

**CEC**

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# **The new CEC OM646LA Engine Wear Test**

**Michael Schulz**

I.S.P. - Institute for Fuels and Lubes Testing, Germany

**Additives 2009**

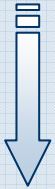
Park Inn Hotel, York, UK

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# History

1994



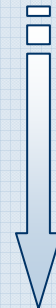
**OM 602 A wear test procedure available**  
1630 engines have been sold in 12 years



2006



**Last OM 602 A test engine was built**  
Remaining engines ensured testing until end 2008  
**Tender for OM 646 LA wear development was issued**  
**Start of OM 646 LA wear test development**



2008

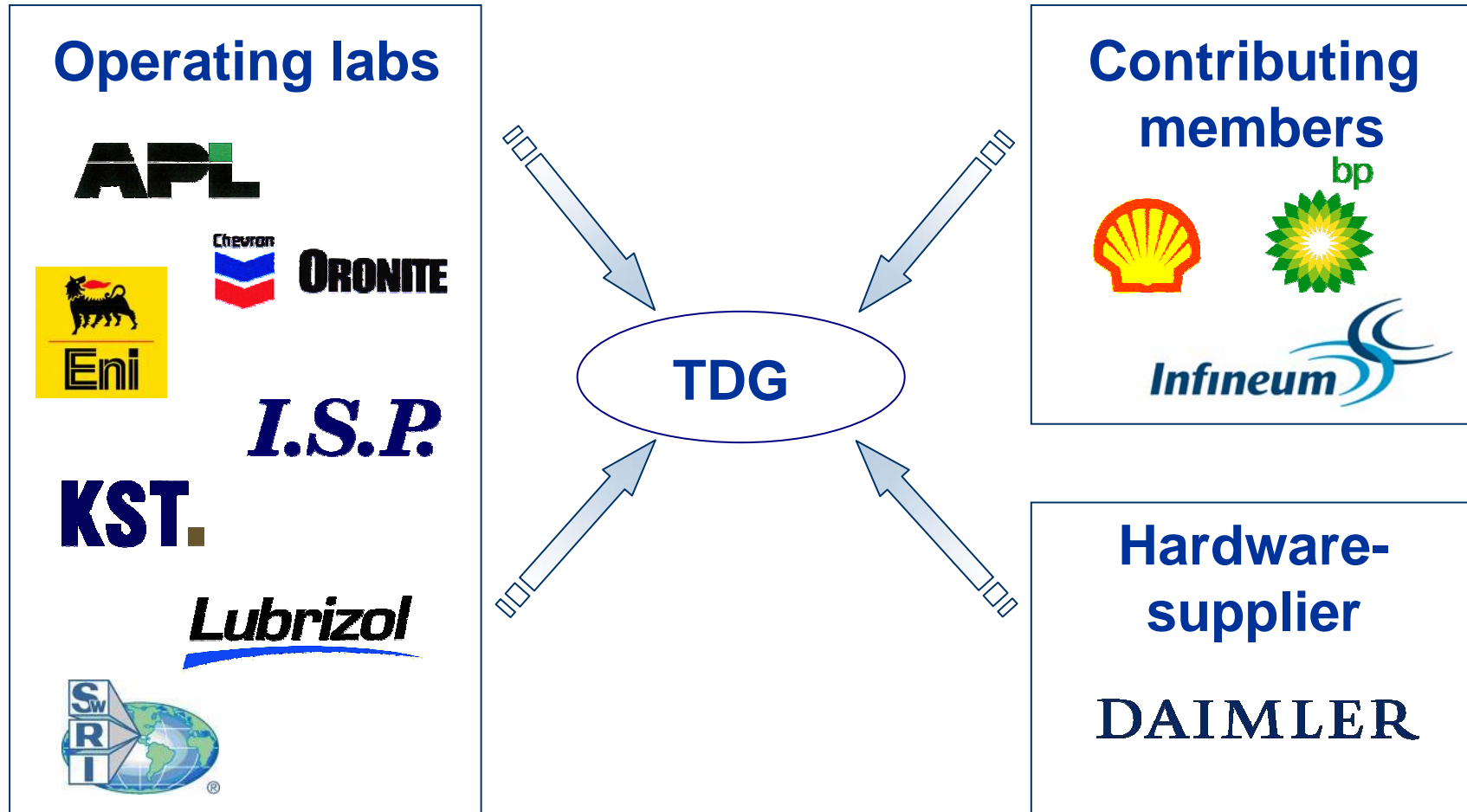
**OM 646 LA wear test procedure available**



# Comparison OM 602 A vs. OM 646 LA Wear Test

	OM 602 A	OM 646 LA
Test hardware	5 Cylinder Diesel, 2.5 l Turbocharger Indirect injection 225 Nm / 93 kW	4 Cylinder Diesel, 2.2 l VTG Turbocharger - I/C Direct injection 340 Nm / 110 kW
Test fuel	2500 – 3000 ppm S No FAME	350 ppm S *) 5 M% RME *)
Test criteria (ACEA)	Cam wear Bore Polish Cylinder wear Viscosity increase Oil consumption	Cam wear *) Bore Polish *) Cylinder wear *) Tappet wear *)
		*) Tender requirements

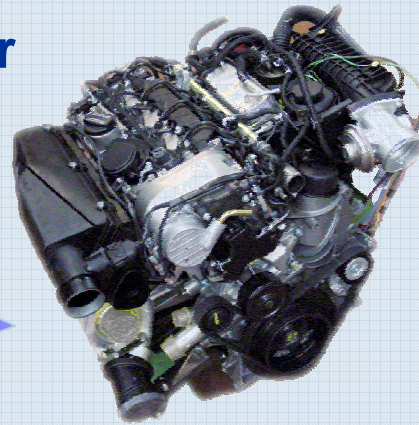
# Members of the Test Development Group (TDG)



# Tender Requirements

## Test Performance Criteria:

- Cam & Tappet Wear
- Bore Polish
- Cylinder Wear



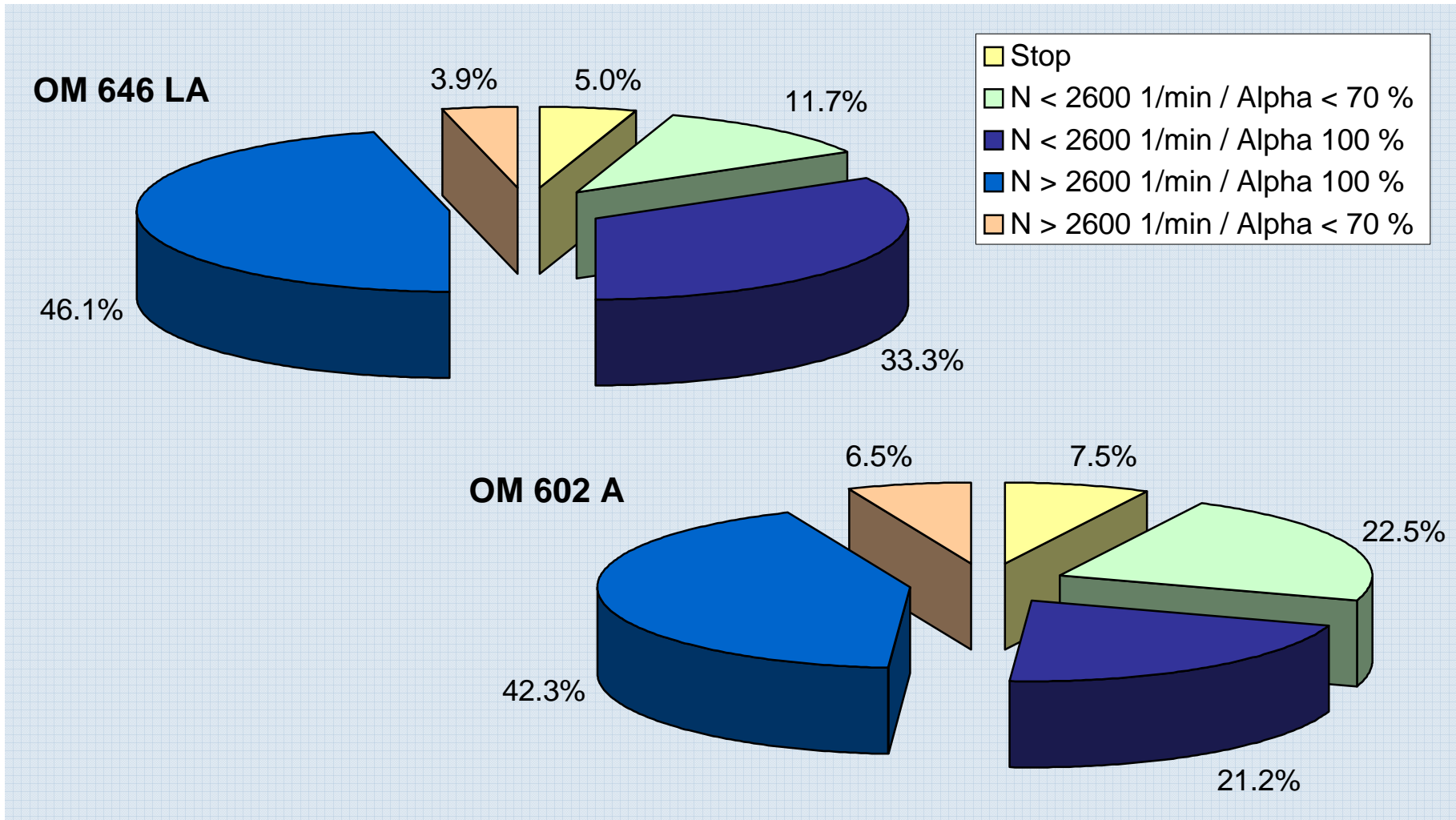
## Test Cycle:

- Fuel dilution:  $5 \pm 1$  %
- Soot content: 5 – 7 %
- Test length: 200 – 300 h

## Test Fuel:

- 5 % FAME
- 350 ppm S

# Test Cycle Development



# Fuel Dilution Strategy

Target: Fuel dilution  $5 \pm 1$  %M

## Engine post-injection

- + Real engine conditions
- Difficult to realise
- Major engineering support of Daimler required
- Modification of ECU settings necessary
- Bad repeatability as several engine parameters are involved

## Artificial injection

- + Controlled injection time
- + Controlled injection amount
- + Repeatable conditions
- + Individual set-up possible
- Artificial system





# Reference Oils

	High reference oil	Low reference oil
Performance	ACEA C3	ACEA C1
SAE Grade	5W-30	0W-30
HTHS	3.5 mPas*s	2.9 mPas*s
Ash content	0.75 %	0.50 %
OM 611 LA results (Daimler in-house test)		
Cam wear outlet	85 microns	213 microns
Cam wear inlet	66 microns	161 microns
Cylinder wear	1.4 microns	2.5 microns
Bore polish	1 %	1 %
Piston cleanliness	31 merits	24 merits



# Test Results of First Reference Tests

Reference test	Test # 1	Test # 2
Reference oil	RL 230 (high)	RL 229 (low)
Reference fuel	DF-96-06	DF-96-06
Sulphur in fuel [mg/kg]	350	350
FAME in fuel [%]	5	5
Artificial fuel injection	Yes	Yes
Avg. Cam wear inlet [ $\mu\text{m}$ ]	28.1	12.6
Avg. Cam wear outlet [ $\mu\text{m}$ ]	25.0	24.6
Avg. Cylinder wear [ $\mu\text{m}$ ]	4.7	3.0
Max. Bore polish [%]	5.7	4.8
Piston cleanliness [merit]	9.0	6.1
Soot @ EOT [%M]	5.3	6.1

❖ **No remarkable cam wear**

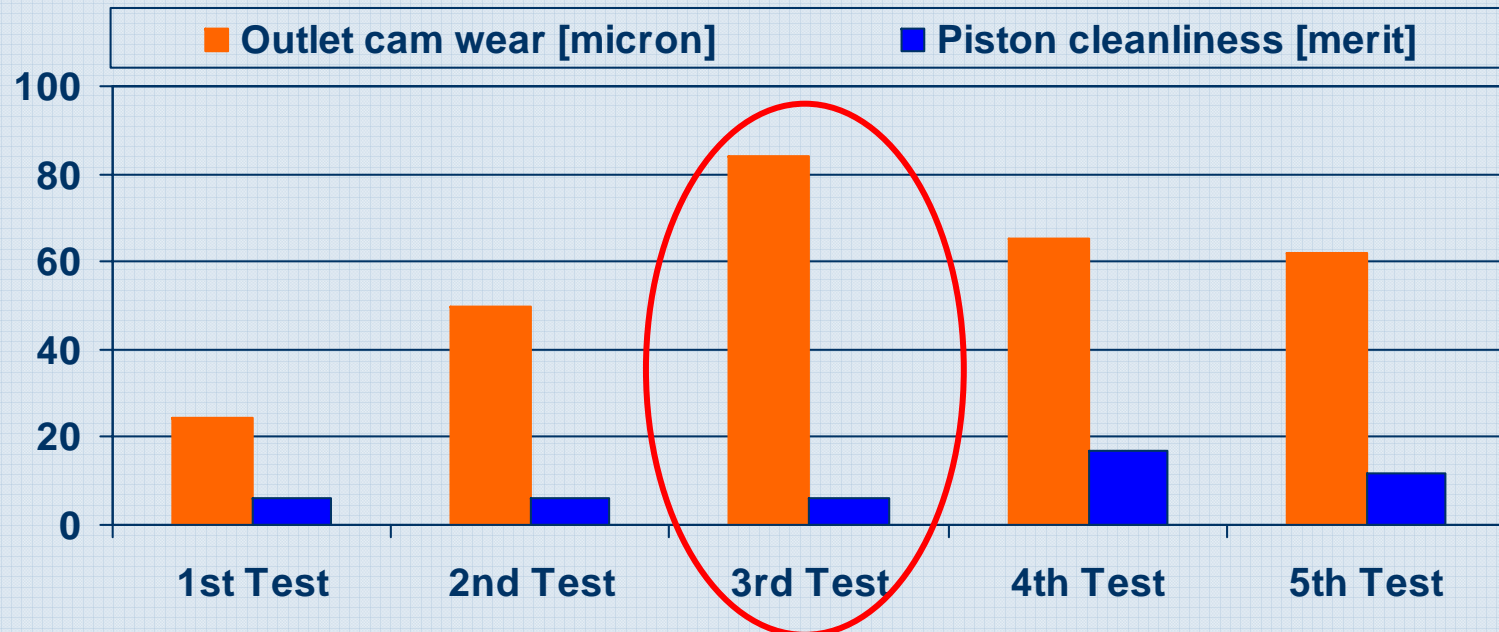
❖ **High bore polishing**

❖ **Poor piston cleanliness**  
(max. 65 merits possible)

❖ **Soot content in target range**

➤ **Test procedure needs to be modified**

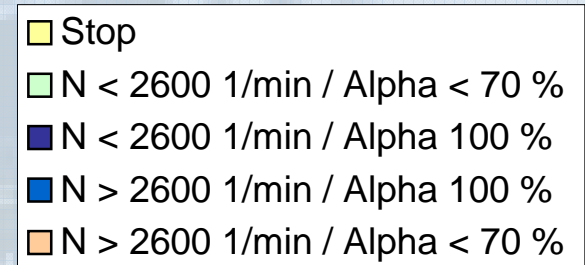
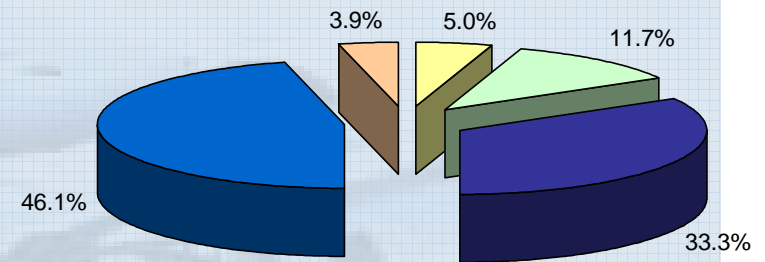
# Test Results on Low Reference Oil



FAME [%M]	5	5	5	0	5
S-Level [ppm]	350	< 10	< 10	< 10	< 10
Fuel Injection	Yes	Yes	No	No	No
Cycle severity	0	0	0	-	-

# Final Test Procedure

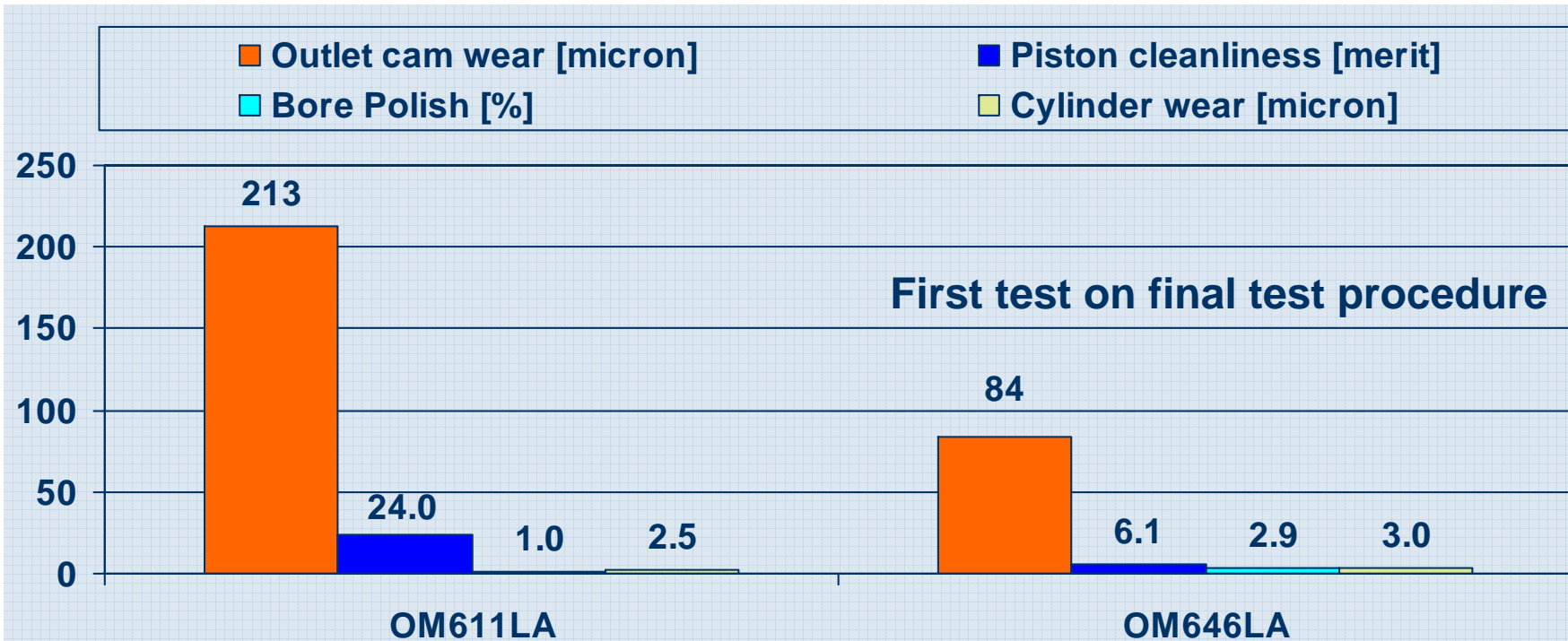
- ❑ 300 h alternating cycle
- ❑ Fuel with 5 %M FAME
- ❑ Sulphur content in the fuel < 10 ppm
- ❑ No artificial fuel injection
- ❑ Oil samples every 50 h
- ❑ Evaluation of...



- |                        |                           |                      |
|------------------------|---------------------------|----------------------|
| ❖ Cam & Tappet wear )* | ❖ Bearing wear            | ❖ Ring sticking      |
| ❖ Bore polish )*       | ❖ Timing chain elongation | ❖ Oil consumption    |
| ❖ Cylinder wear )*     | ❖ Engine sludge           | ❖ Viscosity increase |
| ❖ Piston cleanliness   | ❖ Ring wear               | ❖ Soot @ EoT         |

\*) Part of ACEA European Oil Sequences

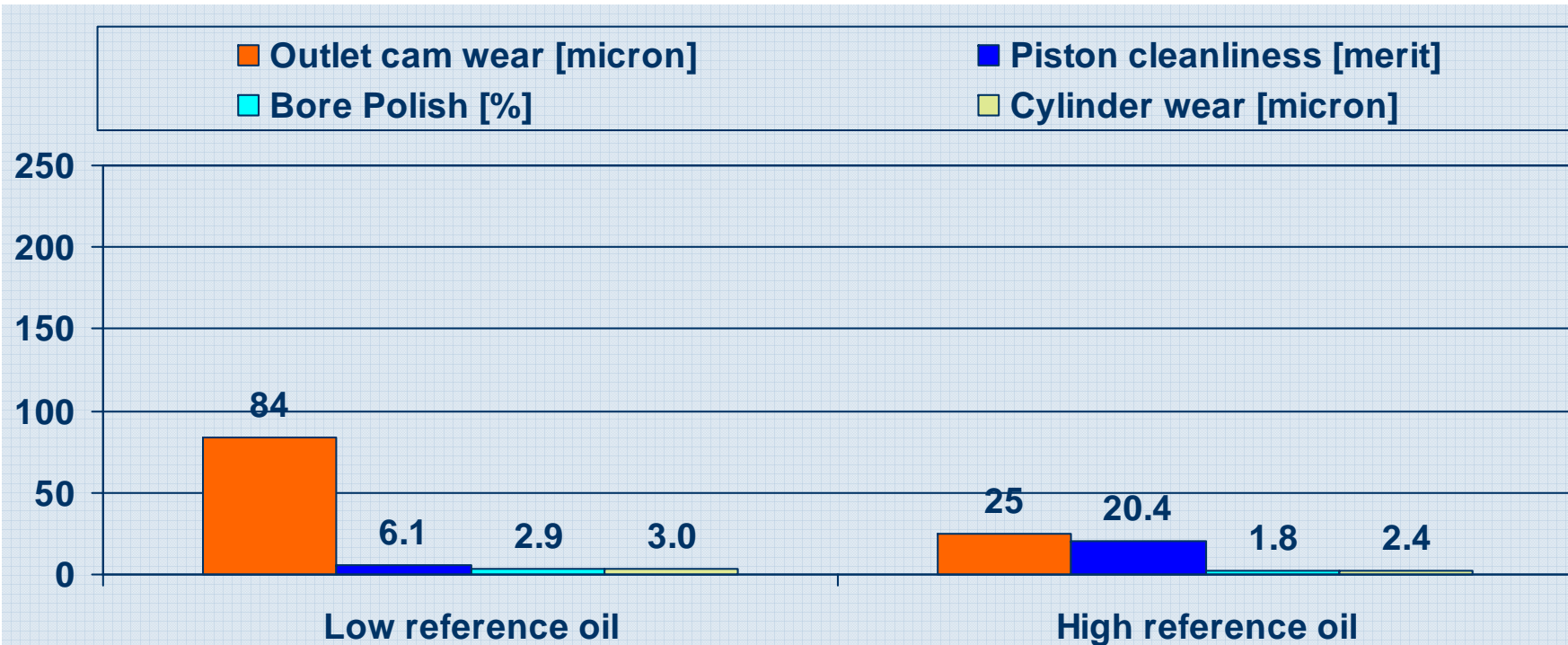
# Test Result Comparison of OM 646 LA vs. OM 611 LA on Low Reference Oil



- ❖ Cam wear significant lower
- ❖ Piston cleanliness more severe

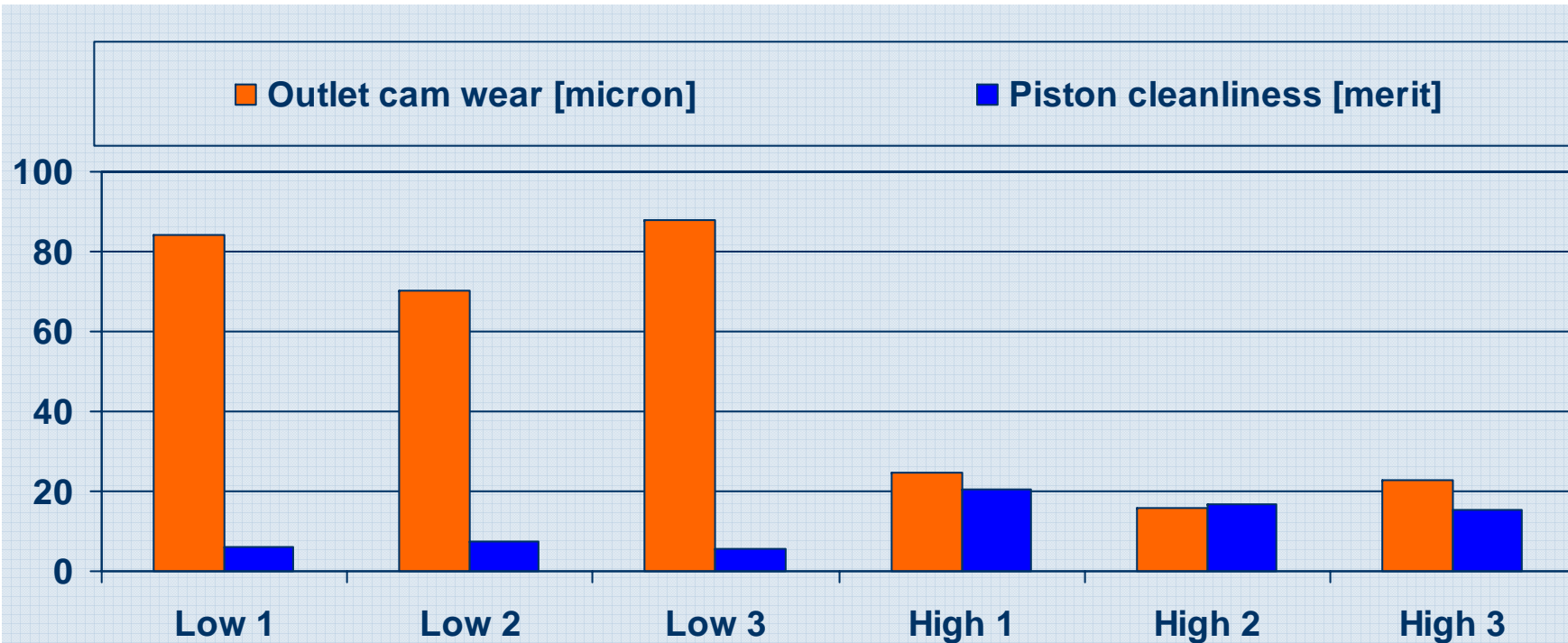
- ❖ Bore Polish slightly more severe
- ❖ Similar cylinder wear

# OM 646 LA Discrimination



- ❖ Good discrimination for outlet cam wear
- ❖ Reasonable discrimination for piston cleanliness
- ❖ Almost no discrimination for bore polish and cylinder wear

# OM 646 LA Repeatability



- ❖ Good repeatability for outlet cam wear and piston cleanliness
- ❖ Phase 1 of the test development successfully completed

# Conclusions & Summary

- ❑ **The OM 646 LA wear test...**
  - **has been successfully developed in 24 months**
  - **is an accepted wear test and part of various industry specifications**
  - **shows good discrimination including for piston cleanliness**
- ❑ **Cam wear levels in the OM646LA are lower than those in the OM 611 LA**
- ❑ **Piston cleanliness in the OM 646 LA is significantly lower than in the OM 611 LA**
- ❑ **Further investigation on stability of Bio-Fuels needs to be conducted**



# Acknowledgement

## Operating labs

**APL**



***I.S.P.***

**KST.**

***Lubrizol***



## Contributing members



**Hardware-  
supplier**

**DAIMLER**

# The New CEC OM646LA Engine Wear Test



**Thank you for your attention !**

