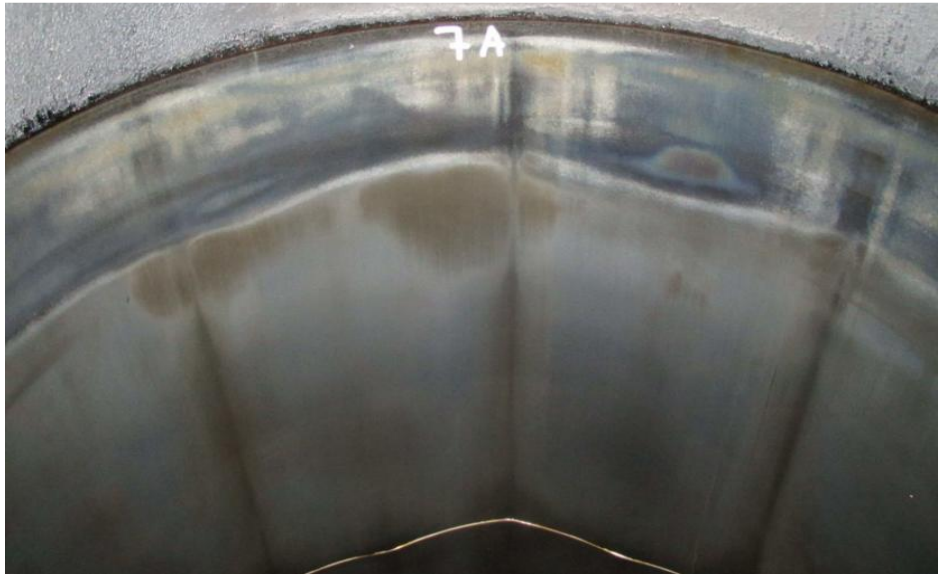
A-3 cam & roller

Gear for A-bank supply unit

# *Service Experience – Piston Running*


8RTA82C
Inspected at 12,732 running hours (rhs)
Cylinder oil 0.95 g/kWh

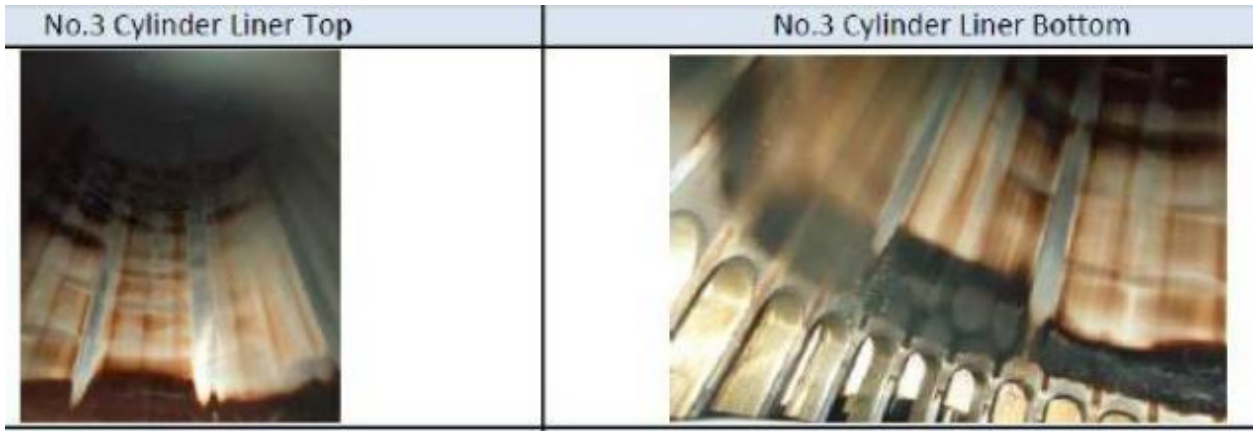
- Liner and pistons in good condition
- Liner wear 0.016 mm/1,000 rhs
- Ring wear A 0.014 mm/1,000 rhs
  Ring wear B/C 0.010 mm/1,000 rhs



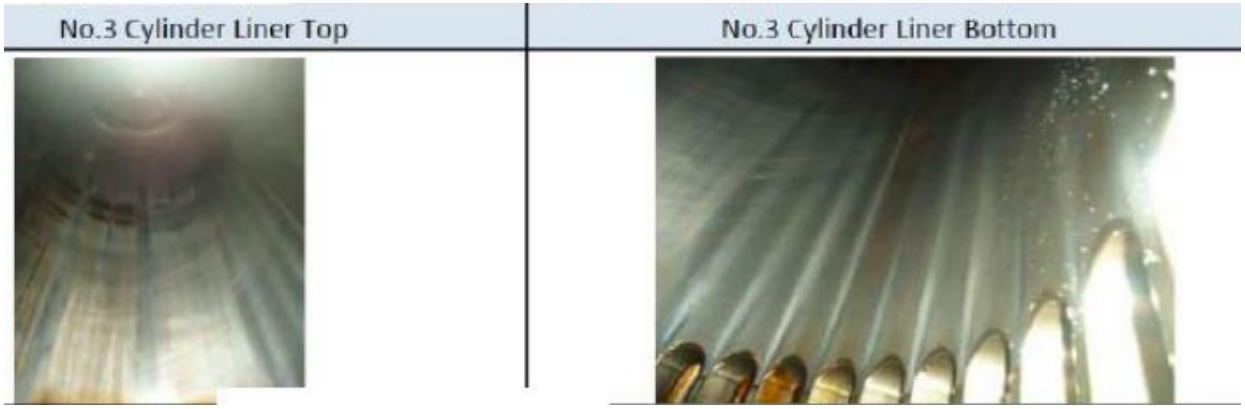
# *Service Experience with high BN Cylinder Oil*

**RT-flex82T MT V S**

- **4776 rhs**
- Engine load: 40 %
- S content: 2.96 %
- Lube oil BN 60
- Feed rate: 1.0 g/kWh



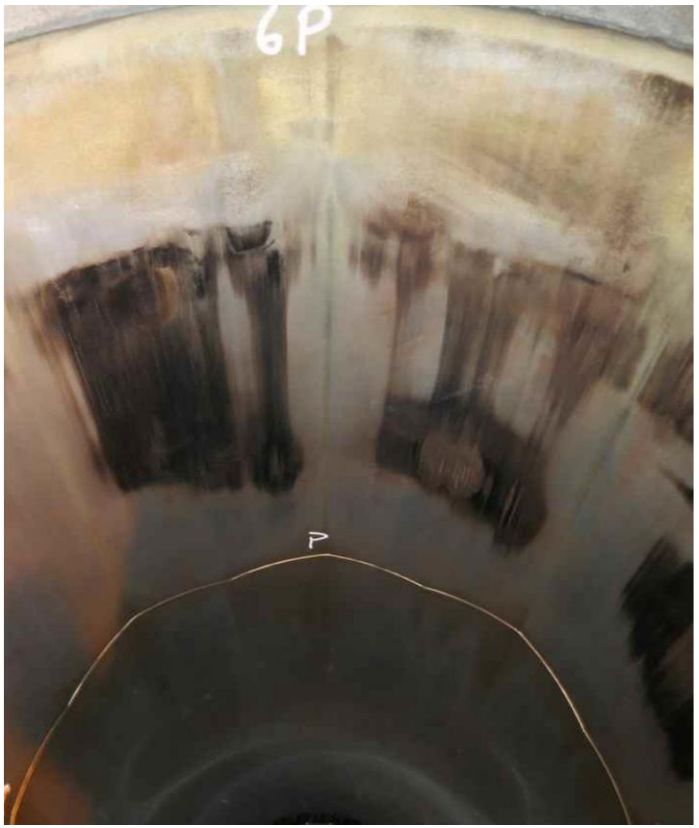

- **5452 rhs**
- Engine load 40 %
- S content: 2.96 %
- Lube oil BN 100
- Feed rate: 0.9 g/kWh




**Liners improved drastically after 700 rhs with BN100 oil**

# *Service Experience – Piston Running*

6RT-flex82T





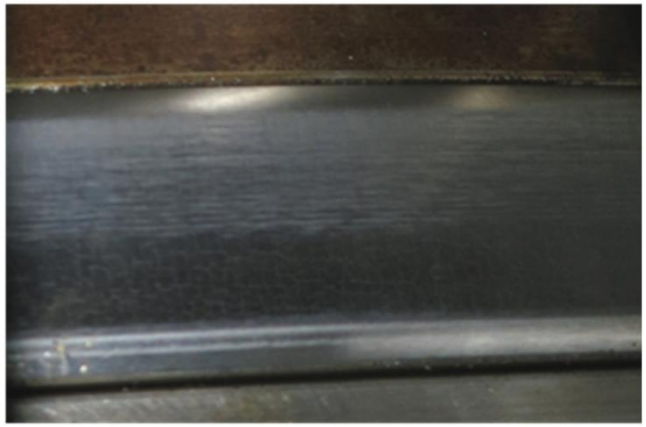
**Unit #6**
Pulse Feed, 82T liner
3’461 hrs
HFO S 2.51%
1.25 g/kWh – BN 60 lube oil
0.014 mm/1000h

**Unit #1**
Pulse Jet, X82 liner
6’353 hrs
HFO S 3.36%
1.35 g/kWh – BN 60 lube oil
0.01 mm/1000h

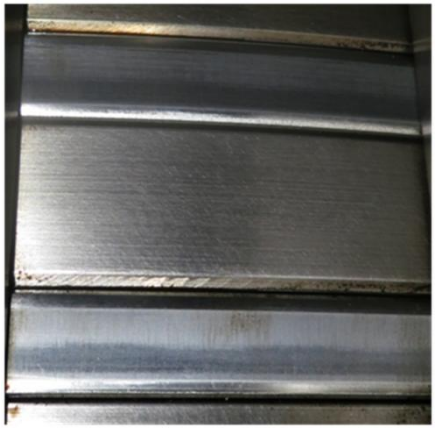
# *Service Experience – Piston Running X82*

**W9X82 – Unit #8**

- **1845 rhs**
- Engine load: 40 – 60 %
- S content: 0.97 %
- Lube oil BN 60
- Feed rate: 0.8 g/kWh



Top piston ring



B and C piston rings

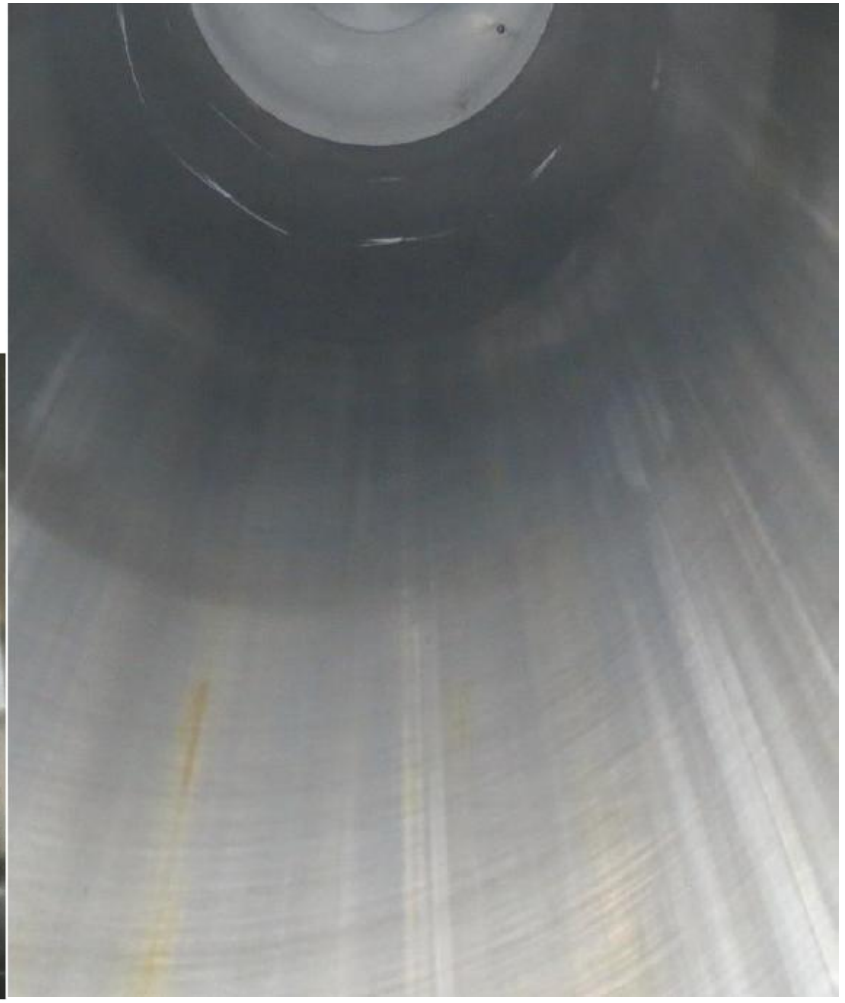
Cylinder liner

# *Service Experience – Piston Running X82*

**W9X82 – Unit #8**

- **10’503 rhs**
- Engine load: 20 %
- S content: 2.7 %
- Lube oil BN ~90
- Feed rate: 0.8 g/kWh

Piston rings
- Good condition



Cylinder liner
- Honing marks visible

# *Service Experience – Piston Running X82*

**W9X82 – Unit #1**

- **17’045 rhs**
- Engine load: 30 – 60 %
- S content: 3.4 %
- Lube oil BN ~90
- Feed rate: 0.75 g/kWh
- **Liner wear rate 0.005 mm/1000h!**

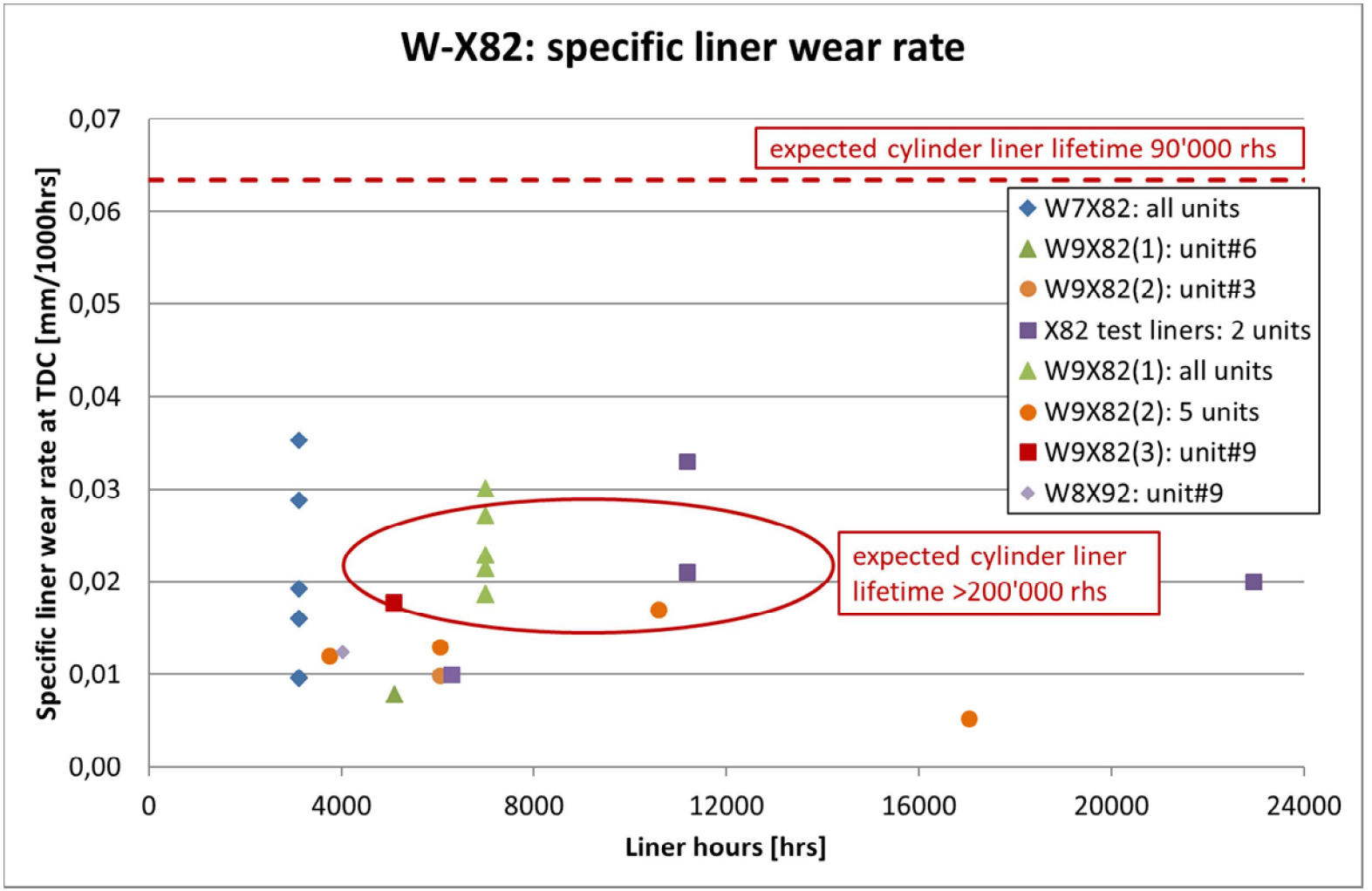
Cylinder liner

- Honing marks still visible
- **Expected lifetime > 500’000h**

Piston rings

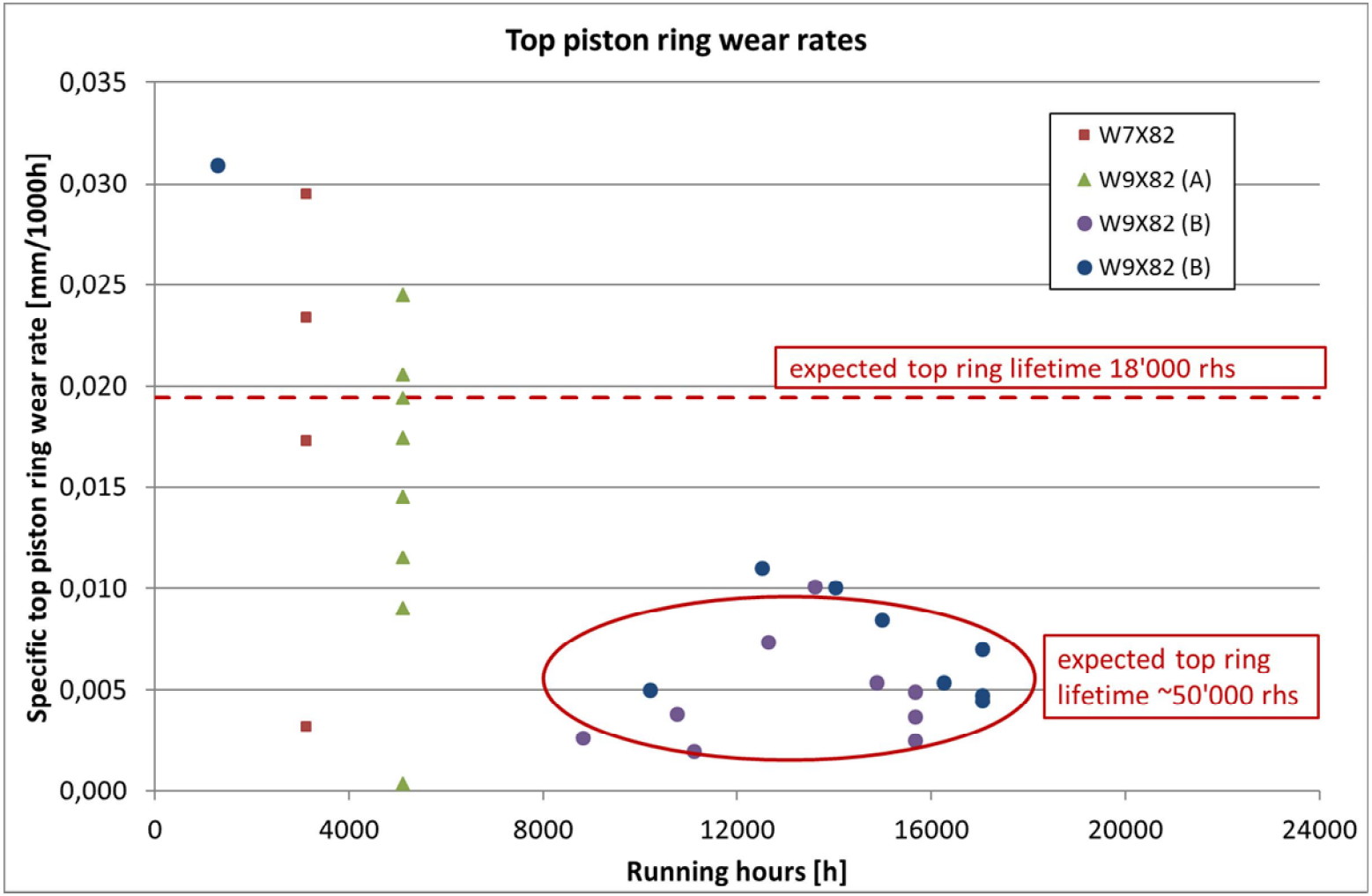
- Excellent condition
- **Expected top ring lifetime > 50’000 h**

# Service Experience – Piston Running X82




X82 piston running concept with excellent specific liner wear rate

# Service Experience – Piston Running X82



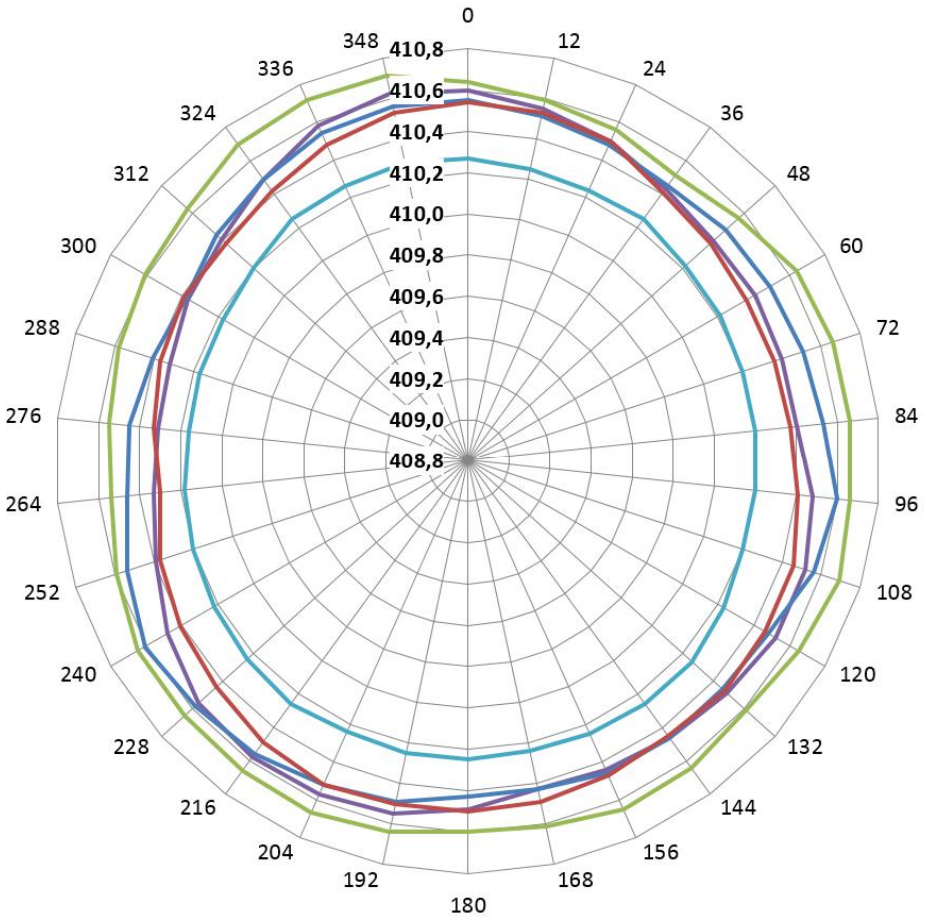

X82 piston running concept with excellent specific piston ring wear rate

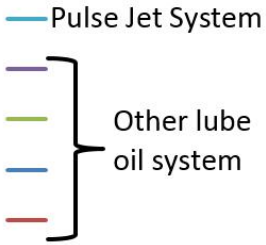


WIN GD
Winterthur Gas & Diesel

# *Service Experience – Piston Running X82*

X82 piston running with Pulse Jet System is the most efficient concept:




- Uniform fresh oil distribution
- Lower wear rate
- Maintain round shape of cylinder liner throughout the entire lifecycle

# *Service Experience – Exhaust Valve*

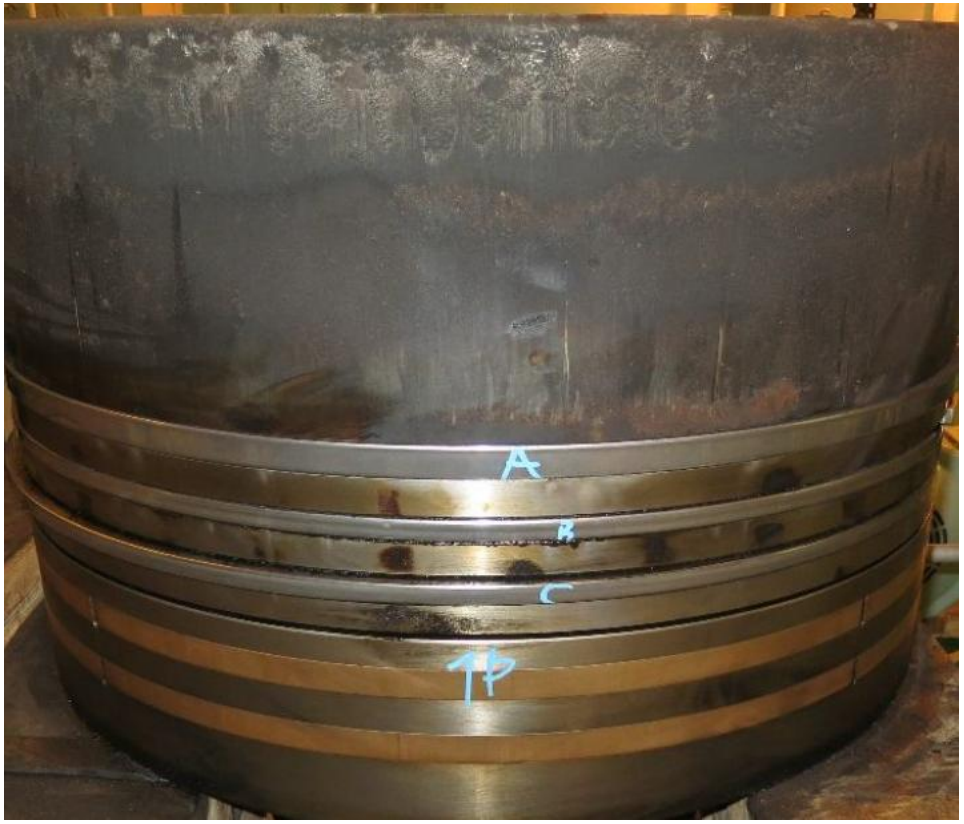
**W9X82 – Unit #1**

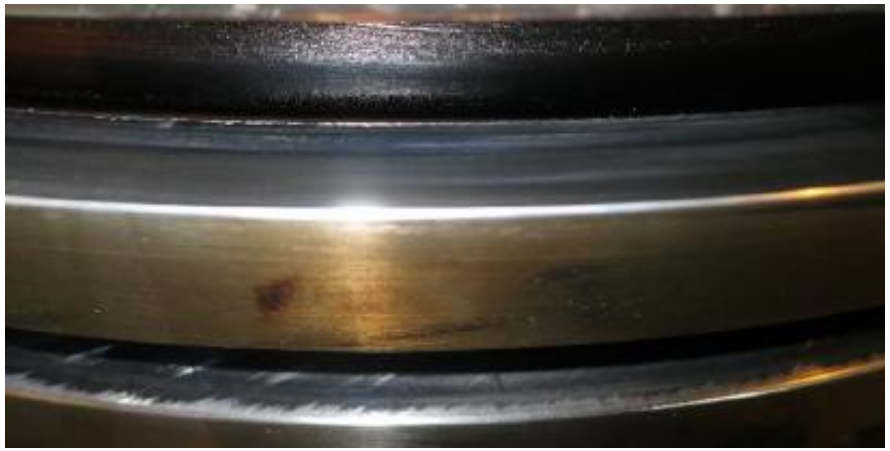
- 17’045 rhs
- Perfect condition
- Exhaust valve plate wear rate 0.05 mm/1000h
- **Estimated time until reconditioning: 240’000h**

# *Service Experience – Piston Head*

**W9X82 – Unit #1**

- 17’045 rhs
- Moderate deposits
- Clean piston ring pack
- Ring grooves in good condition with low wear rate
- **Estimated time until reconditioning: 120’000h**



# *Service Experience – Top Piston Rings*

## Coating layer spalling

- Occurs sometimes after thousand of operating hours on top piston rings
- Damage develops slowly
- Condition to be monitored according «Guide for judging condition of relevant piston-running components»
- Overhaul can be planned accordingly

Early sign of spalling

Material loss, to be monitored

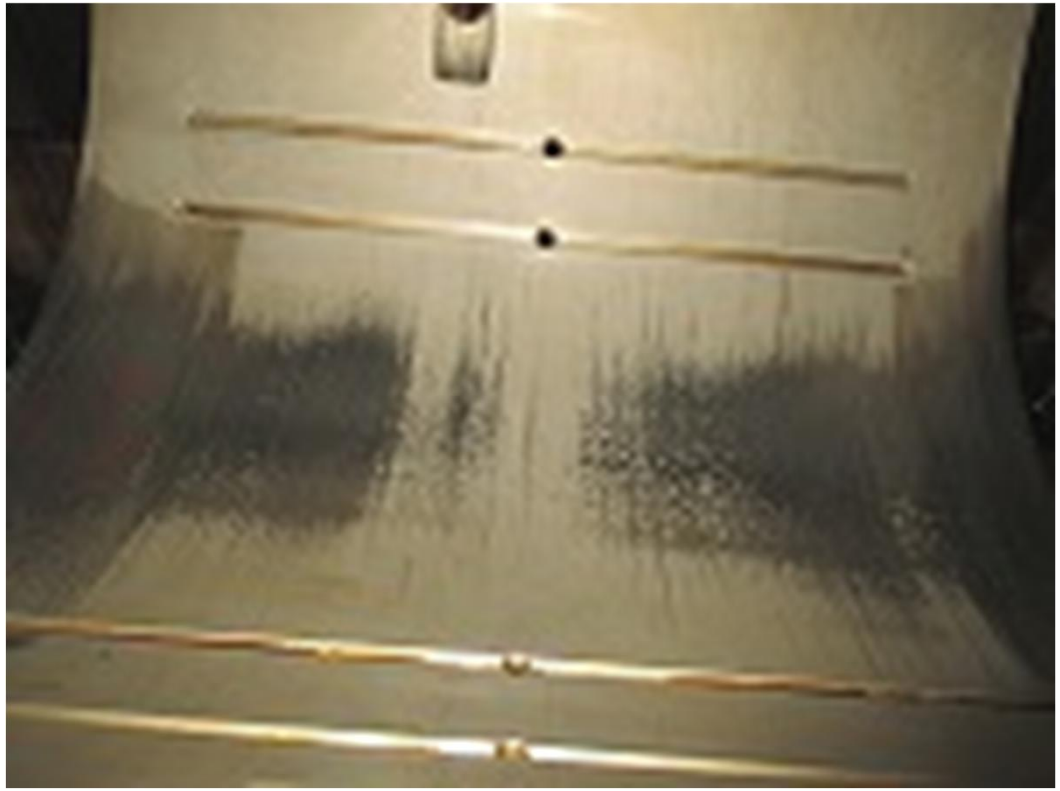
# *Service Experience – Top Piston Rings*

## Coating layer spalling

http://www.wartsila.com/products/marine-oil-gas/engines-generating-sets/low-speed-generation-x-engines


| | |
|---|---|
| **Ring type:** | SCP1CC20, A ring |
| **Condition:** | Cracked CC coating and spalling |
| **Acceptance:** | To be monitored. Limited size of spalling |
| **Action:** | In case spalling is less than 20 mm in length and less than half of the ring height the condition is still acceptable |

# *Service Experience – Crank Train Bearings*



10RT-flex82C
Crosshead bearing
Inspected at 29’008 rhs

- 8 units inspected
- All bearings in good condition
- Even contact marks on loaded lower bearing shell

# *Service Experience – Gear Wheels*

RT-flex82C & T engines
Various field inspections

- Gear wheels in good condition
- Even contact marks over tooth width

# *Service Experience – FAST Injection Nozzle*

RT-flex82T

- Inspection after 12’600 rhs

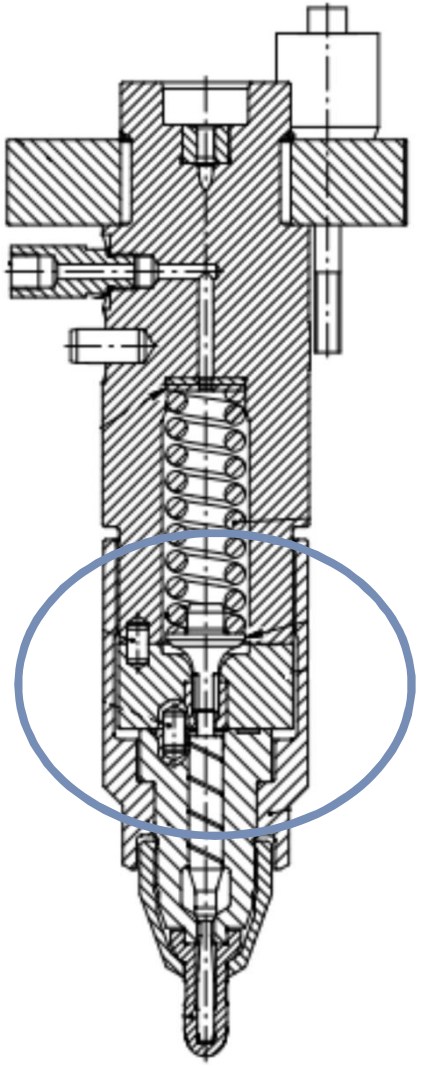
- Nozzle found in good working condition
- Needle and needle seat without wear
- Nozzle tip inside and outside in good condition
- Minor pitting on needle tip
- No cavitation on spring and inside spring chamber

# *Service Experience – FAST Injection Nozzle*

**W7X82 – Cylinder #3 – Feb. 2015**

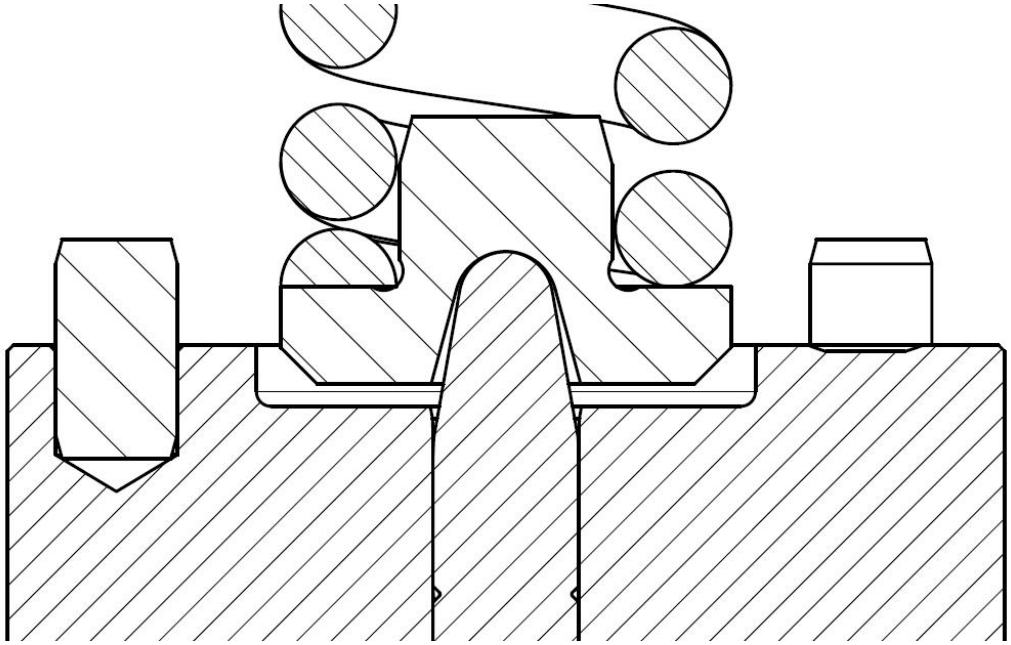
Tappet broken

Contact mark on intermediate piece



# *Service Experience – FAST Injection Nozzle*

Improved solution under validation



- Tappet in two pieces
- To avoid bending force on shaft
- Component test finished
- Field test successful

# *Service Experience – FAST Injection Nozzle*

## Status of the field test from improved design

- Test rig tests done with satisfactory results
- Field test on W7X82 applied on two units (6 injectors)
  - Inspection after 3000h, no abnormality found

✓ New design introduced as standard for new engines

Tappet

Tappet carrier

# *Service Experience X82 Engines*

*New concept for bearing inspection – Service Bulletin RT-188*

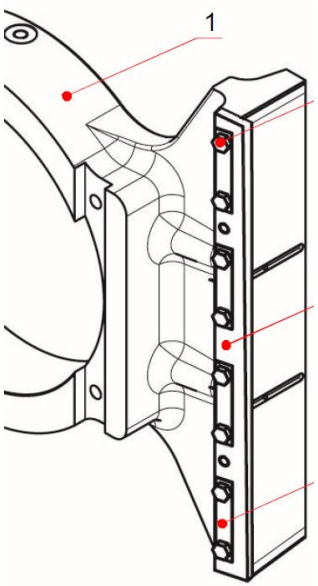
- *Avoid open-up inspection: risk of installation faults or intrusion of foreign particles*
- *Regular inspection interval without opening of bearings*
- *Open up inspection only necessary in case of abnormality or excessive wear*

| Overview | Main bearing | Conrod top end bearing | Conrod bottom end bearing | Thrust bearing | Schedule [rhs] |
|---|---|---|---|---|---|
| Crankcase inspection | X | X | X | X | 1500-3000 |
| Check lubricating oil filter, oil analysis | X | X | X | X | 3000 |
| Bearing clearance measurement | X | X | X | X | 6000 |
| Deflection measurement | X | | | | 6000 |
| Wire check on bearing edges | X | X | X | | 6000 |
| Check bottom drain for free passage | | | | X | 6000 |
| Log of measurements | X | X | X | X | To be kept |

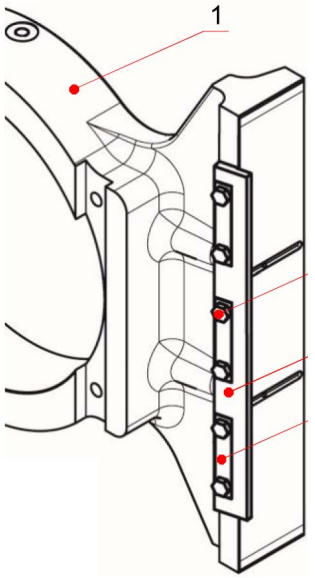
# *Service Experience X82 Engines*

*Service Bulletin RT-193: guide rail on guide shoe*

- *Few cases of white metal peeling off reported on bottom side of the guide rail*
- ✓ *Modification of guide rail introduced*




Original execution




Modified execution

# *Service Experience X82 Engines*

*Service Bulletin RT-123 Appendix 3: Inspection and overhaul interval*

- *Update released in November 2016*

- ✓ *FAST injector nozzle tip and nozzle body: recommended exchange after 18'000 rhs*
- ✓ *Crank train bearings: open up only in case of abnormality*
- ✓ *Crank train bearings: replacement only if required*
- ✓ *Piston rings: replacement condition based on remaining coating thickness (18'000-36'000 rhs)*
- ✓ *FOP: remanufacturing recommended at 18'000 rhs*
- ✓ *ICU: remanufacturing recommended at 36'000 rhs*
- ✓ *WECS 9520: replace modules in case of failure, estimated lifetime 60'000 rhs*

# *Service Experience X82 Engines*

*Service Bulletin RT-138 Appendix 1: Validated cylinder and system oils*

- *Update released in January 2017*

- ✓ *New cylinder oils with BN 100 validated*
- ✓ *Some BN 100 oils field tested with < 0.1% SECA fuel for short time*
- ✓ *Cylinder oils with BN higher as 100 in validation*
- ✓ *New cylinder oils validated between BN 15 and BN 25*

# *Service Experience X82 Engines*

*Service Bulletin RT-191 : FCM-20 rev. 08*

- *Released in January 2017*
- *New hardware revision 08 introduced*

*For engines in service with older hardware revision 06 and 07*

- *WECS9520 software to be updated before installation of FCM rev.08*

*For engines in service with older hardware revision (not for RT-flex82C/T and X82 engines)*

- *WECS9520 software to be updated before installation of FCM rev.08*
- *Recommended to upgrade the whole engine with FCM rev. 08 due to the age of more than 10 years*

# W-X82-B Engine – Conclusion

- *Successful introduction of the 82 bore engines (230 engines ordered)*
- *W-X82-B announced with an extended rating field*
  - *Extended rating field, offering optimum VLCC propeller speeds*
  - *T/C cut-off possible on W9X82 to optimise BSFC below 50% engine load*
- *W-X82 & W-X82-B engines incorporate same design improvements as on previously announced RT-flex82T-B*
  - *128 x RT-flex82 and 23 x RTA82 engines in service*
  - *Piston running RT82C good, on RT82T improved with RT-157 bulletin*
  - *Crank train bearings without complaint*
- *42 x W-X82/-B engines in service, 78 engines ordered*
  - *First W-X82-B successfully passed shop test in March 2017*
  - *First service experience is above the expectations*
  - *Excellent piston running behaviour of X82/X-B engines with very low wear rates*
    - *Time between overhaul can be extended*

***The W-X82 & W-X82-B engine are very competitive prime movers for VLCCs, VLOCs and Panamax Container Vessels***