

Development and Lubrication of 2S Marine Engines

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WIN GD

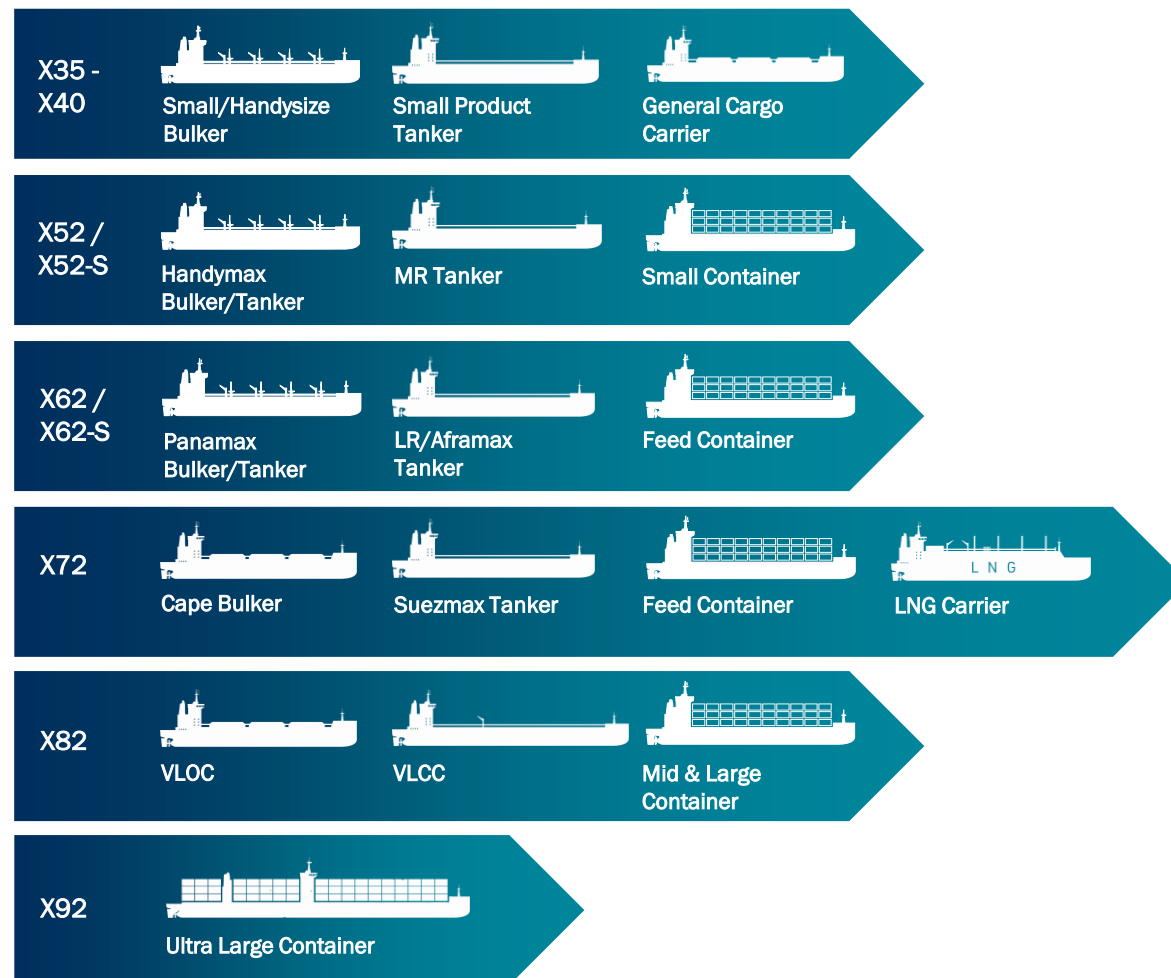
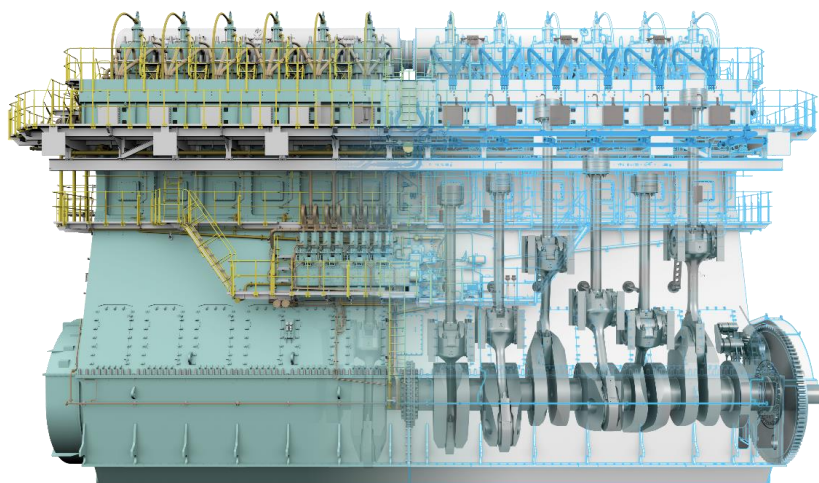


WinGD Product Range

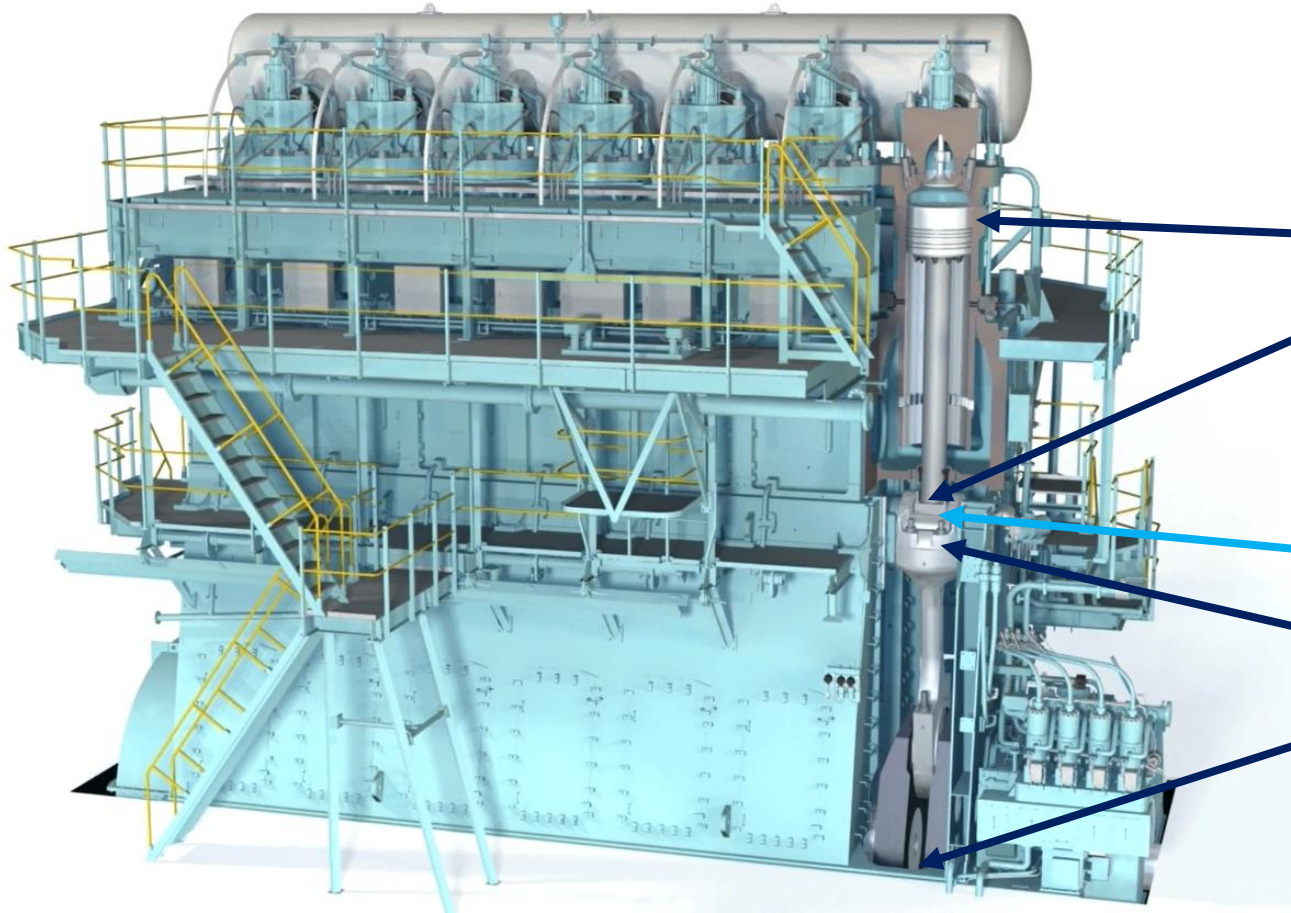
Existing product lines, sizes and typical applications

X Engines:

- Diesel engines designed for operation on distillate / residual fuels
- Highly efficient ship propulsion engines, compliant with most stringent environmental standards
- Low lifecycle cost (CAPEX and OPEX)



Overview Lubrication in 2S Marine Engines



Cylinder Oils (SAE 50 – BN 20 – 140)

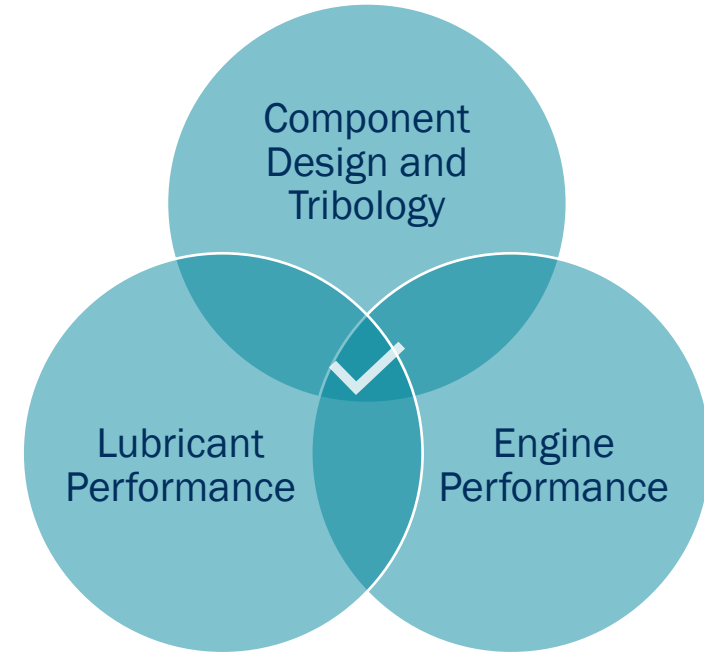
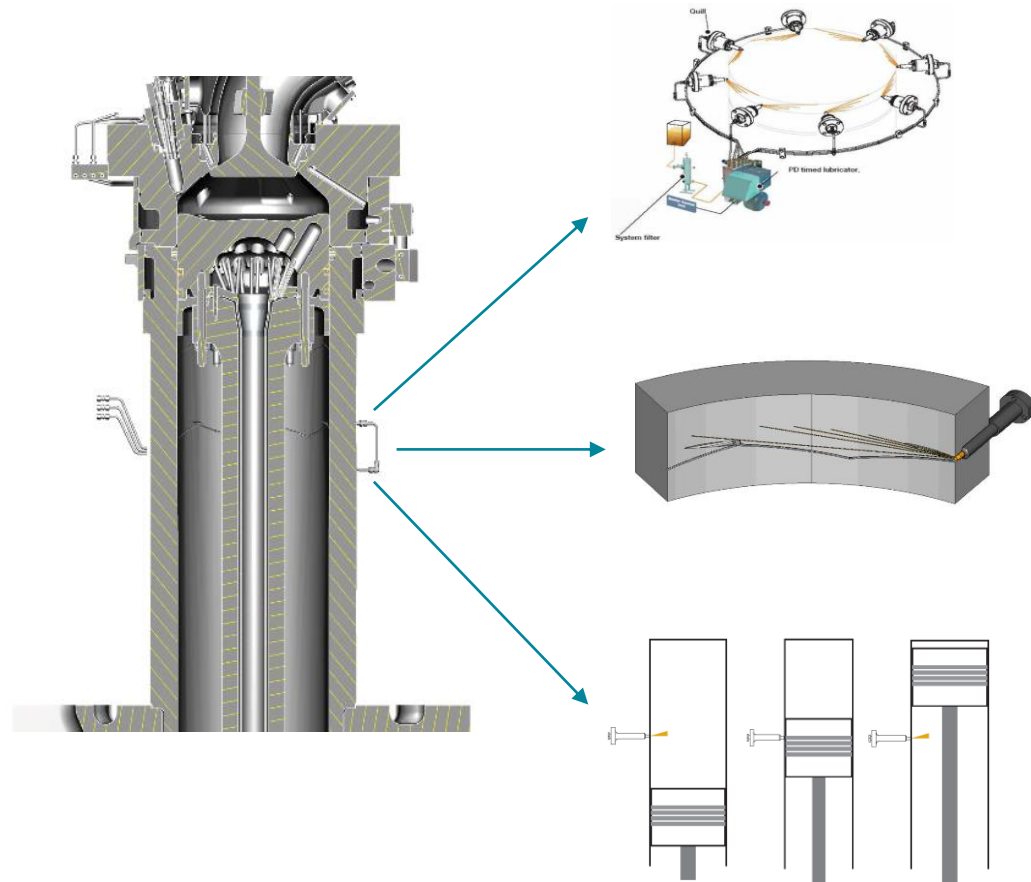
- Lubricate moving components
- Neutralise acids
- Keep engine clean

Separated by Stuffing Box

System Oils (SAE 30 – BN 5 – 9)

- Lubricate running parts
- Provide cooling for piston head
- Servo oil for hydraulic system

Overview Lubrication in 2S Marine Engines

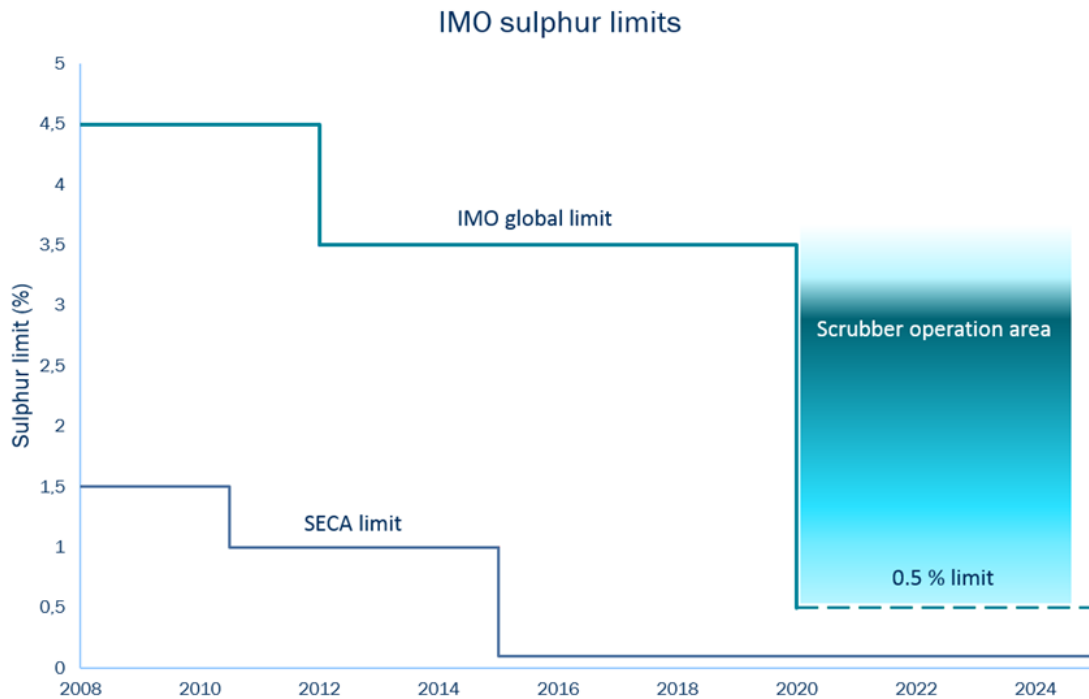


WinGD considers lubricants to be part of the engine design

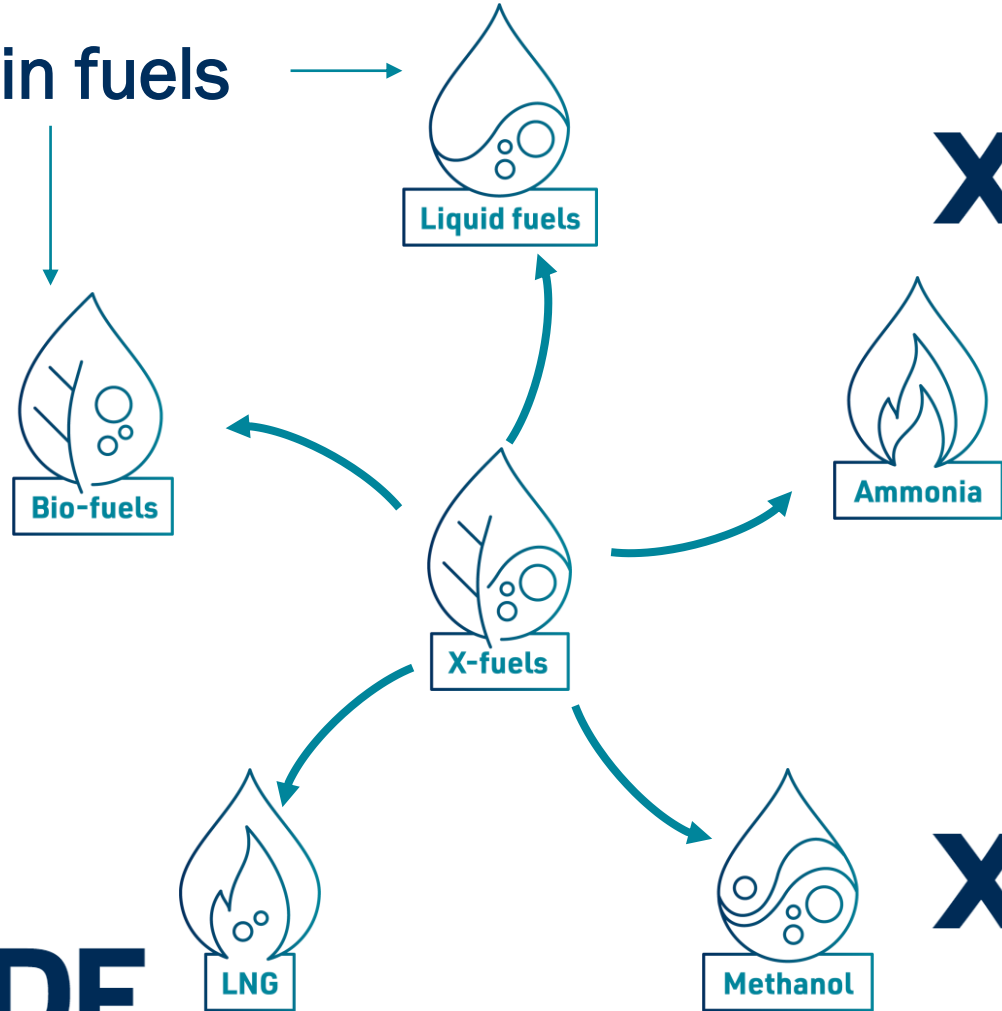
Marine Fuels

Past and Future Fuels

Introduction



Drop-in fuels



X-DFA
by WinGD

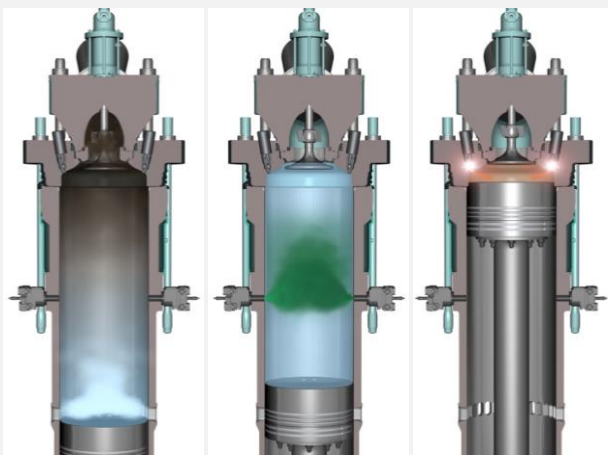
X-DF

X-DFM
by WinGD

LNG X-DF Status

After 6 Million hrs in the total of X-DF fleet

- Dual-Fuel engines designed for operation on LNG as main fuel with distillate as pilot fuel, distillate / residual fuel as backup fuel
- X-DF engines are running very well overall. More than 350 X-DF engines are in service, with longest running >40'000hrs.
- Thermal stability of the classical lubricants was not optimal - improvement of oxidation stability was needed



Scavenging

Compression/
gas admission

Ignition →
expansion



WinGD Cylinder Lubrication Experience

WinGD 5X72DF Engine with 24'000 hours

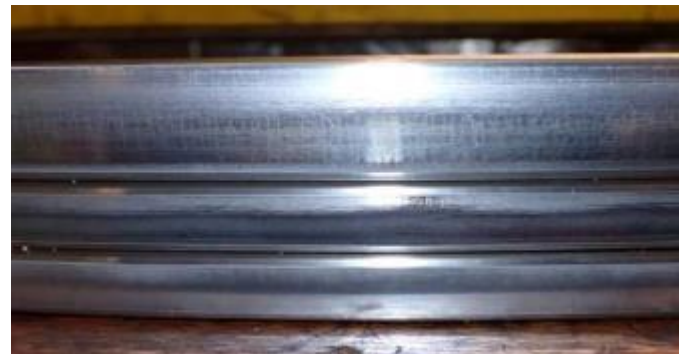
- Gas Carrier with demanding engine load profile
- Burning LNG mostly with CLO at 0.85g/kWh set feedrate using 'gas general usage' oil
- Engine supplied with single (BN40-60) cylinder oil from new
- Engine never opened before
- Excellent results with market general oil



Piston Crown as removed



Piston Crown as removed showing ring grooves



Piston rings with plenty of CC coating remaining



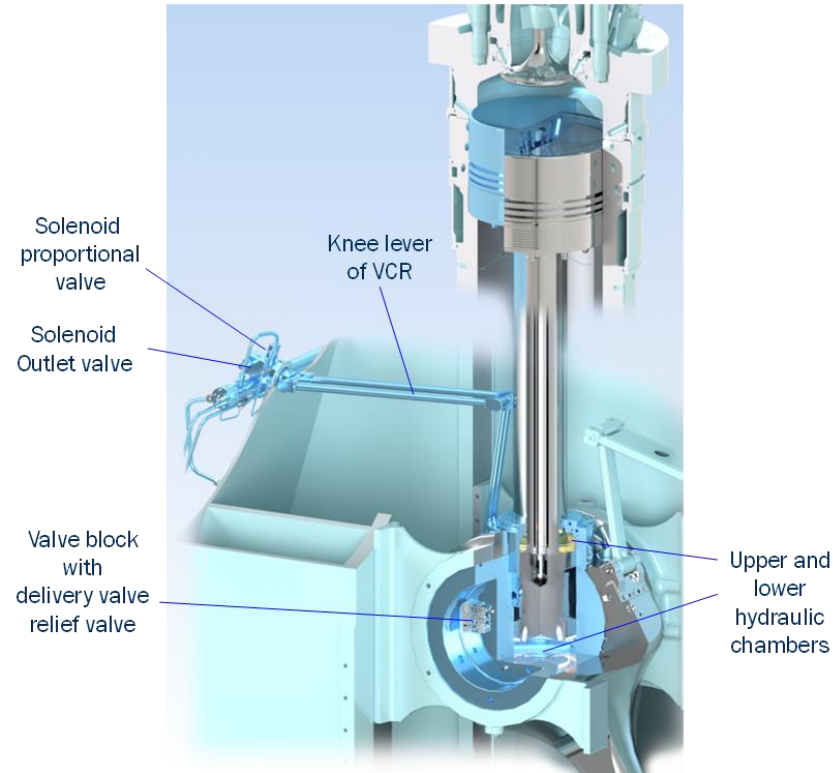
Piston Ring Backsides showing no deposit buildup

New X-DF Technologies

iCER and VCR technology on X-DF-2.0 engines



iCER



VCR

Reduced Gas consumption



Reduced Diesel consumption



Reduced CH₄ reduction and GHG reduction



Reduced Low Particulate Matter (PM)



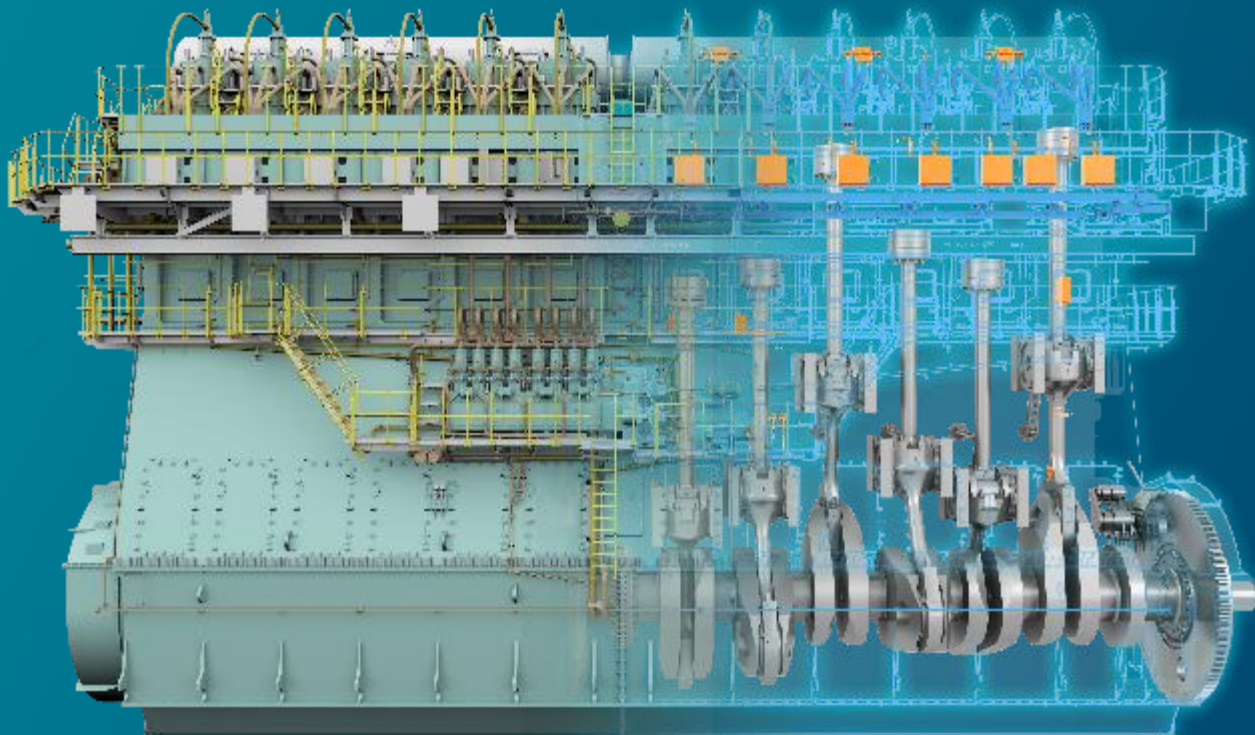
Low NO_x



No DCC activation



Future fuels

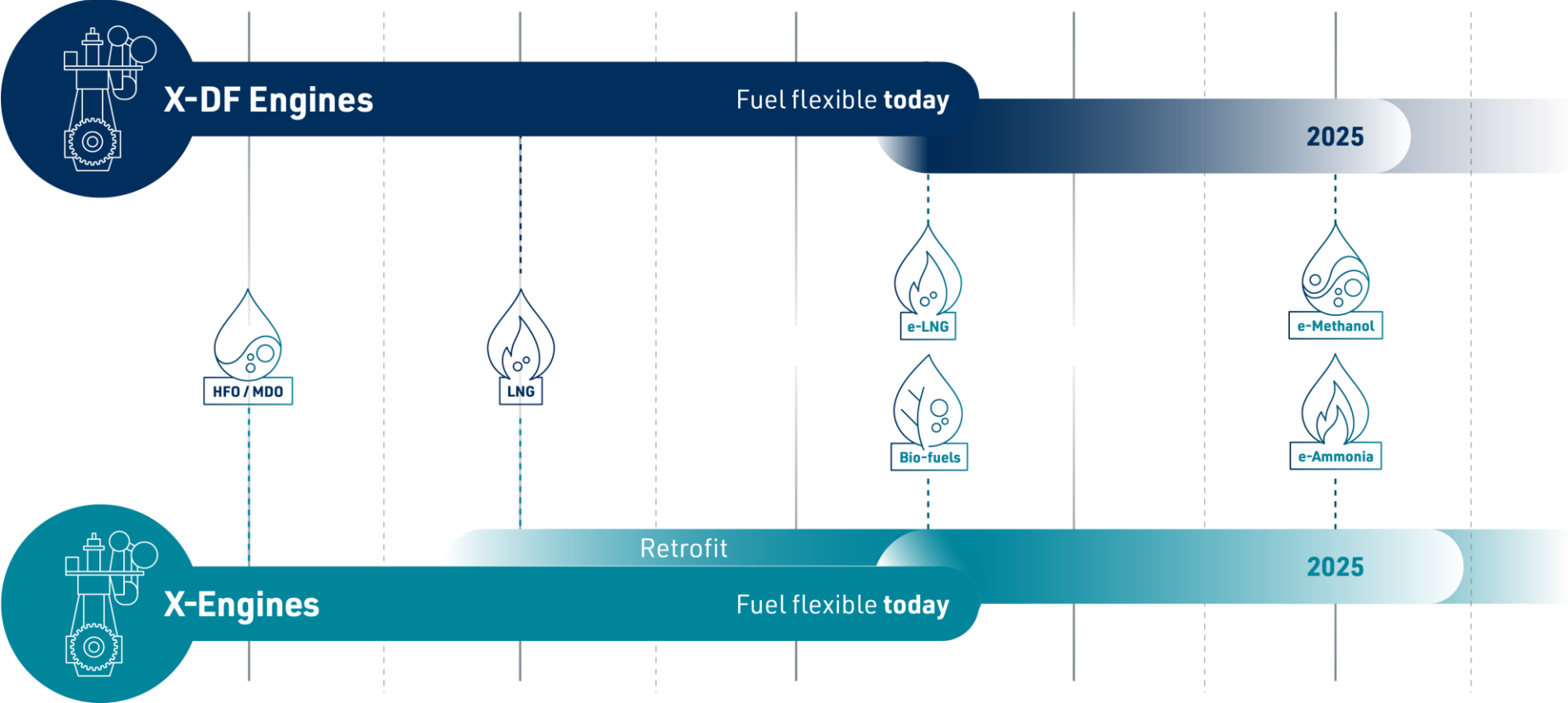


WIN GD

Decarbonisation Technology Development

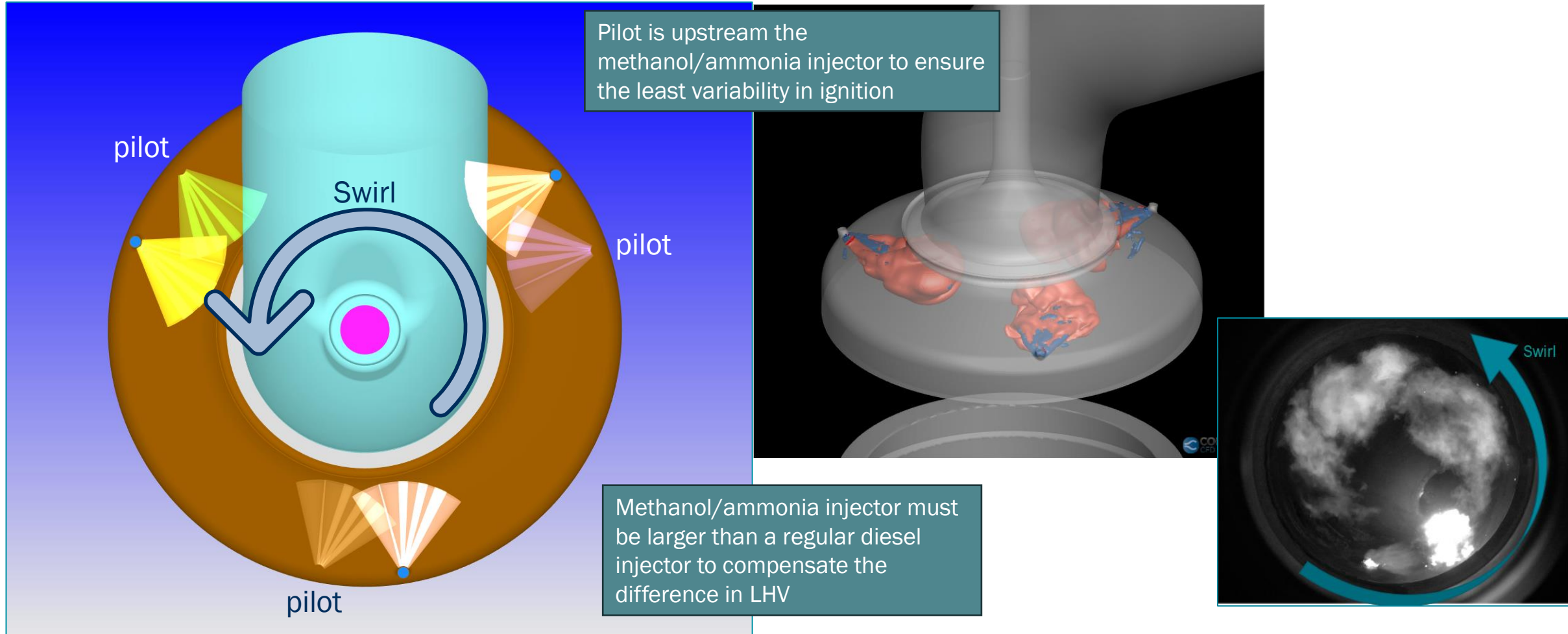
The WinGD decarbonisation roadmap

X-DF-A and X-DF-M engines



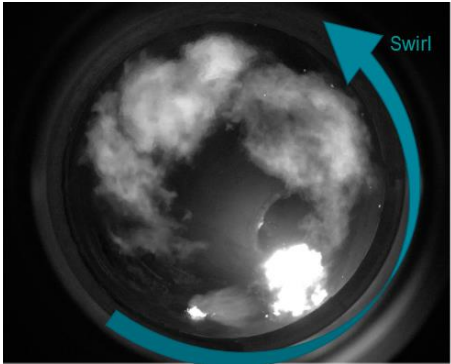
Combustion Concept - Ammonia and Methanol

Injector layout



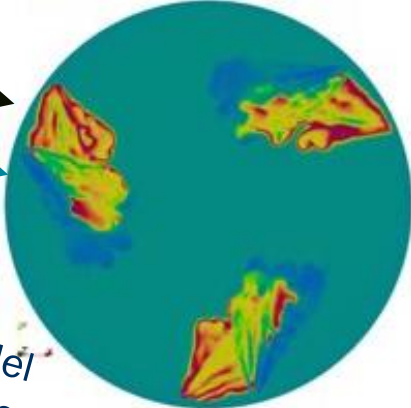
Simulation – Experiment Loop

Spray combustion chamber



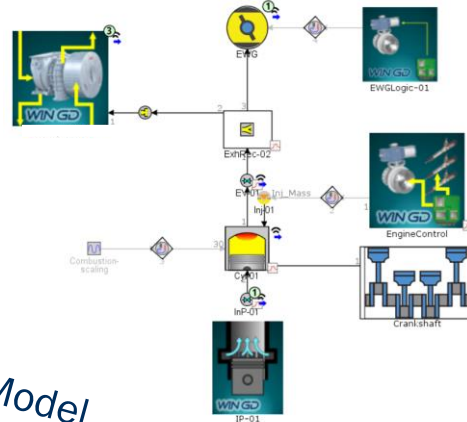
CFD

- Detailed spray / combustion / emission



Performance Simulation

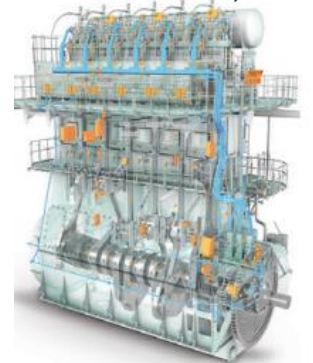
- Engine performance
- Engine operating strategy
- General Technical Data



Diesel
 Methanol/ Ammonia

Engine

- Validation data for
 - Diesel operation
 - Methanol/ Ammonia



Data Transfer / Model Calibration / Validation

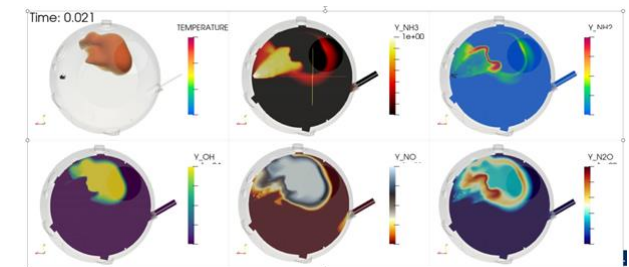
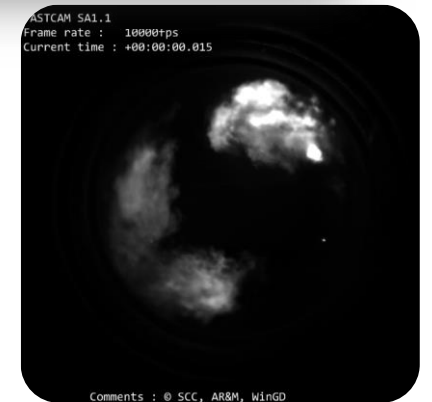
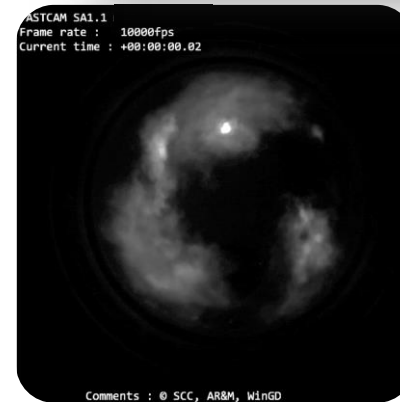
Data Transfer / Model Calibration / Validation

Data Transfer / Model Calibration / Validation

Combustion Tests

Ammonia and Methanol Combustion Optimizations

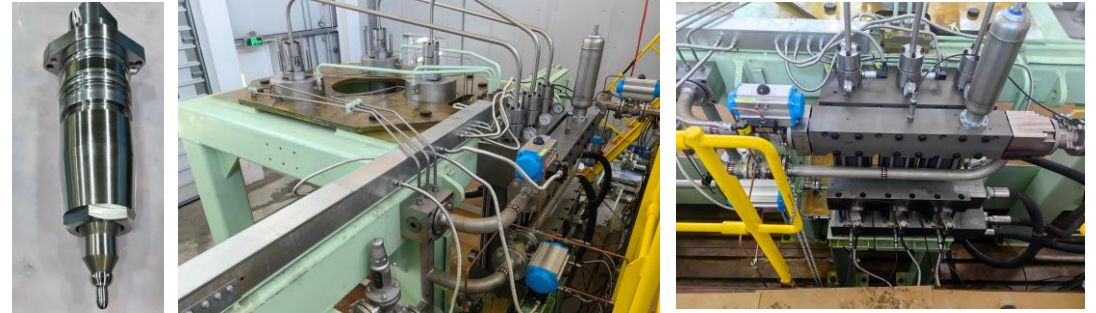
- Combustion tests are monitored through high-speed visualisation and diagnostics tools
- Combustion optimization for Methanol and Ammonia achieved by investigating:
 - Spray morphology
 - Injection behaviour
 - Injectors setup (geometry)
 - Pilot fuel interactions
 - Spray to flame interactions
- Validated combustion models allow for further engine performance optimisation.



Hydraulic Test Rigs

Ammonia and Methanol Test Rigs

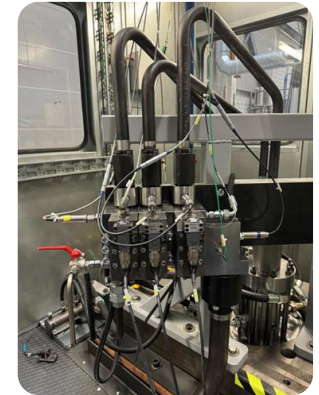
- Methanol injection system tests ongoing
- Ammonia injection systems are under testing both at the injector rig and on RTX-6 test engine in Switzerland
- Test Rigs Capability
 - System validation (design)
 - Functionality
 - Control strategy
 - Shot-to-shot and injector-to-injector variance
 - Endurance
- Injection components characterisation as prerequisite to deeply understand combustion at the test engines.



X92DF-M injector and components at the hydraulic rig in Shanghai



X52DF-A injector and injection system at the hydraulic rig in ERIC (Switzerland)



OCV rig for actuation oil valve tests

Test Engines

Validation on lab engines

RTX-6
ERIC CH
4 cyl, 50 cm bore
Diesel, methanol



RTX-8 / RTX-7
Shanghai CN
4 cyl, 52 cm bore
Methanol, ammonia / Gas LP-DF



SCE
ERIC CH
1 cyl, 50 cm bore
All fuels / concepts

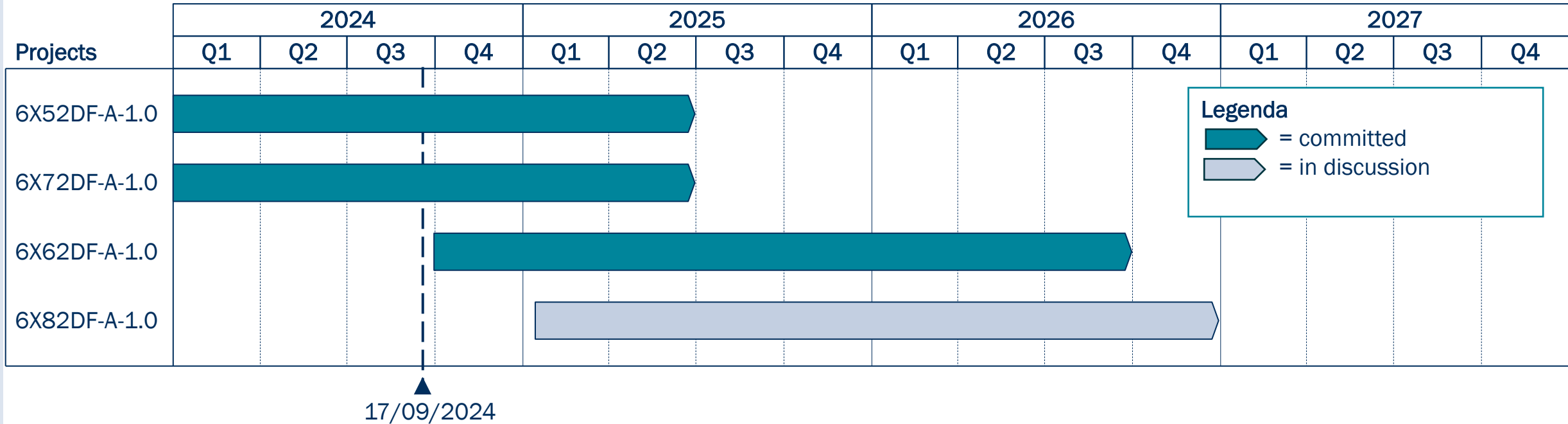


SCE 920
Shanghai CN
1 cyl, 92 cm bore
Diesel, methanol

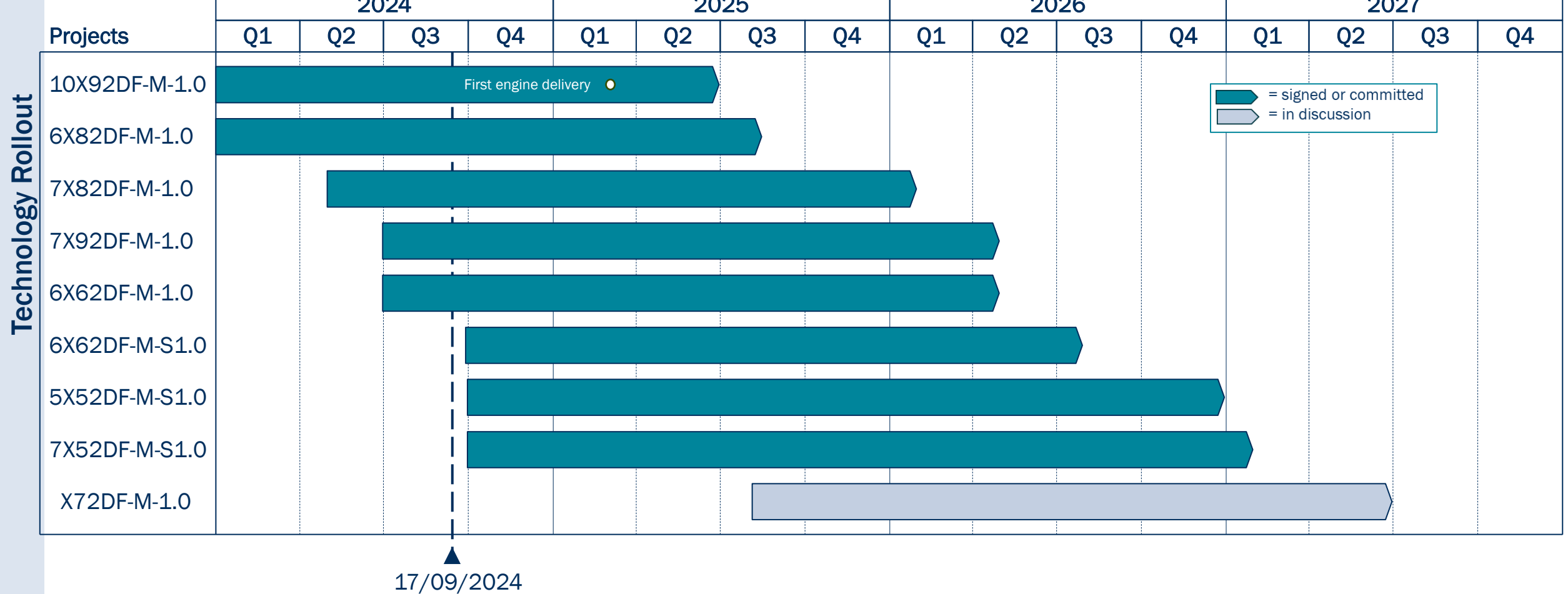
	Unit	
Bore	mm	920
Stroke	mm	3468
Max. rated speed	rpm	80
Max. rated power	kW	8000
BMEP	bar	26.0
Max. pressure	bar	250

Ammonia Technology Roll-out

Technology Rollout



Methanol Technology Rollout



2S Marine Lubricants Development

Problem:
Liner corrosion

Solution:
High BN oils

Problem:
Deposits formation in gas engines

Solution:
New formulations, oils with higher oxidation stability

Problem:
Deposits formation for low sulphur residual fuels

Solution:
High detergency and low BN oils

Gas fuels:

- **Problem:** deposits formation
- **Solution:** Low ash lubricants

Biofuels

- **Problem:** Deposits? Compatibility?

Methanol

- **Problem:** Compatibility?

Ammonia:

- **Problem:** High water content? Reactivity? Deposits? Material compatibility?

Until 2015

After 2015

After 2020

After 2025

One oil to rule them all?

Thank you

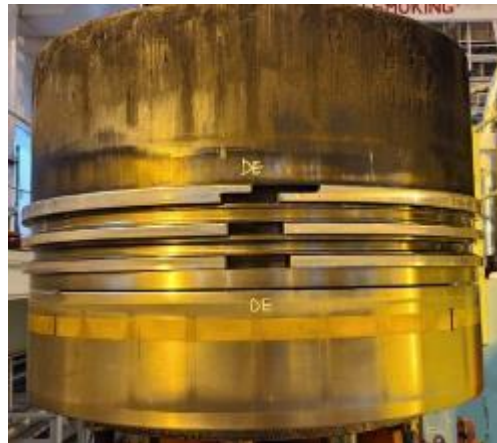


WIN GD

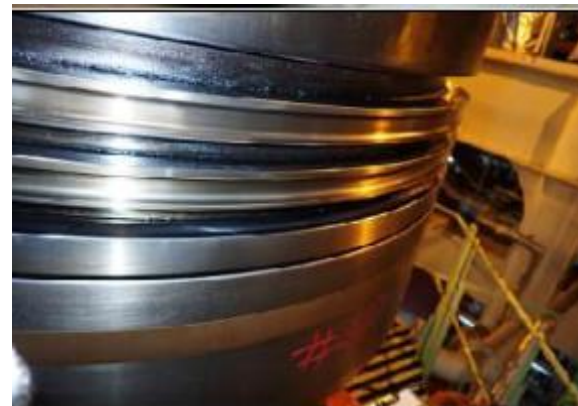
WinGD Cylinder Lubrication Experience

WinGD 8X92 Engine with 32'000 hours

- Container vessel burning VLSFO
- BN40-60 cylinder oil
- Unit never opened before



Piston Crown as removed



Ring Grooves with minor deposits



Piston Ring Backsides showing low deposit buildup

WinGD 5X72DF Engine with 24'000 hours

- LNG carrier
- BN40-60 cylinder oil
- Unit never opened before



Piston Crown as removed



Ring Grooves



Piston Ring Backsides showing no deposit buildup