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# Principles for establishing base stock interchange guidelines

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# Interchange extends back to the beginning of engine oil licensing

- Formal guidance established in early 1990's
- Practical flexibility for oil qualification without compromising system integrity
- API base stock grouping: a framework for establishing interchange guidance

The American Petroleum Institute Engine Oil  
Licensing & Certification System

FINAL DRAFT  
APRIL 20, 1992

All base stocks are divided into three general categories as follows:  
**Base Stock Categories**

GROUP I

< 90% saturates, and/or > 0.03% sulfur, and  $\geq 80$  viscosity index using analytical test methods defined in requirement IV.

GROUP II

$\geq 90\%$  saturates, and  $\leq 0.03\%$  sulfur, and  $\geq 80$  viscosity index using the methods of requirement IV.

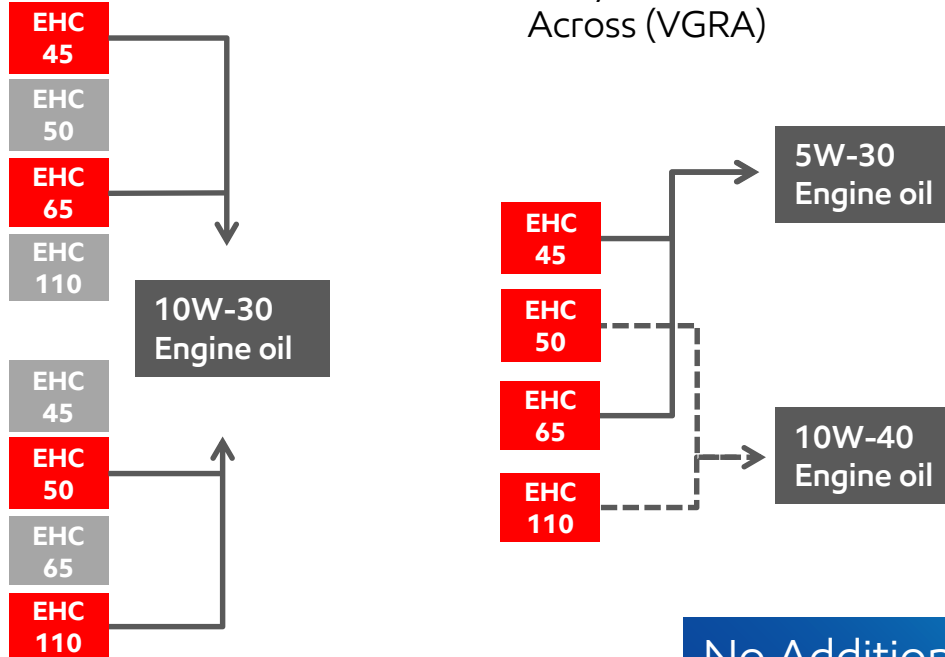
GROUP III

All other base stocks, including synthetics, not covered in Group I or II.

# Two basic types of base stock interchange

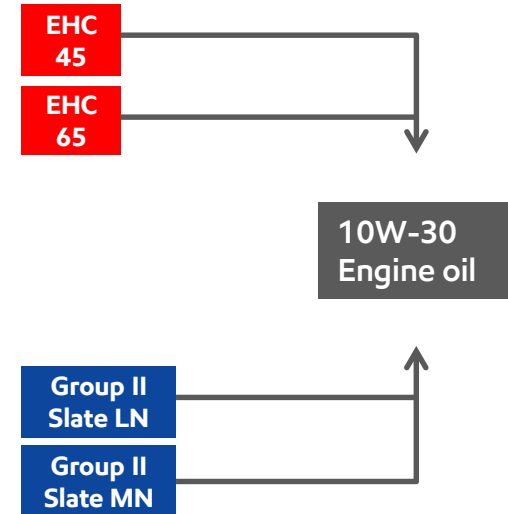
## Within a Base Stock Slate

Viscosity Grade Read-Across (VGRA)



## Between Base Stock Slates

Base Oil Interchange (BOI)



No Additional Engine Testing Required

# The concept of a slate underpins interchange

- Supports industry wide product integrity
- Single manufacturer responsible for:
  - Ensuring consistent base stock quality
  - Demonstrating interchangeability of base stocks within a slate

## API 1509 E.1.2.2

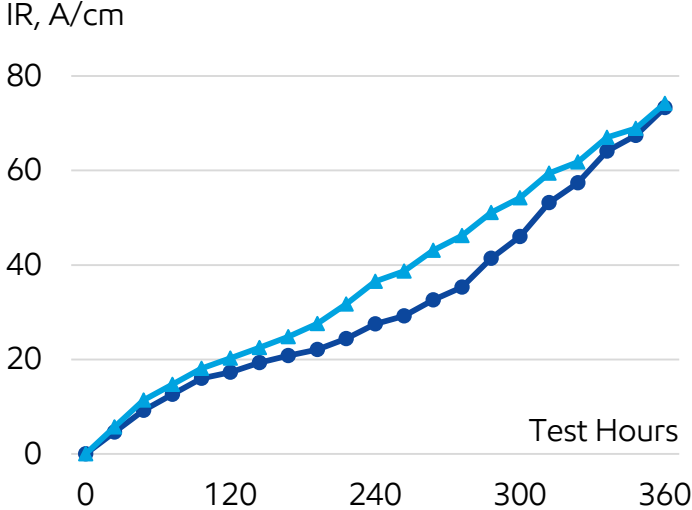
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A **base stock slate** is a product line of base stocks that:

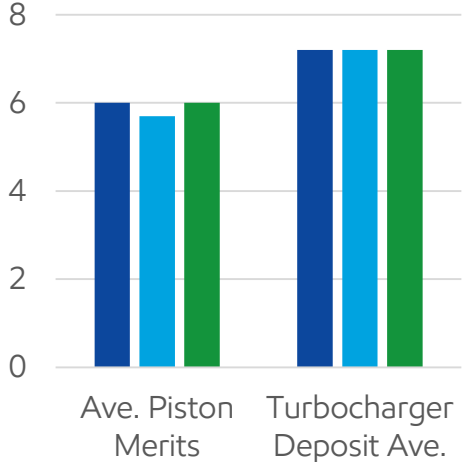
- Have different viscosities
- Are in the same base stock grouping
- Are produced by the same manufacturer
- Are technically substitutable (implied by examples)

# Substantiating a slate definition

Volvo T-13 Test  
*Prototype CK-4 Technology*



EP6CDT  
*ACEA A3/B4-16, MB 229.1 Technology*



■ EHC North America    
 ■ EHC Asia Pacific    
 ■ 2019 EHC Europe & Asia (Pre-prod)



# Base stock interchange principles

Clear  
framework



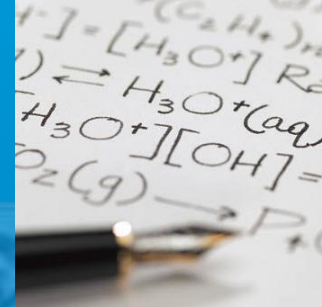
Consistently  
applied



Data  
driven



Science  
based



# Clear framework, consistently applied

Read guidance should apply for all time, for all base stock slates and all additive technologies

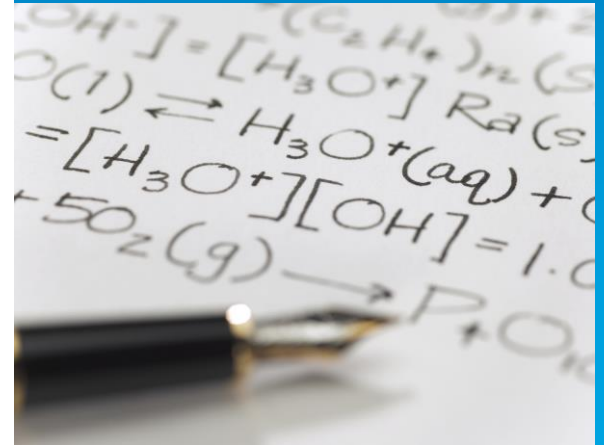
- Risk-based assessment; data reduces, but does not eliminate risk
- Not possible to test all base stock slate/additive technology combinations
- API practice evaluates reads in 3 additive technologies





# Data driven and science based

- To deliver maximum value to the industry, base stock interchange should be evaluated just after test development
  - Integrated with or leveraging the precision matrix is a best practice
- Data to support interchange reads should be generated in a transparent environment
  - Recent practice to fund interchange evaluation tests collaboratively



# Performance testing is necessary

## **ATIEL Code of Practice, Issue 19, Section B.1.4:**

*“The physical and chemical characteristics of base stocks influence their lubrication performance. However, it has not yet proved possible to predict fully the base stock characteristics for a particular engine lubricant application. Practical measurements in engine tests remain the only reliable means of validating the performance of engine lubricants.”*

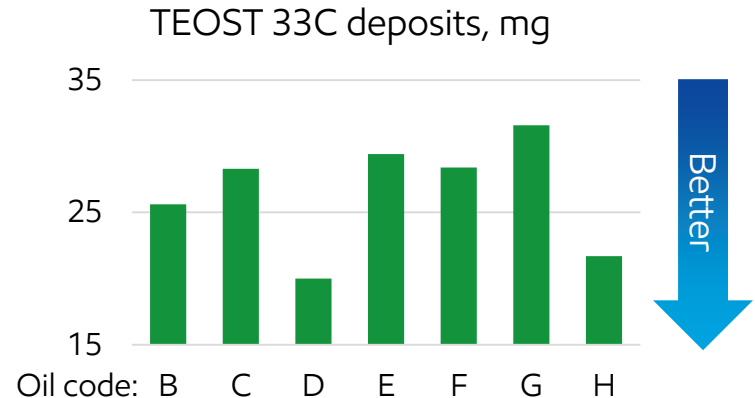
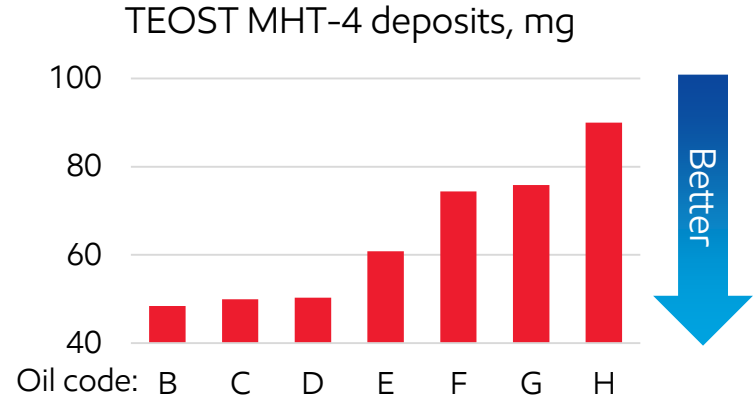
### Predictability challenges

- Evolving performance standards, involving multiple tests
- Insufficiently precise analytical characterization methods
- Test variability

# Performance prediction is challenging

- 100% Group III base oils
- Formulated with GF-4 technology
- Tests differ in duration and temperature

Only a small fraction of the oil contributes to deposits



# Potential consequences

Inconsistent application of guidelines can result in:

- Oils in the marketplace which do not meet the performance specification
- Competitive imbalance from:
  - Additional testing
  - Additive uptreat



# A practical case: real guidance not universally accepted

Table F-3—"Read-Across" for Sequence III E Test

Test Run on	Can Be "Read Across" to											
	5W-30	10W	10W-30	10W-40	15W-40	15W-50	20W	20W-40	20W-50	30	40	50
5W-30	—	X	X	X	X	X	X	X	X	X	X	X
10W		—					X			X	X	X
10W-30		X	—	X	X	X	X	X	X	X	X	X
10W-40		X	X	—	X	X	X	X	X	X	X	X
15W-40		X	X	X	—	X	X	X	X	X	X	X
15W-50		X	X	X	X	—	X	X	X	X	X	X
20W							—			X	X	X
20W-40					X	X	X	—	X	X	X	X
20W-50					X	X	X	X	—	X	X	X
30							X			—	X	X
40										X	—	X
50												—

Note: An X means that read-across is permitted; a blank means that read-across is not permitted. This table originally became effective January 1, 1991, and was revised April 27, 1992.

# API practices (PC-11 and GF-6)

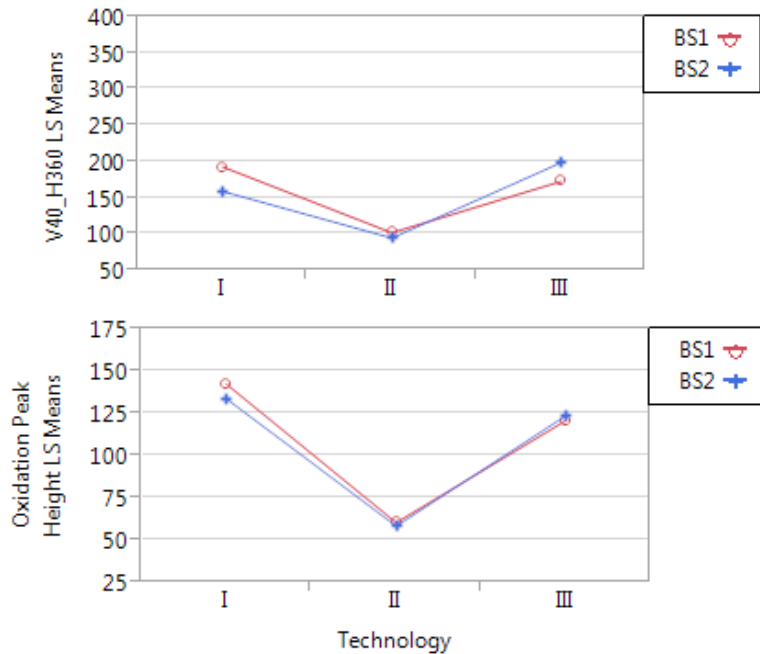
- Experimental designs tailored to evaluate desired interchange reads
- Statistically-designed experiments offer highest confidence in oil discrimination at a given cost
- Pairwise comparison data easy to visualize for less complex reads
- Leveraging precision matrix data increases the degree of confidence for establishing interchange guidelines





# Example Group II BOI matrix analysis – Volvo T-13

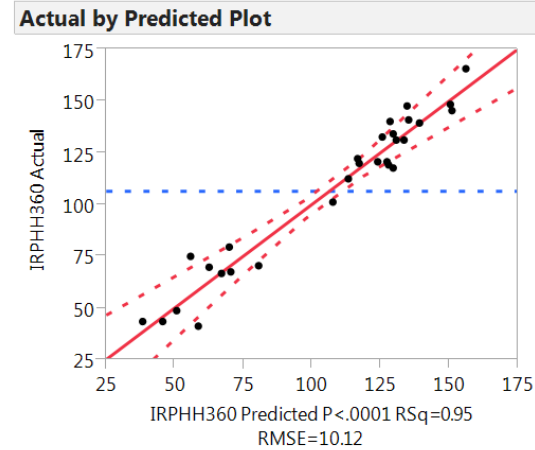
Visual comparison supports negligible impact of base stock slate



Source: Infineum presentation to API BOI/VGRA Task Force, Jan., 2015



Statistical model confirmed visual interpretation



## Parameter Estimates

	Estimate	Prob >  t  <sup>(1)</sup>
Intercept	-148929	0.0045
Base Stock Slate	1.2845	0.5257
Technology 1	31.0517	< 0.001
Technology 2	-48.5984	< 0.001
Serial Date	73.9676	0.0045

(1) Prob < 0.05 statistically significant within 95% confidence

Source: ExxonMobil presentation to API BOI/VGRA Task Force, Feb., 2015

# Key takeaways

- Base stock interchange (BOI and VGRA) is beneficial to the industry and necessary for category delivery timing and cost-efficient oil qualification
- Guidelines should be supported by data generated in the test for which interchange is being developed
- Technical judgment is an important component of data analysis, but does not supplant the need for data
- Data-based interchange guidelines support balanced competition
- Use of interchange guidelines is a risk-based decision; marketers of API licensed oils are not absolved of responsibility for ensuring performance requirements are met (API 1509 Section 4.12)

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