

**WELCOME**

# Interchange Guidelines and Tests for ACEA Performance Automotive Engine Oils

**Lubricants 2021**

Zakopane, 18-20 October 2021

## Speaker introduction



Piotr Niemiec

- LOTOS Oil, Poland
- Coordinator, Technology Dept.
- Member of the ATIEL Board of Directors
- 15-year career in the Lubricants Industry

## Today's session - what we will cover

**01**

Insights into API and European approaches to interchange guidelines and tests

What are the options for running European interchange projects?

**02**

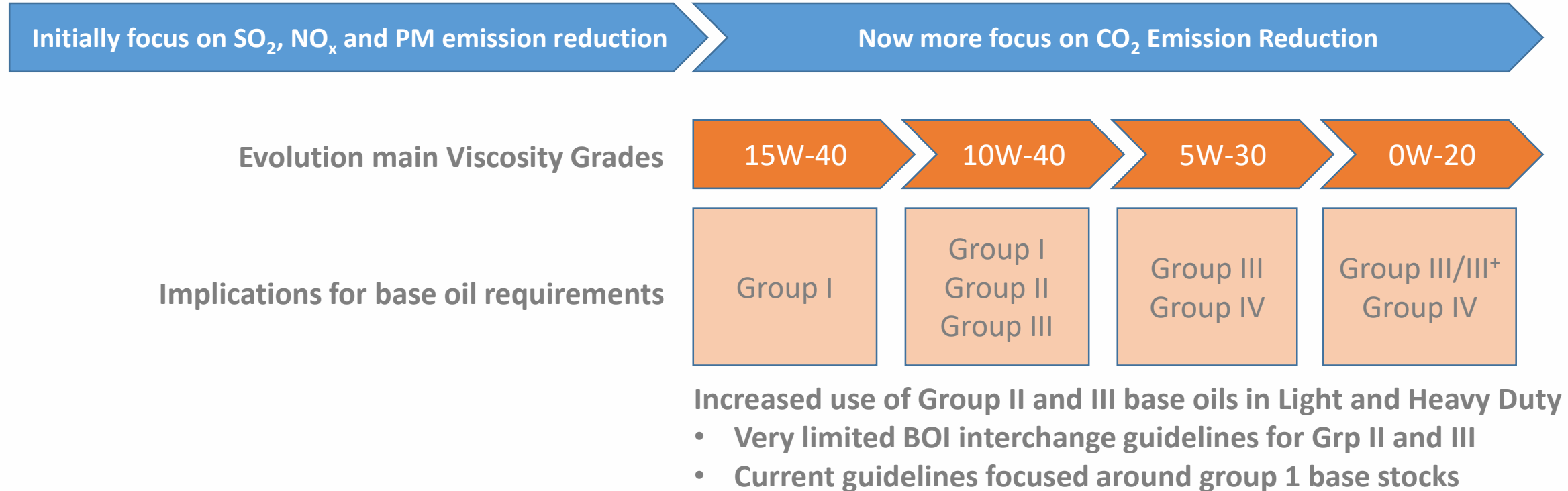
**03**

Hear a case study as well as views on industry hurdles and future initiatives

The background of the slide is a composite image. The top portion shows a close-up of several orange and yellow spherical objects, possibly oil droplets or balloons, with a bright light reflecting off one of them. The bottom portion shows a white plastic bottle pouring a thick, golden-yellow liquid, likely motor oil, which is captured in mid-pour, creating a dynamic splash. The text 'Evolution of European (ACEA) Specification' is overlaid on the white background between these two images.

# **Evolution of European (ACEA) Specification**

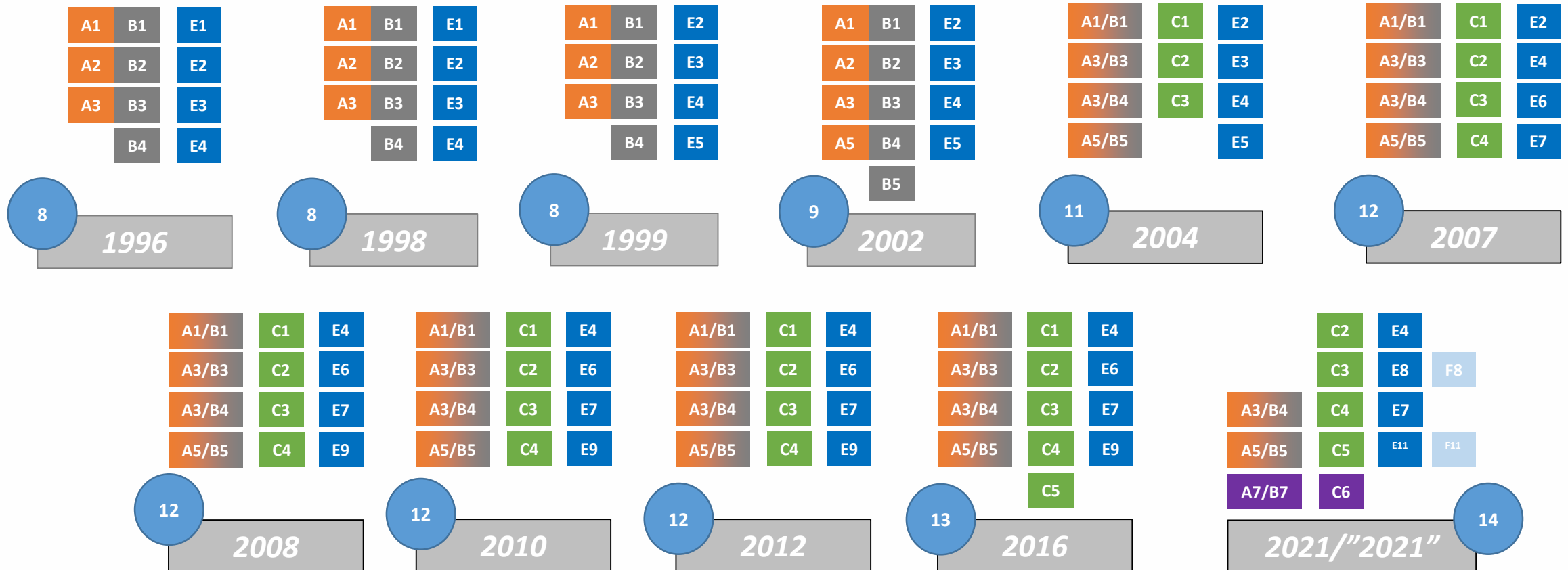
# Engine Oil Specifications driven by Emission Legislation



*Interchange Guidelines did not hold pace with specification evolution*

# The Complexity Challenge

*From 8 to 14 Categories*



*Interchange Guidelines help to manage increasing complexity*

# New Engine Tests Add Complexity

*For the first time, ACEA 2021 has separated the Light Duty and Heavy Duty Oil Sequences to allow a more flexible approach to updating the specifications*

*New engine tests in Light Duty ACEA 2021 Sequences*

- JASO FE M366 (Toyota 2ZR-FXE)
- CEC L-114-19 (Toyota 1KD-FTV) **CEC**
- CEC L-117-20 (VW TDI 3) **CEC**
- Seq IVB Wear 
- Seq. IX LSPI 
- Seq. X Chain Wear 

- For new **CEC** Tests no VGRA/BOI interchange guidelines available
- For  tests the North American (API) Interchange guidelines are applied



# LD ACEA 2021 Engine Tests

ACEA	ACEA 2021 EUROPEAN OIL SEQUENCES FOR LIGHT-DUTY ENGINE SERVICE-FILL OILS						April 2021 Rev. 0	
This sequence defines the minimum quality level of a product for self-certification to EELQMS and for presentation to ACEA members. Individual member companies may indicate performance parameters other than those covered by the tests shown or more stringent limits.								
REQUIREMENT	TEST METHOD	PROPERTIES	UNIT	LIMITS				
				C2-21	C3-21	C4-21	C5-21	C6-21
2. ENGINE TESTS								
2.1* Gasoline DI Engine Cleanliness	CEC L-111-16 (EP6CDT)	Piston Cleanliness	Merit	≥ RL259				
		Turbo Charger Deposits **, average value of zones C, D, E & F	Merit	≥ 6.0				
2.2* Low Temperature Sludge	ASTM D8256 (Sequence VH)	Average Engine Sludge	Merit	≥ 7.6				
		Rocker Cover Sludge	Merit	≥ 7.7				
		Average Engine Varnish	Merit	≥ 8.6				
		Average Piston Skirt Varnish	Merit	≥ 7.6				
		Compression Ring (hot stuck)	None	Report				
2.3* Valvetrain Wear	ASTM D8350 (Sequence IVB, Toyota 2NR-FE)	Average Intake Lifter Volume Loss (8 position average)	mm <sup>3</sup>	≤ 3.3			≤ 2.7	
		End of Test Iron	ppm	≤ 400			≤ 400	
2.4* Black Sludge	CEC L-107-19 (M271 EVO)	Engine Sludge, average	Merit	≥ 8.3				
2.5 Fuel Economy	CEC L-54-96 (M111)	Fuel Economy Improvement	%	≥ 2.5	≥ 1.0 (for xW-30 only, no limit for xW-40)		≥ 3.0	-----
	JASO FE M366 (Toyota 2ZR-FXE)	Fuel Economy Improvement	%	-----				≥ 0.0
2.6* DI Diesel Oil Dispersion at Medium Temperature	CEC L-106-14 (DV6C)	Absolute Viscosity Increase at 100 °C and 5.5% Soot	mm <sup>2</sup> /s	≤ 0.9 x RL248				
		Piston Cleanliness **	Merit	≥ 2.5				
2.7* DI Diesel piston Cleanliness & Ring Sticking	CEC L-117-20 (VW TDI)	Piston Cleanliness	Merit	≥ RL276 - 5				
		Cylinder-spreading limit**	Merit	≤ 13				
		No Ring Sticking, max for any ring**	ASF	0				
2.8 Turbocharger Compressor Deposit (Diesel)	CEC L-114-19 (Toyota 1KD-FTV)	Turbocharger rating	Merit	-----			≥ 25	
2.9 Low Speed Pre-Ignition GDI Turbo	ASTM D8291 (Sequence IX, Ford)	Pre-Ignition events	Average number of events for 4 iterations	-----			≤ 5	
			Number of events per iteration	-----			≤ 8	
2.10 Chain Wear GDI	ASTM D8279 (Sequence X, Ford)	Elongation of Timing Chain	%	-----			≤ 0.085	

Source: <https://www.acea.auto/publication/acea-oil-sequences-2021/>

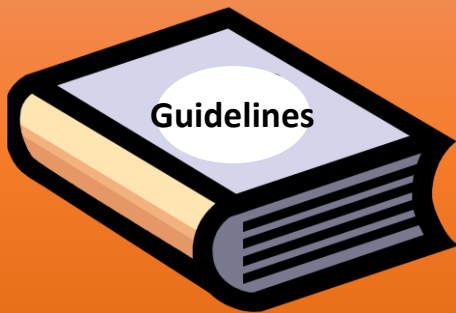


# The Industry Response



## Complexity Increase

- Number of ACEA categories increased from 8 to 14
- New and more engine tests in ACEA Sequence for which there are no interchange guidelines
- Changing viscosity grades
- New and more base oils appearing on the market



## Interchange Guidelines

- Viscosity Grade Read Across and base oil interchange can contribute to managing the increased complexity and reduce engine oil development costs, while continuing to assure final product performance.
- ATIEL and ATC joined forces to move the development of read across guidelines for (new) CEC tests forward.

A background image showing a stream of water being poured from a white plastic bottle on the left side. The water is captured in motion, creating a dynamic splash and ripples as it falls. The overall tone is light and fresh.

# **NA vs European Approach**

# Differences between API and ACEA systems



## Engine Oil Licensing & Certification System (EOLCS)

- One organisation (API) representing OEMs, Oil and Additives industries
- API develops and owns lubricant classifications
- Enabled development of licensing system
- Logo and policing system
- Fee-based licensing
- Licensing ('Donut') still voluntary



## Voluntary code

- Different organisations representing OEMs, Oil and Additives industries
- ACEA owns Oil Sequences, but chooses not to license
- Not legally possible for ATIEL to license/police against the Oil Sequences
- Voluntary code, with signatory system (Letter of Conformance) - required by ACEA to make performance claims

## Differences between API and ACEA systems (Cont'd)



Read Across Guideline development embedded in test development

- Viscosity Grade Read Across and Base Oil Interchange Guidelines are developed as integral part of new test development.
- Read across guidelines available at start of new category.
- Funding:
  - Light Duty OEMs, ILSAC members
  - Heavy Duty OEMs, EMA members
  - Additive companies, ACC members
  - Oil marketers, API members.



Read Across Guideline Development separated from test development

- Viscosity Grade read Across and Base Oil Interchange Guidelines are responsibility of ATIEL
- No read across guidelines available at start of new tests.
- Funding:
  - Oil Marketers, ATIEL members
  - Additive companies, ATC Members

# **The EP6 VGRA Programme**

**First European Industry  
Read Across Test Program**

# Interchange Guideline development in Europe

## First ACEA Sequences

Interchange Guidelines based on agreed technical principles and combined engine test data of ATIEL members

**After  
1996**

## ATC/ATIEL

ATIEL and ATC workgroup to progress development of interchange guidelines.

**2015**



## EP6 VGRA

ATC/ATIEL established funding mechanism to run a statistically designed full E6 engine VGRA test programme.

**2018**



## Grandfathering

Interchange guidelines since then primarily based on "grandfathering" as most tests were evolution of existing tests.



**2012**

## TU5 VGRA + BOI

ATIEL and ATC cooperation resulted in VGRA and BOI interchange rule based on collective data from ATC/ATIEL members and a full statistical evaluation.



**2016**

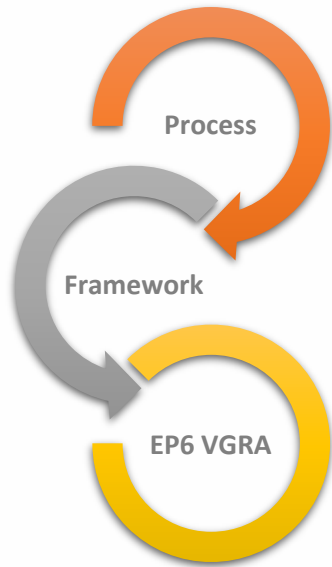
## EP6 completed

50/50 funded ATIEL and ATC sponsored test programme was completed resulting in a new VGRA guideline for the EP6 test engine to be published in ATIEL CoP in 2019



**1996**

# EP6 Engine Test Development - joint ATIEL/ATC Initiative



Prior to 2016, there was **no process in place** to develop read-across guidelines for new engine tests

ATIEL/ATC developed a **framework for read-across guideline development**, with plans to apply this framework to the new ACEA 2016 engine tests

Agreement was reached to proceed with **EP6 VGRA** as the first read-across guideline development programme

## EP6 VGRA Working Group Objectives

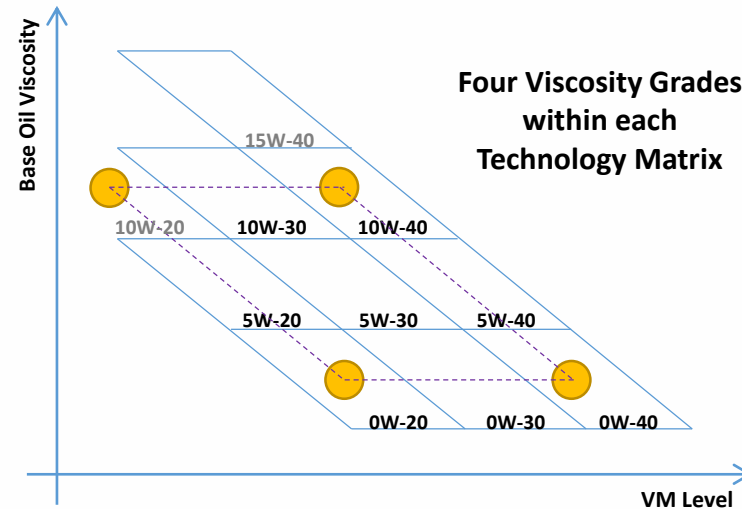
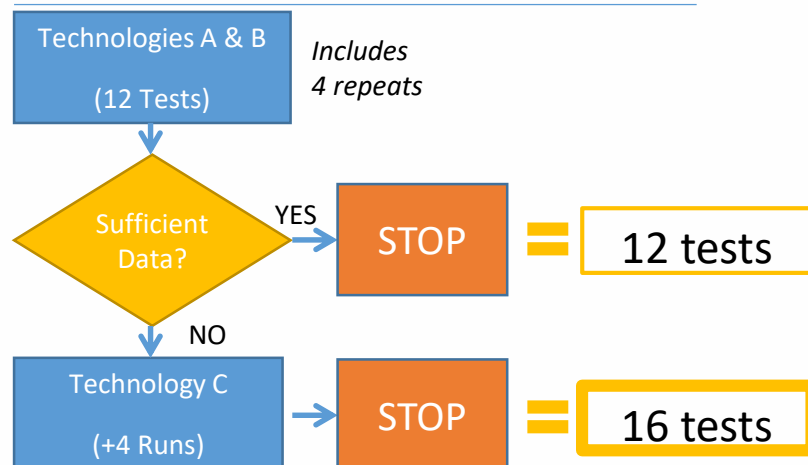
- **Develop & validate EP6 VGRA guidelines for the ATIEL Code of Practice.**
  - Plan and run a statistically designed experiment in the EP6, exploring the effect of base oil viscosity and viscosity modifier treatment on test performance.
  - Interpret results and recommend VGRA guidelines for incorporation into the ATIEL Code of Practice.



# Test Matrix Design

- Viscosity Grade coverage from **0W-20** to **10W-40**
  - Maximises change in base oil viscosity and VM Level to achieve high statically power to identify effects above the noise of the test
- **Three technologies**, across three suppliers
  - Maximises opportunity to identify unexpected effects and interactions,.
- BOI is **not** being considered – base stock slate will be consistent within each Technology

## EP6 Test Order



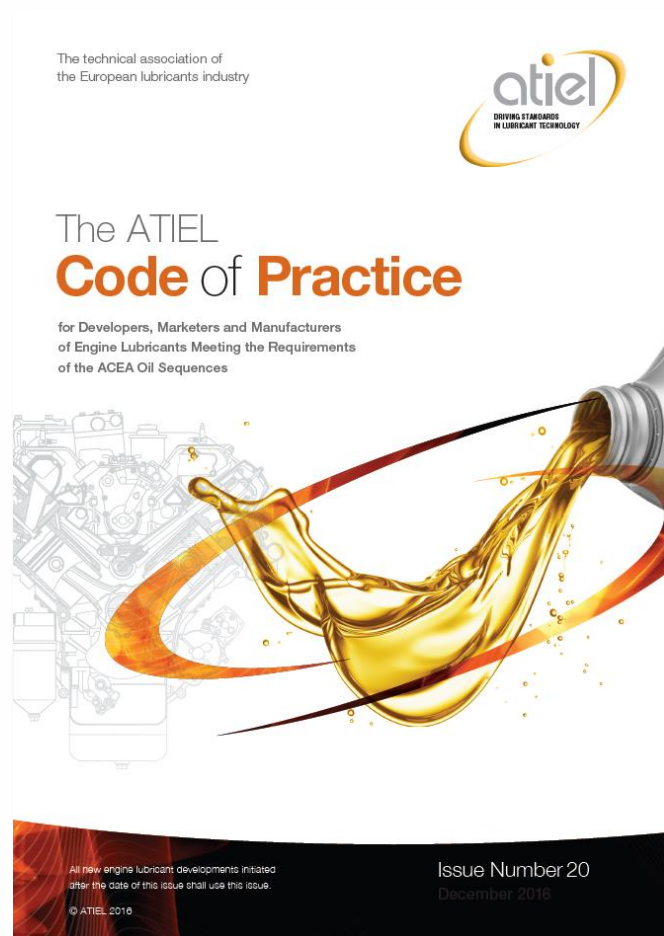
## Technology C will only be required if:

- Analysis of the first two technologies gives neutral results
- Initial conclusions conflict with technical judgement and experience
- Results demonstrate strong interactions and read-across cannot be permitted

Program costs ~ € 1 million for 16 tests

# Format of the Current EP6 VGRA Guideline

Issue 20, Appendix A, December 2016



**Table VGRA.5 VGRA guidelines for the VW TDI or OM646LA Bio or EP6CDT engine test**  
(Applicable only to engine lubricant with **non-dispersant type of viscosity modifier**)

Test run on	Can be read-across to														
	0W-20	0W-30	0W-40	5W-20	5W-30	5W-40	5W-50	10W-30	10W-40	10W-50	10W-60	15W-40	15W-50	20W-40	20W-50
0W-20		no	no	yes if (7)	yes if (7)	no	no	yes if (7)	yes if (7)	no	no	yes if (7)	yes if (7)	yes if (7)	yes if (7)
0W-30	yes if (7)		no	yes if (7)	yes if (7)	yes if (7)	no	yes if (7)	yes if (7)	yes if (7)	no	yes if (7)	yes if (7)	yes if (7)	yes if (7)
0W-40	yes if (7)	yes if (7)		yes if (7)	yes if (7)	yes if (7)	yes if (7)	yes if (7)	yes if (7)	yes if (7)	yes if (7)	yes if (7)	yes if (7)	yes if (7)	yes if (7)
5W-20	no	no	no		no	no	no	yes if (7)	no	no	no	yes if (7)	no	yes if (7)	yes if (7)
5W-30	yes if (7)	no	no	yes if (7)		no	no	yes if (7)	yes if (7)	no	no	yes if (7)	yes if (7)	yes if (7)	yes if (7)
5W-40	yes if (7)	yes if (7)	no	yes if (7)	yes if (7)		no	yes if (7)	yes if (7)	yes if (7)	no	yes if (7)	yes if (7)	yes if (7)	yes if (7)
5W-50	yes if (7)	yes if (7)	yes if (7)	yes if (7)	yes if (7)	yes if (7)		yes if (7)	yes if (7)	yes if (7)	yes if (7)	yes if (7)	yes if (7)	yes if (7)	yes if (7)
10W-30	no	no	no	yes if (7)	no	no	no		no	no	no	yes if (7)	no	yes if (7)	yes if (7)
10W-40	yes if (7)	no	no	yes if (7)	yes if (7)	no	no	yes if (7)		no	no	yes if (7)	yes if (7)	yes if (7)	yes if (7)
10W-50	yes if (7)	no	no	yes if (7)	yes if (7)	yes if (7)	no	yes if (7)	yes if (7)		no	yes if (7)	yes if (7)	yes if (7)	yes if (7)
10W-60	yes if (7)	yes if (7)	yes if (7)	yes if (7)	yes if (7)	yes if (7)	yes if (7)	yes if (7)	yes if (7)	yes if (7)		yes if (7)	yes if (7)	yes if (7)	yes if (7)
15W-40	no	no	no	yes if (7)	no	no	no	yes if (7)	no	no	no		no	yes if (7)	yes if (7)
15W-50	no	no	no	yes if (7)	yes if (7)	no	no	yes if (7)	yes if (7)	no	no	yes if (7)		yes if (7)	yes if (7)
20W-40	no	no	no	no	no	no	no	no	no	no	no	no	no		no
20W-50	no	no	no	yes if (7)	no	no	no	yes if (7)	no	no	no	yes if (7)	no	yes if (7)	

(\*) Yes, VGRA is permitted if the **viscosity modifier concentration increase** in the read-across viscosity grade vs the tested viscosity grade is **less than 15% mass fraction relative**.

If the viscosity modifier concentration increase is larger than 15% mass fraction relative, VGRA can be permitted if **technical support data** as defined in Section h.15 of the ATC Code of Practice<sup>1</sup> is available to justify read-across.

# The new VGRA Guideline for the EP6CDT test provides more flexibility



VGRA is permitted if the viscosity modifier concentration is decreased, or if the increase in the read-across viscosity grade vs the tested viscosity grade is less than 15% mass fraction relative.



This VGRA guideline is the result of a statistically designed matrix of EP6 test oils run by ATIEL and ATC in a diverse range of technologies.



If the viscosity modifier concentration increase is larger than 15% mass fraction relative, VGRA can be permitted if technical support data as defined in Section h.15 of the ATC Code of Practice is available to justify read-across.

# VGRA Guideline for the EP6CDT - Example

## Question:

An EP6 test has been run and passed on a 5W-30 engine oil with a non-dispersant viscosity modifier treat-rate of 8%.

As part of the test programme, is it possible to use this test result to support a 0W-20 engine oil, where the only changes are a reduction in viscosity modifier treat-rate to 6% and a rebalance of the base oil blend?

## Answer:

Yes, it is allowed

## Explanation:

In Guideline A.1 for the EP6CDT engine test, VGRA is permitted if the viscosity modifier treat-rate is decreased. No restrictions are placed upon the rebalance of the base oil blend.

# **Future Programs**

**Viscosity Grade Read Across**



# Next VGRA Programm Selection Criteria

Factors considered in the process of selecting VGRA programs:

**Are VGRA  
Guidelines  
available today ?**

**Expected in ACEA  
Heavy Duty  
Categories ?**

**Expected  
Lifetime of  
tests ?**

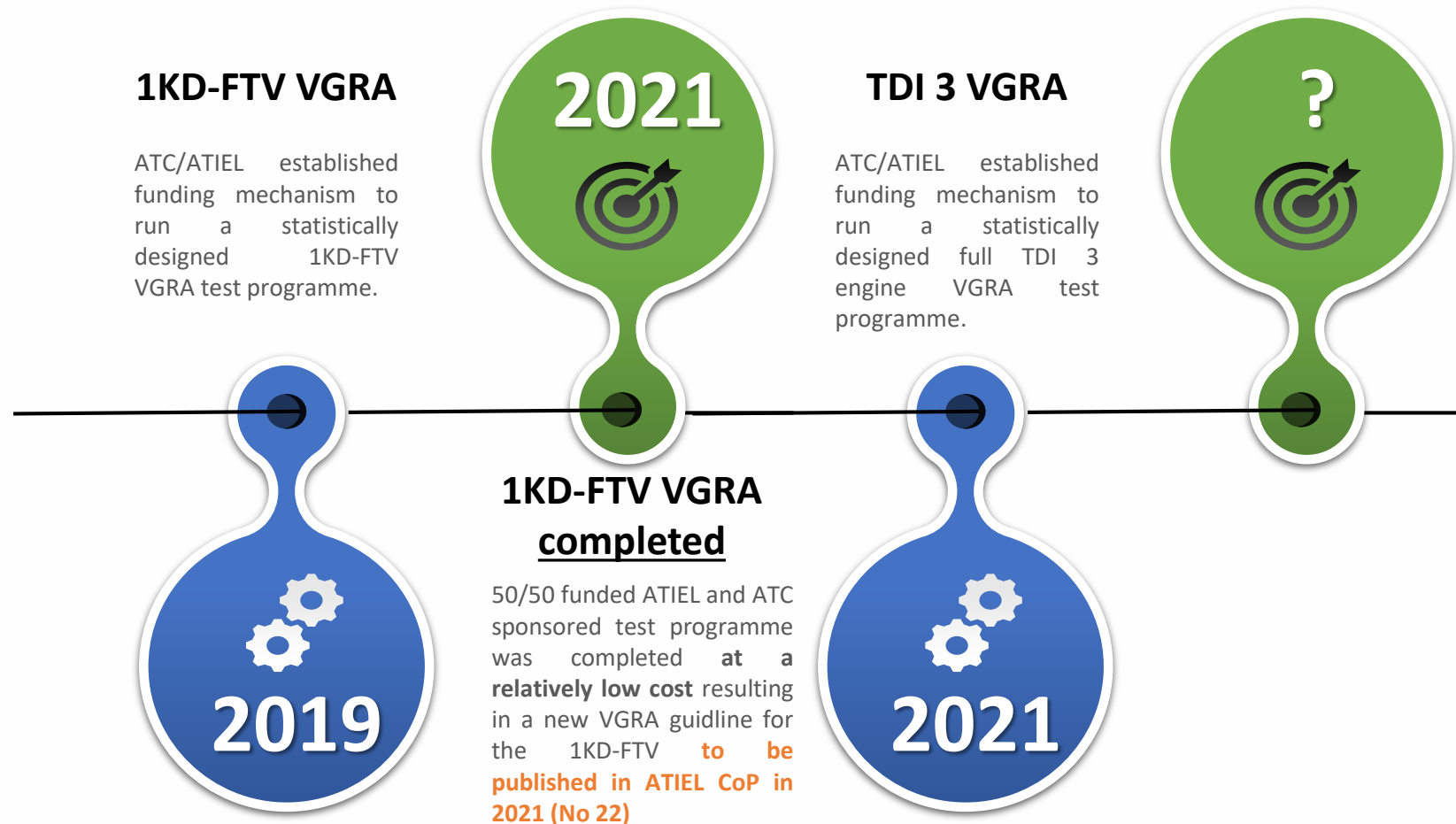
**Expected in  
ACEA Light Duty  
Categories ?**

**Test Costs per  
run ?**

**Duration of test?**



# Status of Next VGRA Programmes





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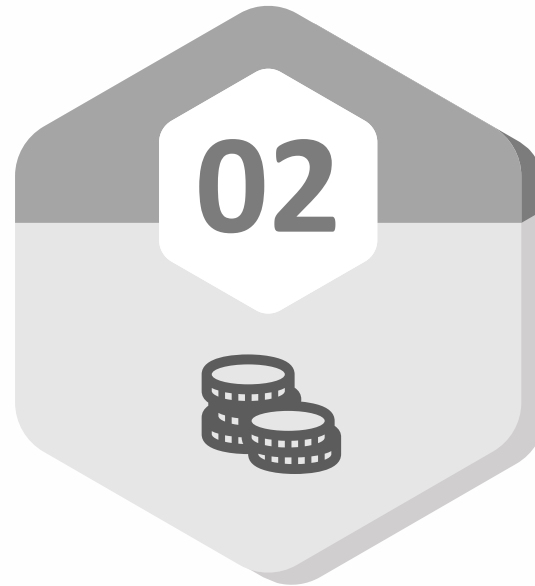
# **Industry Challenges**

# Main Industry Challenges



## Alignment

Industry alignment within and across organisations (ATC and ATIEL)



## Cost

- Especially Base Oil Interchange Programs require significant level of funding
- Currently only PCMO
- HDDO will be even more expensive



## Funding

- Funding mechanism
- How to distribute costs amongst beneficiaries ?



## Test Engines

Availability of test engines

## Main Industry Challenges

- It is ATIEL's position that ultimately the best option is to include VGRA and/or BOI in the CEC test development phase (similar to API approach)
  - Most cost effective overall solution
  - Possibly delays engine test development
- This will require further industry alignment and funding



ATIEL is committed to progress the development of interchange guidelines for the benefit of its members and the industry

# Thank you!

For more information visit:

[www.atiel.org](http://www.atiel.org)  
[www.eelqms.eu](http://www.eelqms.eu)

Contact us at: [info@atiel.eu](mailto:info@atiel.eu)

# BACK UP SLIDES

# EP6 VGRA Program. Test Samples Selection

	"Technology"	1	2	5	6	7
Supplier	Coded	OS-B	OS-N	OS-T	OS-L	OS-C
Formulation						
Estimated SAPS Performance level (ACEA-16)	Disclosed	Mid SAPS	Full SAPS	Mid SAPS	Mid SAPS	Mid SAPS
<u>Group III Base Stock</u>						
Base Stock Manufacturer	Coded	BS-J	BS-J	BS-J	BS-Q	BS-J
Base Stock Slate Name	Coded	BS-JF	BS-JF	BS-JF	BS-QA	BS-JF
<u>Additive Package</u>						
Additive Package Supplier	Coded	AP-H	AP-K	AP-R	AP-K	AP-K
Additive Package Name	Coded	AP-HR	AP-KF	AP-RA	AP-KN	AP-KH
<u>Viscosity Modifier</u>						
Viscosity Modifier Supplier	Coded	VM-D	VM-P	VM-E	VM-P	VM-A
Viscosity Modifier Name	Coded	VM-DQ	VM-PW	VM-EF	VM-PX	VM-AK
Viscosity Modifier Chemical Type	Disclosed	SD	SD	OCP	SD	PMA
Pour Point Depressant Name	Coded	PP-A	PP-Y	PP-K	PP-J	PP-B
			Initial Matrix		Backup	