

## APPENDIX F—API GUIDELINES FOR SAE VISCOSITY–GRADE ENGINE TESTING

### F.1 General

If oil is eligible for SAE Viscosity-Grade Engine Test Guidelines for PCMOs or diesel engine oils and the sponsoring company desires to waive testing, the sponsoring company shall conform to the registration process, the ACC Code, and the Multiple Test Evaluation Procedure for the required engine tests.

#### F.1.1 SAE VISCOSITY CRITERIA

The SAE viscosity grades constitute a classification for engine lubricating oils in rheological terms only and are intended for use by engine manufacturers in determining the engine oil viscosity grades to be recommended for use in their engines and by oil marketers in formulating and labeling their products.

Two series of viscosity grades are defined in SAE J300: (a) those that contain the letter W and those that do not contain the letter W. Single-viscosity-grade oils (“single-grades”) with the letter W are defined by maximum low-temperature cranking and pumping viscosities and a minimum kinematic viscosity at 100°C. Single grades without the letter W are based on a set of minimum and maximum kinematic viscosities at 100°C and a minimum high-temperature/high-shear measured at 150°C and 1 million reciprocal seconds. Multiple-viscosity-grade oils (“multigrades”) are defined by all of the following criteria:

- a. Maximum low-temperature cranking and pumping viscosities.
- b. A kinematic viscosity at 100°C that falls within the prescribed range of one of the non-W grade classifications.
- c. A minimum high-temperature/high-shear viscosity at 150°C and 1 million reciprocal seconds.

#### F.1.2 VISCOSITY-GRADE READ ACROSS GUIDELINES

In certain situations, data generated from one viscosity grade of a given engine oil formulation may be extrapolated to another viscosity grade that uses the same additive technology by means of a practice commonly referred to as “read-across” (See Tables F-1 through F-13).

These Viscosity-Grade Engine Testing Guidelines can be used to complete a testing program using the most severe viscosity grade for each individual test for the grades being licensed. Engine tests shall be registered using the ACC Code. No read-across or substitute data are permitted for physical and chemical analyses or for bench tests (except as allowed in F.1.3 and F.4); that is, all specified physical and chemical analyses must be run on the final formulation. Proposed changes to the read-across tables or F.1.3 should be sent to the Chair of API’s Base Oil Interchange (BOI)/Viscosity Grade Read-Across (VGRA) Task Force or API. The proposal must include a justification and supporting data for such change.

#### F.1.3 PRINCIPLES FOR VISCOSITY GRADES NOT COVERED

Tables F-2 through F-12 indicate when a viscosity grade read-across is allowed (X) and not allowed (—). For viscosity grades not included in those tables, read-across is allowed for certain tests if the viscosity grades meet all the applicable technical principles described in Table F-1. Read-across for viscosity grades not covered by Tables F-1 through F-13 is not allowed until API’s BOI/VGRA Task Force reviews the justification and data supporting a change to the tables and recommends the change to the API Lubricants Committee and the Lubricants Committee approves the change. Check marks in Table F-1 indicate which technical principles apply to a specific test. Paragraph F.3 provides examples on applying these technical principles to new viscosity grades.

**Table F-1—Technical Principles for New Viscosity Grades and Read Across**

<b>Passenger Car Motor Oils</b>		IID	L-38/VIII	IIIE/IIIF/ IIIG	IIIGA (Note 2)	IIIGB	IVA	VE	VG	VIA/VIB/VID
a	Detergent (dispersant)-inhibitor (DI) content of the read-across viscosity grade shall be equal to or higher than that of the original viscosity grade. The increase in DI is limited to the maximum allowed by the ACC Code	✓	✓	✓	✓	✓	✓	✓	✓	Note 3
b	Base stock blend kinematic viscosity at 100°C of the read-across viscosity grade must be equal to or higher than that of the original viscosity grade, considering the precision of the test method	NA	NA	✓	✓	NA	✓	✓	NA	Note 3
c	The viscosity modifier (VM) content of the read-across viscosity grade must be equal to or lower than that of the original viscosity grade	NA	NA	Note 4	Note 4	NA	✓	✓ or Note 5	✓ or Note 5	Note 3

<b>Diesel Engine Oils</b>		1M-PC
a	Detergent (dispersant)-inhibitor (DI) content of the read-across viscosity grade shall be equal to or higher than that of the original viscosity grade. The increase in DI is limited to the maximum allowed by the ACC Code	✓
b	Base stock blend kinematic viscosity at 100°C of the read-across viscosity grade must be equal to or higher than that of the original viscosity grade, considering the precision of the test method	✓
c	The viscosity modifier (VM) content of the read-across viscosity grade must be equal to or lower than that of the original viscosity grade	✓
d	Finished oil volatility of the read-across viscosity grade must be equal to or lower than that of the original viscosity grade	✓

Notes:

- ✓ = principle is applicable; NA = not applicable.
- Technical principles for the Sequence IIIGA are limited to 0W, 5W, and 10W multigrades.
- New viscosity grades and associated read-across can only be added after review by the API BOI/VGRA Task Force and approval by the API Lubricants Committee.
- Viscosity modifier content must be no more than 1.5 times higher than the viscosity modifier content in the oil on which the test was run.
- For dispersant-type VM, the VM content of the read-across viscosity grade must be equal to or higher than the original viscosity grade.
- Read-across viscosity grades must contain an equal amount of the same Group V base stock (e.g., ester) in the finished oil blend if a Group V base stock is used in the original viscosity grade.

## F.2 Requirements for Passenger Car Motor Oils

**F.2.1** Blends shall use only base stocks as defined in Appendix E.

**F.2.2** Base oils introduced from other manufacturers shall be tested in accordance with Appendix E.

**F.2.3** The same detergent-(dispersant) inhibitor (DI) portion of the total performance additive package shall be used at equal or higher concentrations for alternative viscosity grades. The increase in DI is limited to that allowed in the ACC Code. Viscosity modifier, foam inhibitor, and pour point depressant levels may be adjusted for alternative viscosity grades, in accordance with the ACC Code.

**F.2.4** ACC Code and ASTM Multiple Test Evaluation Procedure testing practices shall be followed.

## F.3 Examples Using VGRA Tables and Technical Principles for VGRA

### F.3.1 GENERAL

Read-across to or from viscosity grades not shown in the tables is allowed if the requirements in F.1.3 are met. If the requirements are not met, read-across is not allowed. Examples of how F.1.3 can be applied are provided below.

### F.3.2 EXAMPLE 1

In this example, a Sequence IIIE test is run on an SAE 0W-30 core viscosity grade [i.e., tested viscosity grade]. What other viscosity grades can be covered by read-across from the tested SAE 0W-30? To answer this question, take the following steps:

Step 1: Determine if requirement “a” in Table F-1 is met for all the desired read-across viscosity grades. This requires keeping the DI constant, or if higher, consistent with the ACC Code of Practice. Since an SAE 0W-30 is most likely blended with some or all Group III or Group IV base stocks, many of the higher viscosity grades would probably not be part of this product line. The higher viscosity grades, if marketed, could have a different DI and/or base stock slate.

Step 2: For the read-across viscosity grades (i.e., those you are reading to) of interest in Table F-4, determine if the requirements for both “b” and “c” in Table F-1 can be met concurrently. This involves having equal or higher base stock blend viscosity and a VM content in the “read to” multigrades that is no more than 1.5 times higher than that in the SAE 0W-30. There are some grades that are certain to meet “b” and “c”, and some where it will depend on the blending approach. Some trial blends may have to be made. Decide if there are single grades desired or feasible considering the base stocks used in the core formulation.

Step 3: For viscosity grades that you wish to cover by read-across but are not shown in Table F-4, follow the instructions for “b” and “c” described in Step 2.

Step 4: Determine which viscosity grades meet Table F-1 requirements “a,” “b”, and “c”. These grades are covered by viscosity grade read-across. Grades that fail to meet all these requirements are not covered by read-across.

Note: The marketer of a formulation has the final responsibility for assuring that the product meets API requirements.

### F.3.3 EXAMPLE 2

In this example, an SAE 5W-30 blended with Group IV base stocks and a nondispersant VM has passed a VE test. A marketer wants to read-across this test to an SAE 5W-40 grade, one not included in Table F-7. Since the SAE 5W-40 is not included in Table F-7, “a,” “b”, and “c” in Table F-1 must be consulted. It is likely that the DI content of the SAE 5W-40 would be equal to or higher than the SAE 5W-30, so requirement “a” would be met. However, “b” and “c” probably cannot be met. A SAE 5W-40 oil would normally not have a higher base stock blend kinematic viscosity at 100°C than an SAE 5W-30, and more nondispersant VM would be required in a SAE 5W-40 oil. Therefore, this read-across is not allowed.

## **F.4 VGRA for Other Bench Tests**

### **F.4.1 HOMOGENEITY AND MISCIBILITY (H&M) AND EOFT (GM 9099P FILTERABILITY–STANDARD METHOD)**

Homogeneity and Miscibility (H&M) and Engine Oil Filterability [EOFT (formerly GM 9099P Filterability–Standard Method)] tests are required in the core data set (see ACC Code for definition of core data set), and then read-across is allowed to all other viscosity grades within the same base stock slate.

### **F.4.2 EOWTT (GM 9099P FILTERABILITY–MODIFIED METHOD FOR ILSAC GF-2/GF-3)**

The Engine Oil Water Tolerance Test [EOWTT (formerly GM 9099P Filterability–Modified Method for ILSAC GF-2/GF-3)] must be run on the formulation with the highest additive (DI/VI) combination. Results are then read-across to all other base oil/viscosity grade formulations using the same or lower concentration of the identical additive (DI/VI) combination. Each different (DI/VI) combination must be tested.

### **F.4.3 BALL RUST TEST (BRT)**

If there is one passing Ball Rust Test (BRT) (ASTM D 6557) in the core data set as defined by the ACC Code, read-across is allowed to all other viscosity grades and base oil slates.

### **F.4.4 EMULSION RETENTION D7563 - VGRA**

For oils formulated with Group II and/or Group III base stocks, the Emulsion Retention ASTM D7563 is required only for the highest additive (DI/VI) concentration. Read across is allowed to all other Group II, Group III and combinations of Group II and Group III base oil/viscosity grade formulations using the same or lower concentration of the identical additive (DI/VI) combination. If the PPD type is changed for the DI/VI combination, testing is required.

## **F.5 Requirements for Diesel Engine Oils**

**F.5.1** Blends shall use only base stocks as defined in Appendix E.

**F.5.2** Base oils introduced from other sources shall be tested in accordance with Appendix E.

**F.5.3** The same detergent-(dispersant) inhibitor (DI) portion of the total performance additive package shall be used at equal or higher concentrations for alternative viscosity grades. The increase in DI is limited to that allowed in the ACC Code. Viscosity modifier, foam inhibitor, and pour point depressant levels may be adjusted for alternative viscosity grades, in accordance with the ACC Code.

**F.5.4** If there is one passing HTCBT (D6594) in the core data set as defined by the ACC Code of Practice, read-across is allowed to all other viscosity grades and base oil slates.

Note: Engine manufacturers may not recommend all of the viscosity grades shown in Tables F-2 through F-13 for a particular engine type.

**Table F-2—Groups I, II, III and IV Viscosity Read-Across: L-38/Sequence VIII Tests**

Test Run on	5W-20	5W-30	10W	10W-30	10W-40	15W-40	15W-50	20W	20W-40	20W-50	30	40	50
5W-20	NA	X	X	X	X	X	X	X	X	X	X	X	X
5W-30	X	NA	X	X	X	X	X	X	X	X	X	X	X
10W	—	—	NA	—	—	—	—	X	—	—	X	X	X
10W-30	—	—	X	NA	X	X	X	X	X	X	X	X	X
10W-40	—	—	X	X	NA	X	X	X	X	X	X	X	X
15W-40	—	—	—	X	X	NA	X	X	X	X	X	X	X
15W-50	—	—	—	—	X	X	NA	X	X	X	X	X	X
20W	—	—	—	—	—	—	—	NA	—	—	X	X	X
20W-40	—	—	—	—	—	X	X	X	NA	X	X	X	X
20W-50	—	—	—	—	—	—	X	X	X	NA	X	X	X
30	—	—	—	—	—	—	—	—	—	—	NA	X	X
40	—	—	—	—	—	—	—	—	—	—	—	NA	X
50	—	—	—	—	—	—	—	—	—	—	—	—	NA

Notes:

1. X = read-across is permitted for the viscosity grades identified based on data and some applications of the technical principles approved by API BOI/VGRA Task Force and API Lubricants Committee.
2. A dash (—) means that read-across is not permitted; NA = not applicable.
3. New viscosity grades and associated read-across are allowed if the requirements described in F.1.3 are met.
4. Tested formulations containing Group V stocks must contain an equal amount of the same Group V base stock (e.g., ester) in the finished oil blend for application of viscosity grade read-across.
5. The read-across in this table applies only to bearing weight loss and piston varnish. All multigrade oils must stay-in-grade for 10 hours in the L-38/Seq. VIII tests (see ILSAC GF-1, GF-2, GF-3 and GF-4). Data to support stay-in-grade “read-across” shall be provided by the licensee for API Service Categories SM, SL, SJ, SH, and CG-4 and ILSAC GF-1, GF-2, and GF-3 oils (0W-XX, 5W-XX, 10W-XX).
6. The guidelines in this table apply only to bearing weight loss. All multigrade oils must stay in grade for 10 hours. Data to support stay-in-grade read across shall be provided by the licensee for active API Service Categories and ILSAC Standards. ASTM D 6278 (30 passes) may be used to support stay-in-grade requirements, where the following limits must be met at 100 °C: SAE XW-20 5.6 cSt minimum, XW-30 8.5 cSt minimum, XW-40 11.5 cSt minimum, and XW-50 15.0 cSt minimum.

**Table F-3—Groups I, II, III and IV Viscosity Read-Across: Sequence IID Test**

Test Run on	Can Be “Read-Across” to:												
	5W-20	5W-30	10W	10W-30	10W-40	15W-40	15W-50	20W	20W-40	20W-50	30	40	50
5W-20	NA	X	X	X	X	X	X	X	X	X	X	X	—
5W-30	X	NA	X	X	X	X	X	X	X	X	X	X	—
10W	—	—	NA	—	—	—	—	X	—	—	X	X	—
10W-30	—	—	X	NA	X	X	X	X	X	X	X	X	—
10W-40	—	—	X	X	NA	X	X	X	X	X	X	X	—
15W-40	—	—	—	X	X	NA	X	X	X	X	X	X	X
15W-50	—	—	—	—	X	X	NA	X	X	X	X	X	X
20W	—	—	—	—	—	—	—	NA	—	—	X	X	X
20W-40	—	—	—	—	X	X	X	X	NA	X	X	X	X
20W-50	—	—	—	—	—	X	X	X	X	NA	X	X	X
30	—	—	—	—	—	—	—	X	—	—	NA	X	X
40	—	—	—	—	—	—	—	—	—	—	X	NA	X
50	—	—	—	—	—	—	—	—	—	—	—	—	NA

Notes:

1. X = read-across is permitted for the viscosity grades identified based on data and some applications of the technical principles approved by API BOI/VGRA Task Force and API Lubricants Committee.
2. A dash (—) means that read-across is not permitted; NA = not applicable.
3. New viscosity grades and associated read-across are allowed if the requirements described in F.1.3 are met.
4. Tested formulations containing Group V stocks must contain an equal amount of the same Group V base stock (e.g., ester) in the finished oil blend for application of viscosity grade read-across.

**Table F-4—Groups I, II, III and IV Viscosity Read-Across: Sequence IIIE/IIIF/IIIG/IIIGB Tests**

Test Run on	Can Be "Read-Across" to:												
	5W-20	5W-30	10W	10W-30	10W-40	15W-40	15W-50	20W	20W-40	20W-50	30	40	50
5W-20	NA	—	X	X	—	—	—	X	X	X	X	X	X
5W-30	X <sup>a</sup>	NA	X	X	X	X	X	X	X	X	X	X	X
10W	—	—	NA	—	—	—	—	X	—	—	X	X	X
10W-30	—	—	X	NA	X	X	X	X	X	X	X	X	X
10W-40	—	—	X	X	NA	X	X	X	X	X	X	X	X
15W-40	—	—	—	X	X	NA	X	X	X	X	X	X	X
15W-50	—	—	—	—	—	X	NA	—	X	X	X	X	X
20W	—	—	—	—	—	—	—	NA	—	—	X	X	X
20W-40	—	—	—	—	—	—	—	X	NA	X	X	X	X
20W-50	—	—	—	—	—	—	—	—	X	NA	X	X	X
30	—	—	—	—	—	—	—	—	—	—	NA	X	X
40	—	—	—	—	—	—	—	—	—	—	—	NA	X
50	—	—	—	—	—	—	—	—	—	—	—	—	NA

Notes:

1. X = read-across is permitted for the viscosity grades identified based on data and some applications of the technical principles approved by API BOI/VGRA Task Force and API Lubricants Committee. Viscosity modifier content must be no more than 1.5 times higher than the viscosity modifier content in the oil on which the test was run.
2. A dash (—) means that read-across is not permitted; NA = not applicable.
3. New viscosity grades and associated read-across are allowed if the requirements described in F.1.3 are met.
4. Tested formulations containing Group V stocks must contain an equal amount of the same Group V base stock (e.g., ester) in the finished oil blend for application of viscosity grade read-across.

<sup>a</sup>The read from 5W-30 to 5W-20 applies to Sequence IIIF/IIIG only.

**Table F-5—Groups I, II, III and IV Viscosity Read-Across: Sequence IIIGA and ROBO Test**

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

Notes:

1. X = read-across is permitted for the viscosity grades identified based on data and some applications of the technical principles approved by API BOI/VGRA Task Force and API Lubricants Committee. Viscosity modifier content must be no more than 1.5 times higher than the viscosity modifier content in the oil on which the test was run.
2. A dash (—) means that read-across is not permitted; NA = not applicable.
3. Tested formulations containing Group V stocks must contain an equal amount of the same Group V base stock (e.g., ester) in the finished oil blend for application of viscosity grade read-across.

**Table F-6—Groups I, II, III and IV Viscosity Read-Across: Sequence IVA Test**

Test Run on	Can Be "Read-Across" to:												
	5W-20	5W-30	10W	10W-30	10W-40	15W-40	15W-50	20W	20W-40	20W-50	30	40	50
5W-20	NA	—	X	X	—	—	—	X	X <sup>a</sup>	X <sup>a</sup>	X	X	X
5W-30	X	NA	X	X	X	X	X	X	X	X	X	X	X
10W	—	—	NA	—	—	—	—	X	—	—	X	X	X
10W-30	—	—	—	NA	—	X	—	X	X	X	X	X	X
10W-40	—	—	—	X	NA	X	X	X	X	X	X	X	X
15W-40	—	—	—	X	—	NA	X	X	X	X	X	X	X
15W-50	—	—	—	—	—	—	NA	—	X	X	X	X	X
20W	—	—	—	—	—	—	—	NA	—	—	X	X	X
20W-40	—	—	—	—	—	X	—	—	NA	X	X	X	X
20W-50	—	—	—	—	—	—	—	—	—	NA	X	X	X
30	—	—	—	—	—	—	—	—	—	—	NA	X	X
40	—	—	—	—	—	—	—	—	—	—	—	NA	X
50	—	—	—	—	—	—	—	—	—	—	—	—	NA

Notes:

1. X = read-across is permitted for the viscosity grades identified based on data and some applications of the technical principles approved by API BOI/VGRA Task Force and API Lubricants Committee.
2. A dash (—) means that read-across is not permitted; NA = not applicable.
3. New viscosity grades and associated read-across are allowed if the requirements described in F.1.3 are met.
4. Tested formulations containing Group V stocks must contain an equal amount of the same Group V base stock (e.g., ester) in the finished oil blend for application of viscosity grade read-across.

<sup>a</sup>Read-across permitted if requirements in F.1.3 are met.

**Table F-7—Groups I, II, III and IV Viscosity Read-Across: Sequence VE/VG Test  
Nondispersant Viscosity Modifier**

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

Notes:

1. X = read-across is permitted for the viscosity grades identified based on data and some applications of the technical principles approved by API BOI/VGRA Task Force and API Lubricants Committee.
2. A dash (—) means that read-across is not permitted; NA = not applicable.
3. New viscosity grades and associated read-across are allowed if the requirements described in F.1.3 are met.
4. Tested formulations containing Group V stocks must contain an equal amount of the same Group V base stock (e.g., ester) in the finished oil blend for application of viscosity grade read-across.

**Table F-8—Groups I, II, III and IV Viscosity Read Across: Sequence VE/VG Test Dispersant Viscosity Modifier<sup>a</sup>**

Test Run on	Can Be "Read-Across" to:												
	5W-20	5W-30	10W	10W-30	10W-40	15W-40	15W-50	20W	20W-40	20W-50	30	40	50
5W-20	NA	X	—	X	X	X	X	—	X	X	—	—	—
5W-30	—	NA	—	X <sup>b</sup>	X	X	X	—	X	X	—	—	—
10W	—	—	NA	—	—	—	—	X	—	—	X	X	—
10W-30	—	—	—	NA	X	X	X	—	X	X	—	—	—
10W-40	—	—	—	X	NA	X	X	—	X	X	—	—	—
15W-40	—	—	—	X	X	NA	X	—	X	X	—	—	—
15W-50	—	—	—	—	—	—	NA	—	X	X	—	—	—
20W	—	—	—	—	—	—	—	NA	—	—	X	X	X
20W-40	—	—	—	—	—	X	X	—	NA	X	—	—	—
20W-50	—	—	—	—	—	—	X	—	—	NA	—	—	—
30	—	—	—	—	—	X	X	—	X	X	NA	X	X
40	—	—	—	—	—	—	—	—	—	—	—	NA	X
50	—	—	—	—	—	—	—	—	—	—	—	—	NA

Notes:

1. X = read-across is permitted for the viscosity grades identified based on data and some applications of the technical principles approved by API BOI/VGRA Task Force and API Lubricants Committee.
  2. A dash (—) means that read-across is not permitted; NA = not applicable.
  3. New viscosity grades and associated read-across are allowed if the requirements described in F.1.3 are met.
  4. Tested formulations containing Group V stocks must contain an equal amount of the same Group V base stock (e.g., ester) in the finished oil blend for application of viscosity grade read-across.
- <sup>a</sup>Read-across is allowed to formulations with an equal or higher concentration of dispersant viscosity modifier.  
<sup>b</sup>10W-30 read-across is permitted at a lower concentration of dispersant viscosity modifier than the 5W-30 provided that a passing SAE 30 is also obtained on the formulation where the DI treat remains unchanged.

**Table F-9—Groups I, II, III and IV Viscosity Read-Across: Sequence VIA Test**

Test Run on	Can Be "Read-Across" to:							
	0W-20	5W-20	0W-30	5W-30	0W-40	5W-40	10W-30	10W-40
0W-20	NA	—	—	—	—	—	—	—
5W-20	X1	NA	—	—	—	—	—	—
0W-30	X1	—	NA	—	—	—	—	—
5W-30	X1	X1	X2	NA	—	—	X4	—
0W-40	X1	—	X2	—	NA	—	—	—
5W-40	X1	X1	X2	X2	—	NA	—	—
10W-30	—	X1	X2	X2	—	—	NA	—
10W-40	—	—	—	X2	—	X2	X3	NA

Notes:

1. X1 = read-across allowed at 1.4% FEI or greater.
2. X2 = read-across allowed at 1.1% FEI or greater.
3. X3 = read-across allowed at 0.5% FEI or greater.
4. X4 = read-across allowed if the 5W-30 meets 1.1% FEI and the HTHS of the 10W-30 is no more than 0.2cP higher than the 5W-30. This read-across is currently applicable to Group I base stocks only.
5. The data set used to establish the Sequence VIA viscosity grade read-across table had the following range of (Group I and Group II) base oil parameters:
  - Viscosity Index: Min. 93 – Max. 116
  - Saturates: Min. 71.5% – Max. 100%
  - Aromatics: Min. 0.0% – Max. 27%
  - Sulfur: Min. 0.0% – Max. 0.4% wt.

This information is for reference. It does not restrict application of the guidelines by the marketer who is responsible for ensuring that each licensed engine oil satisfies all engine and bench test performance requirements.

6. A dash (—) means that the read-across is not permitted; NA = not applicable.
7. New viscosity grades and associated read-across can only be added by requests to the API BOI/VGRA Task Force.
8. Tested formulations containing Group V stocks must contain an equal amount of the same Group V base stock (e.g., ester) in the finished oil blend for application of viscosity grade read-across.



**Table F-10—Groups I, II, III and IV Viscosity Read-Across: Sequence VIB Test**

Test Run on	Can Be “Read-Across” to:							
	0W-20	5W-20	0W-30	5W-30	0W-40	5W-40	10W-30	10W-40
0W-20	NA	—	—	—	—	—	—	—
5W-20	X1	NA	—	—	—	—	—	—
0W-30	X1	—	NA	—	—	—	—	—
5W-30	X1	X1	X1	NA	—	—	X3	—
0W-40	X1	—	X1	—	NA	—	—	—
5W-40	X1	X1	X1	X1	—	NA	—	—
10W-30	X1	X1	X1	X1	—	—	NA	—
10W-40	X1	X1	X1	X1	X2	X2	X2	NA

Notes:

1. X1 = VGRA allowed if result on the tested oil meets requirements for the read-across grade.
2. X2 = read-across allowed.
3. X3 = read-across allowed provided the Noack volatility of the 10W-30 is less than or equal to the Noack of the 5W-30 and the HTHS of the 10W-30 is no more than 0.1 cP higher than the HTHS of the 5W-30, within the precision of the tests, and the delta between the CCS of the 10W-30 oil and the maximum CCS limit is greater than or equal to the delta between the CCS of the 5W-30 oil and the maximum CCS limit at the appropriate temperatures.
4. A dash (—) means that the read-across is not permitted; NA = not applicable.
5. New viscosity grades and associated read-across can only be added by requests to the API BOI/VGRA Task Force.
6. Tested formulations containing Group V stocks must contain an equal amount of the same Group V base stock (e.g., ester) in the finished oil blend for application of viscosity grade read-across.

**Table F-11 Groups I, II, III, and IV Viscosity Grade Read-Across: Sequence VID Test**

Passing test run on	Can be “Read-Across” to:							
	0W-20	5W-20	0W-30	5W-30	10W-30	0W-40	5W-40	10W-40
0W-20	NA	X1	-	-	-	-	-	-
5W-20	X1	NA	-	-	-	-	-	-
0W-30	X2	X2	NA	X1	X1	-	-	-
5W-30	X2	X2	X1	NA	X1	-	-	-
10W-30	X2	X2	X2	X2	NA	X1	X1	X1
0W-40	-	-	-	-	X1	NA	X1	X1
5W-40	-	-	-	-	X1	X1	NA	X1
10W-40	-	-	-	-	X1	X1	X1	NA

Notes:

X1 = VGRA is allowed if HTHS@100°C (D6616) of the candidate oil is less than or equal to the original tested oil OR if HTHS@100°C (D6616) of the candidate oil meets the conditions of Equations F.1.0.

X2 = VGRA is allowed if the original tested oil meets the FEI Sum and FEI2 limit requirements for the read-across viscosity grade and the HTHS@100°C (D6616) of the candidate oil is less than or equal to the original tested oil.

**Equations F.1.0**

Testing is not required if both equations are true:

$$H_{\text{Candidate}} \leq H_{\text{Original}} + \{(FEI_{\text{SumLimit}} - FEI_{\text{SumOriginal}}) / -0.485\} + (H_{\text{Original}} * R)$$

$$H_{\text{Candidate}} \leq H_{\text{Original}} + \{(FEI2_{\text{Limit}} - FEI2_{\text{Original}}) / -0.227\} + (H_{\text{Original}} * R)$$

Where:

$H_{\text{Candidate}}$  is the HTHS@100°C of the candidate oil as measured by ASTM D6616

$H_{\text{Original}}$  is the HTHS@100°C of the original tested oil as measured by ASTM D6616

$FEI_{\text{sumLimit}}$  is the FEI sum passing limit for the original tested viscosity grade

$FEI_{\text{sumOriginal}}$  is the FEI sum ( $FEI1_{\text{Original}} + FEI2_{\text{Original}}$ ) result of the original tested oil

-0.485 is the FEIsum coefficient from the Seq. VID industry matrix model

$FEI2_{\text{Limit}}$  is the FEI2 passing limit for the original tested viscosity grade

$FEI2_{\text{Original}}$  is the FEI2 result of the original tested oil

-0.227 is the FEI2 coefficient from the Seq. VID industry matrix model

Notes:

$R$  is the reproducibility as reported in the most recent version of ASTM D6616. The current  $R = 0.035$  (3.5%) for ASTM D6616-07.

The range of the HTHS@100°C used to develop the Seq. VID industry matrix model was 5.44 to 7.68 cP (5.25 to 7.95 cP when allowance is made for D6616 reproducibility). This information is for reference. It does not restrict application of the guidelines by the marketer who is responsible for ensuring that each licensed engine oil satisfies all engine and bench test performance requirements.

**In addition the following Examples will be adopted into API 1509 to illustrate the use of the Seq. VID VGRA Table and Equations.**

**Example 1:** (This example illustrates the application of footnote X1 - Reading to another viscosity grade at the same Sequence VID limits where the HTHS@100 C of the candidate is less than or equal to the HTHS @100C of the original tested oil.)

One has a passing 0W-20 oil with HTHS@100°C of 5.71 cP. Can one read that oil to a 5W-20 oil with a HTHS@100°C of 5.71 cP? The answer is yes because the HTHS@100°C values are equal.

**Example 2:** (This example illustrates the application of footnote X1 - Reading to another viscosity grade at the same Sequence VID limits but where the HTHS@100 C of the candidate oil is greater than the original tested oil.)

One has a passing 0W-20 oil with HTHS@100°C of 5.71 cP. Can one read that oil to a 5W-20 oil with a HTHS@100°C of 6.08 cP? In order to determine if this read is possible, the conditions of Equation F.1.0 must be met. The 0W-20 original result is FEIsum and FEI2 of 2.69 and 1.51 respectively. The 5W-20 candidate's HTHS@100°C must be equal to or less than the values from the equations:

$$A = FEI_{\text{sum}} \text{ HTHS} = 5.71 + \{(2.6-2.69)/ -0.485\} + (5.71 * 0.035) = 6.10 \text{ cP}$$

$$B = FEI2 \text{ HTHS} = 5.71 + \{(1.2-1.51)/ -0.227\} + (5.71 * 0.035) = 7.28 \text{ cP}$$

The candidate 5W-20 oil has an HTHS@100°C of 6.08 cP which is less than either calculated value A or B so VGRA is allowed from this 0W-20 to this 5W-20.

**Example 3:** (This example illustrates the application of footnote X2 – Reading a heavier viscosity grade to a lighter viscosity grade when the Seq. VID result on the heavier grade meets the lighter grade's Sequence VID limits.)

One has a 10W-30 Seq. VID result of FEIsum of 2.62 and FEI2 of 1.34; this 10W-30 oil has an HTHS@100°C of 7.48 cP. These Seq. VID results meet the 0W-20 and 5W-20 Seq. VID limits (FEIsum 2.6 min, FEI2 1.2 min.) and surpass the 0W-30 and 5W-30 Seq. VID limits (FEIsum 1.9 min, FEI2 0.9 min.). This 10W-30 can now be read to a 0W-20, 5W-20, 0W-30, and 5W-30 formulated with the same technology provided that the HTHS@100°C for any of these other viscosity grades is less than 7.48 cP, the HTHS@100°C of the tested 10W-30.

**Example 4:** (This example illustrates the application of footnote X1 - Reading a 5W-30 to a 10W-30.)

One has a 5W-30 oil with an HTHS@100°C viscosity of 6.66 cP. This 5W-30 oil has passed the Seq. VID with a result of FEIsum of 2.06 and FEI2 of 0.96. These values meet the 5W-30 Seq. VID limits of FEIsum 1.9 min. and FEI2 0.9 min. A 10W-30 candidate oil has an HTHS@100°C of 7.22 cP. Using equations in F.1.0 the read to this 10W-30 can now be assessed.

$$A = \text{FEIsum HTHS} = 6.66 + \{(1.9-2.06)/ -0.485\} + (6.66 * 0.035) = 7.22 \text{ cP}$$

$$B = \text{FEI2 HTHS} = 6.66 + \{(0.90-0.96)/ -0.227\} + (6.66 * 0.035) = 7.16 \text{ cP}$$

In order for the 5W-30 to read to the 10W-30, the HTHS@100°C for the 10W-30 must be less than or equal to A and B. The candidate 10W-30 has a HTHS@100°C of 7.22 cP, equal to A (7.22 cP) from FEIsum equation, but it is greater than B (7.16 cP) derived from FEI2 equation. Since there is no further allowance for test reproducibility, this read is not permitted. If, however, the 10W-30 was reformulated to a HTHS@100°C of less than or equal to 7.16 cP, the read from the 5W-30 would be allowed.

**Table F-12—Groups I, II, III and IV Viscosity Read-Across: TEOST Test (Method 33)**

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

Notes:

1. X = read-across is permitted for viscosity grades identified based on data and some application of technical principles approved by API BOI/VGRA Task Force and API Lubricants Committee.
2. Monogrades are defined as SAE 10W, SAE 20W, SAE 30, SAE 40, and SAE 50.
3. A dash (—) means that read-across is not permitted; NA = not applicable.
4. Tested formulations containing Group V stocks must contain an equal amount of the same Group V base stock (e.g., ester) in the finished oil blend for application of viscosity grade read-across.
5. New viscosity grades and associated read-across are allowed if requirements described in F.1.3 are met.

**Table F-13—Groups I, II, III and IV Viscosity Read-Across: TEOST MHT-4**

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

Notes:

1. X = read-across is permitted for the viscosity grades identified based on data and some applications of the technical principles approved by API BOI/VGRA Task Force and API Lubricants Committee.
2. A dash (—) means that read-across is not permitted; NA = not applicable.
3. Tested formulations containing Group V stocks must contain an equal amount of the same Group V base stock (e.g., ester) in the finished oil blend for application of viscosity grade read-across.
4. If the viscosity grade of interest is not in the table, then the TEOST MHT-4 must be run.
5. The principles behind this table are that higher base oil viscosity tends to give poorer performance and that VM level is not necessarily detrimental.

**Table F-14—Groups II and III Viscosity Read-Across: GF-5 Elastomer Compatibility Test (ASTM D 7216 Annex 2A)**

Test Run on	Can Be "Read-Across" to:					
	0W-20	0W-30	5W-20	5W-30	10W-30	10W-40
0W-20	NA	X	X	X	X	X
0W-30	X	NA	X	X	X	X
5W-20	X	X	NA	X	X	X
5W-30	X	X	X	NA	X	X
10W-30	X	X	X	X	NA	X
10W-40	X	X	X	X	X	NA

**For viscosity grades not listed in the table above, bracketing two passing formulations for a given technology may be used to waive additional testing. VGRA is allowed if the candidate's base oil viscosity at 100°C falls within the range of the base oil viscosity at 100°C of the 2 passing formulations.**

**Example:**

	Matrix Oil 1	Matrix Oil 2	Candidate Oil A	Candidate Oil B
Base Oil Viscosity @ 100°C, cSt	4.6	10.9	9.0	12.4
D7216 A2 Result	Pass	Pass		
Test Required?			No	Yes
Reason			Formulation falls within the base oil viscosity range	Formulation does not fall within the base oil viscosity range

**Table F-15—Groups I, II, III and IV Viscosity-Grade Read Across for Diesel Engine Oils**

Read-across for viscosity grades not covered explicitly by this table are not allowed unless permitted by table F-1.

Performance Test	From SAE	To SAE
1K	10W-40	10W-30, 15W-40, 15W-50
	15W-40	10W-30, 20W-40, 20W-50
	30	10W, 20W, 40, 10W-30, 15W-40, 20W-50
	40	10W, 20W, 30, 10W-30, 15W-40, 20W-50
1M-PC <sup>a</sup>	5W-30	All single grades and 5W-20, 10W-30, 10W-40, 15W-40, 15W-50, 20W-40, 20W-50
	10W-30	All single grades and 15W-40, 15W-50, 20W-40, 20W-50
	10W-40	All single grades and 10W-30, 15W-40, 15W-50, 20W-40, 20W-50
	20W-20 <sup>b</sup>	All single grades except 10W
	30	All single grades except 10W
	40	All single grades except 10W
	50	All single grades except 10W
	10W	All single grades
	15W-40	All single grades and 20W-40, 20W-50
	15W-50	All single grades and 15W-40, 20W-40, 20W-50
	20W-40	All single grades except 10W and 20W-50
	20W-50	All single grades except 10W and 20W-40
	1N	15W-40
20W-20 <sup>b</sup>		10W
30		10W, 20W-20 <sup>b</sup>
40		10W, 20W-20 <sup>b</sup> , 30
50		10W, 20W-20 <sup>b</sup> , 30, 40
1P	10W-30	15W-40, 20W-40, 20W-50
	10W-40	10W-30, 15W-40, 15W-50, 20W-40, 20W-50
	15W-40	20W-40, 20W-50
	15W-50	15W-40, 20W-40, 20W-50
1R	10W-30	15W-40
	10W-40	10W-30, 15W-40, 15W-50
C13	10W-30	15W-40
	10W-40	10W-30, 15W-40
	15W-50	15W-40
CBT	10W-30	15W-40
Elastomer Compatibility	10W-30	15W-40
	15W-40	10W-30
HT-CBT	See F.5.4	
M11HST	10W-30	10W-40, 15W-40, 15W-50
	15W-40	10W-40, 15W-50
M11EGR	10W-30	10W-40, 15W-40, 15W-50
	15W-40	10W-40, 15W-50
ISB	10W-30	10W-40, 15W-40, 15W-50
	15W-40	10W-40, 15W-50
ISM	10W-30	10W-40, 15W-40, 15W-50
	15W-40	10W-40, 15W-50
NTC-400	15W-40	10W-30, 20W-50 <sup>c</sup>
	20W-50	10W-30, 15W-40
	30	10W, 20W, 10W-30, 15W-40, 20W-50
	40	10W, 20W, 30, 10W-30, 15W-40, 20W-50
6V 92TA	10W-XX <sup>d</sup>	15W-XX <sup>d</sup> , 20W-XX <sup>d</sup> , 30, 40, 50
	10W-30	15W-40, 20W-50, 30, 40, 50
	15W-XX <sup>d</sup>	20W-XX <sup>d</sup> , 30, 40, 50
	15W-40	20W-50, 30, 40, 50
	20W-XX <sup>d</sup>	30, 40, 50
	30	40, 50

Performance Test	From SAE	To SAE
	40	50
T-6 <sup>e</sup>	10W-30	15W-40, 20W-50
	15W-40	10W-30, 20W-50
	20W-50	10W-30, 15W-40
	30	10W, 20W, 40, 10W-30, 15W-40, 20W-50
T-7 <sup>f</sup>	10W-30	15W-40, 20W-50
	15W-40	10W-30, 20W-50
	20W-50	10W-30, 15W-40
	30	10W, 20W, 40, 10W-30, 15W-40, 20W-50
T-8, T-8A and T-8E <sup>f</sup>	15W-40	10W-30, 10W-40, 15W-50
T-9 <sup>e</sup>	10W-30	10W-40, 15W-40, 15W-50, 20W-40 <sup>h</sup> , 20W-50 <sup>h</sup>
	15W-40	15W-50, 20W-40 <sup>h</sup> , 20W-50 <sup>h</sup>
T-10	10W-30	10W-40, 15W-40, 15W-50, 20W-40 <sup>h</sup> , 20W-50 <sup>h</sup>
	15W-40	15W-50, 20W-40 <sup>h</sup> , 20W-50 <sup>h</sup>
T-10A	15W-40	0W-XX, 5W-XX, 10W-XX
T-11 <sup>g</sup>	10W-30	10W-40
	10W-40	10W-30
	15W-40	10W-30, 10W-40, 15W-50
	15W-50	10W-30, 10W-40, 15W-40
	20W-40	10W-30, 10W-40, 15W-40, 15W-50, 20W-50
	20W-50	10W-30, 10W-40, 15W-40, 15W-50, 20W-40
T-11A	15W-40	0W-XX, 5W-XX, 10W-XX
T-12	10W-30	10W-40, 15W-40, 15W-50, 20W-40 <sup>h</sup> , 20W-50 <sup>h</sup>
	15W-40	15W-50, 20W-40 <sup>h</sup> , 20W-50 <sup>h</sup>
EOAT	10W	10W-30, 15W-40, 15W-50
	10W-30	10W, 15W-40, 15W-50
	15W-40	10W, 10W-30, 15W-50
	15W-50	10W, 10W-30, 15W-40
	40	10W, 30, 10W-30, 15W-40, 15W-50
RFWT	10W-30	10W-40, 15W-40, 15W-50, 20W-40, 20W-50, 30, 40, 50
	15W-40	15W-50, 20W-40, 20W-50, 40, 50

Notes:

1. This table originally became effective January 1, 1992. Engine manufacturers may not recommend all of the viscosity grades shown in the table for a particular engine type.

2. Tested formulations containing Group V stocks must contain an equal amount of the same Group V base stock (e.g., ester) in the finished oil blend for application of viscosity grade read-across.

<sup>a</sup>No 0W and 5W single grades were considered for this table. 1M-PC read-across guidelines effective December 1, 2002.

<sup>b</sup>These read across also apply to SAE 20 and SAE 20W monograde oils.

<sup>c</sup>20W-50 must contain no more bright stock than the 15W-40.

<sup>d</sup>Provided the XX for "Grade Tested" is less than or equal to XX of the multigrade oil for "Read Across to."

<sup>e</sup>A CF-4 test program with T-9 data to validate engine wear performance must use the T-6 viscosity grade read across guidelines.

<sup>f</sup>A CF-4 test program with T-8A or T-8E data to validate soot handling performance must use the T-7 viscosity grade read across guidelines.

<sup>g</sup>Base oil saturates in the test and final formulations must comply with the guidelines in E.3.1.9, and in cases where a dispersant viscosity modifier (DVM) is used, the DVM level in the final formulation must be equal to or greater than the level in the test oil.

<sup>h</sup>Provided the saturates level in the new candidate oil is equal to or greater than the original candidate oil and the sulfur level is equal to or less than that of the original candidate oil within the precision of the tests.