



Sequence VID Precision & BOI/VGRA Matrix Oil

Matrix Base Oil Status

Base Oil Status

- **Base Oil IIA**
 - Base Oil Supply Issues Resolved
 - Supply Drums In Process
- **Base Oil IIB**
 - Base Oil Supply Issues Resolved
 - Drums Shipped
- **Base Stock IIIA**
 - 5 USG Samples Shipped
 - Drums Shipping
- **Base Stock IIIB**
 - Drums Shipped



Sequence VID Precision & BOI/VGRA Matrix Oil

Recommendation Process
Matrix Oil Combinations and
Potential Reference Oil Selection

Organizations involved in Developing Seq.VID Precision & BOI/VGRA Matrix

- ASTM
 - PCEOCP
 - Matrix Design Task Force
- ACC
 - PAPTG
 - Precision Matrix
 - BOI/VGRA Matrix
- API
 - BOI/VGRA Task Force
 - Precision & BOI/VGRA Matrix
 - Base Oil Selection
- ILSAC
 - Chooses Matrix Oil Technologies

API BOI/VGRA Task Force

Initial MDF Request

- BOI/VGRA Task Force Support
 - Defined Precision & BOI/VGRA Matrix
 - In Cooperation with PAPTG
 - Defined Base Oil Properties
 - Data Support to Establish Read Across
 - Selected Seq. VID Base Oils
 - Representative of Commercial Oils in the Market
- BOI/VGRA Task Force Acted on PCEOCP/MDF Request for Support



Sequence VID Test Matrix Precision & BOI/VGRA

**Precision & BOI/VGRA
Matrix Process**

Combined Precision/BOI/VGRA Matrix Design – Step 1

Stand 1	Stand 2	Stand 3	Stand 4
A	B	C	D
E	F	G	H
I	J	K	L
M	N	O	P
Q	R	S	T
X	X	X	X
A	A	C	C
D	B	B	D

- Two independent labs / 2 stands each
- Oils A-T & X are the 21 Oils from the BOI/VGRA Test Oil Matrix
- Oil X part of the BOI-VGRA matrix and is run on all 4 stands
- **Oils A-D & X will be pre-selected to represent all 5 viscosity grades**
- Run order to be established
- Provides Data for:
 - Establishing BOI/VGRA, within stand & stand to stand comparisons, Lab to Lab comparisons

Combined Precision/BOI/VGRA Matrix Design – Step 2

Stand 1	Stand 2	Stand 3	Stand 4
R1	R2	R1	R2
R2	R1	R2	R1
R3	R3	R3	R3

- ▲ To enhance the statistics, 3 of the 5 oils A, B, C, D, & X will be tested 4 more times. This gives a minimum of 7 runs on the 3 selected oils.
- ▲ The 3 oils are being called R1, R2 and R3 for Step 2.
 - ▲ R1, R2 & R3 will represent 0W, 5W, & 10W-30 in order to give better discrimination for VGRA.
 - ▲ One or more of these 3 oils will likely be selected as Sequence VID calibration/reference oil(s).
- ▲ These additional runs are required to establish future reference oil identity, reference oil means, & reference oil standard deviations. Run order to be established.
- ▲ Additional reference oil data will come from non-matrix lab/stand calibration runs. (Supplemental data from additional labs & stands deemed ready by ASTM will be included in development of the precision statement unless identified and confirmed as a statistical outlier by the industry statistician team, assuming the last test of part of the data submission has started by the end of step 2.)



Sequence VID Test Matrix Precision & BOI/VGRA

Base Oil Properties

BOI/VGRA Requirements

- **Currently commercially available in North America, Korea and/or Japan**
- **Two Different Group III base oil slates**
- **Two Different Group II base oil slates**
- **No mixed slates of Group II and Group III**
- **At least one Group III Base Oil Slate must be able to make all 5 viscosity grades**
- **Other Group III and the Group II base oil slates must be able to make the SAE viscosity grade 0W-20, 5W-20, 0W-30, 5W-30, 10W-30**
- **All base oils must be capable of being blend to formulate a PCMC meeting ILSAC GF-4**
- **Low Sulfur 0.5% except 0.7% for 10W-30.**
- **Volatility 15% Noack**



Sequence VID Test Matrix Precision & BOI/VGRA

**Base Oil Selection
Logic and Reasoning**

Submitted Base Oil Slates

- Group II Base Oil
 - 2 Group II Base Oil Slates Nominated
- Group III Base Oil Slate
 - 4 Group III Base Oil Slates Nominated

Base Oil Selection Logic and Reasoning

- Group II Selection
 - Only 2 Group II Base Oils were offered and both were accepted.
- Group III Selection
 - For Oil IIIA use Base Oil 5
 - 8 cSt in Slate which shows ability to make 10W-30 with a typical viscometrics
 - Recommend only cSt 4+ be used in the blends and cSt 4+ will meet the requirement to blend all viscosity grades in all technologies.
 - VI of the slate is typical of Group III base oils used for GF-4
 - Consensus is there is no obvious back-up to Oil 5

Oils Not Selected to be IIIA

- Oil 1
 - VI appears too high on 6 cSt to make a typical 10W-30
 - No 8cSt oil (heavier oil) offered/available
- Oil 2 and Oil 4
 - Concerns about making a 0W-30 in a wide range of technologies.
- Oil 3
 - VI of the slate is atypical of the VI level used in GF-4 oils

Selection of IIB Oil

- Group III Oils #1 and Oil #3 are not chosen because
 - Highest VI oils are not broadly available in the market place. When available we may revisit the higher VI base oils.
 - We expect a reference oil will be a Group III oil and represent a tie point for expanding BOI in the future.

Selection of IIIB

- First Choice is Oil #4
 - Slightly lower viscosity spec range should make it easier to blend 0W oils than Oil #2
- Second Choice is Oil #2
 - Close to Oil #4

API BOI/VGRA Task Force

Additional Requests of BOI/VGRA TF

- ASTM MDF Requested BOI/VGRA
 - Set Matrix Test Oil Blend Targets
 - Map Technologies with Base Oils
 - Assign each of the Test Oils a Letter Identifier
 - Oils A-T & X
 - Match Oil A-D & X with Technology and Base Oils
 - Possible Reference Oils
 - Larger Test Oil Blends



Sequence VID Test Matrix Precision & BOI/VGRA

Blending Targets

API BOI/VGRA Task Force

- BOI/VGRA Task Force Blending Target Recommendation
 - After discussion the consensus - Need some leeway is needed for KV 100 and CCS values considering the various base oil and additive technologies to be used.
 - Following table was the consensus Blend Target Recommendation

	Target	Target	Report	Check
Grade	KV 100C, cSt	CCS, cP	HTHS, cP	NOACK
0W-20	8.6 - 8.8	5800 at -35 °C	2.6 min.	15 max.
5W-20	8.6 - 8.8	6200 at -30 °C	2.6 min.	15 max.
0W-30	10.5 - 11.0	5800 at -35 °C	2.9 min.	15 max.
5W-30	10.5 - 11.0	6200 at -30 °C	2.9 min.	15 max.
10W-30	10.5 - 11.0	6600 at -25 °C	2.9 min.	15 max.



Sequence VID Test Matrix Precision & BOI/VGRA

Technology Assignment & Oil Mapping

API BOI/VGRA Task Force

- API Preferred PCEOCP/MDF Action to Match Technologies and Map Oils
- Due to Timeline Delay BOI/VGRA agreed to a Nonbinding Mapping of the Oils

API BOI/VGRA Task Force

- BOI/VGRA Task Force Approach to Mapping Seq. VID Matrix Oil
 - Technologies & Base Oils Considered Equal
 - Secure ILSAC Input on Mapping
 - Assign Oils A-D & X Based on Widest Acceptance
 - Assign Oils E-T on Random Basis

Matrix Oil Mapping Process

- **Assign base oils to Sequence VID matrix oils**
- **Map critical oils A, B, C, D, and X**
 - Possible future reference oils
 - Match up viscosity grade and base oil designation
- **Assign base oils for the other 16 matrix oils**
 - 21 candidates total
 - Oils Assigned at Random
- **Make recommendation for Technology assignments**
 - ILSAC owns this decision
 - BOI/VGRA can offer a starting point

Combined Precision/BOI/VGRA Matrix Design – Base Oils & Viscosity Grades

Vis. Grade	Technology 1	Technology 2	Technology 3	# of Oils
0W-20		IIIA, IIIB	IIIA, IIIB	4
5W-20	IIA, IIIA	IIIA		3
0W-30	IIIA, IIIB		IIIA	3
5W-30	IIA, IIB, IIIA, IIIB	IIA, IIB, IIIA		7
10W-30		IIIA	IIA, IIB, IIIA	4
# of Oils	8	7	6	21

Decision process to get to 5 test oils:

- 1) Use common base oils per grade: 0W as Group III, 5W and 10W as Group II
- 2) Be sure that all 3 technologies are represented in the final reference oil selection
- 3) Tech 3 has the only 10W-30 in Group II (mark oils with a)
- 4) Tech 3 assigned to 0W-20 since 0W-30 and 10W-30 not considered for reference oils
- 5) With Tech 3 already assigned, Tech 1 has the only remaining 0W-30
- 6) Tech 1 has the only 5W-20 in Group II
- 7) Leaves Tech 2 as the 5W-30 since already have a 0W-20 with Tech 3

ILSAC Technology Selections (Information shared at PCEOCP)

Technology Supplier	1	2	3
Vis Grade	5W-20	5W-20	5W-20 / 5W-30
Performance Level	GF-4	GF-4	GF-5
Seq VIB FEI-1	2.36	2.51	2.74 / 2.36
Seq VIB FEI-2	2.07	2.21	2.29 / 1.71

Recommend that ILSAC simply assign the same Technology Supplier Number to the API BOI/VGRA Technology Codes in the mapping table:

Technology 1 is Technology 1

Technology 2 is Technology 2

Technology 3 is Technology 3

Straw Man Proposals Considered

Three Straw Man Proposals

- Afton Straw Man
- Oronite/ConocoPhillips Straw Man
- Lubrizol Straw Man

Discussion Focused on Afton Straw Man
and possible changes

Original Afton Straw Man Proposal

	Technology 1	Technology 2	Technology 3
Technology Supplier	1	2	3
ILSAC Level	GF-4	GF-4	GF-5
0W-20		IIIA=K, IIIB=L	IIIA=Q, IIIB=X
5W-20	IIA=A, IIIA=E	IIIA=M	
0W-30	IIIA=B, IIIB=F		IIIA=R
5W-30	IIA=G, IIB=H, IIIA=I, IIIB=J	IIA=N, IIB=C, IIIA=O	
10W-30		IIIA=P	IIA=S, IIB=D, IIIA=T

Changes to Afton Straw Man

BOI/VGRA Discussion and Changes

- Accept Afton Straw Man with Changes
- Changes Accepted by BOI/VGRA
 - Swapping ILSAC technologies 2 & 3
 - under original matrix technologies 2 & 3
 - Potential GF-5 Oil Tested in 5W-30 Vis Grade
 - Swapping Oils X and L for the SAE 0W-20 grade
 - Potential GF-5 Oil Tested in 0W-20 Vis Grade
- Recommended A Revised Matrix

BOI/VGRA Recommendation

Seq. VID Matrix Oils Letter Assignments

ORIG. MATRIX DESIGNATION	Technology 1	Technology 2	Technology 3
ILSAC Technology Supplier Choice	1	3	2
ILSAC Level	GF-4	GF-5	GF-4
0W-20		IIIA=K, IIIB=X*	IIIA=Q, IIIB=L
5W-20	IIA=A*, IIIA=E	IIIA=M	
0W-30	IIIA=B*, IIIB=F		IIIA=R
5W-30	IIA=G, IIB=H, IIIA=I, IIIB=J	IIA=N, IIB*=C, IIIA=O	
10W-30		IIIA=P	IIA=S, IIB*=D, IIIA=T

*Potential Reference Oil

