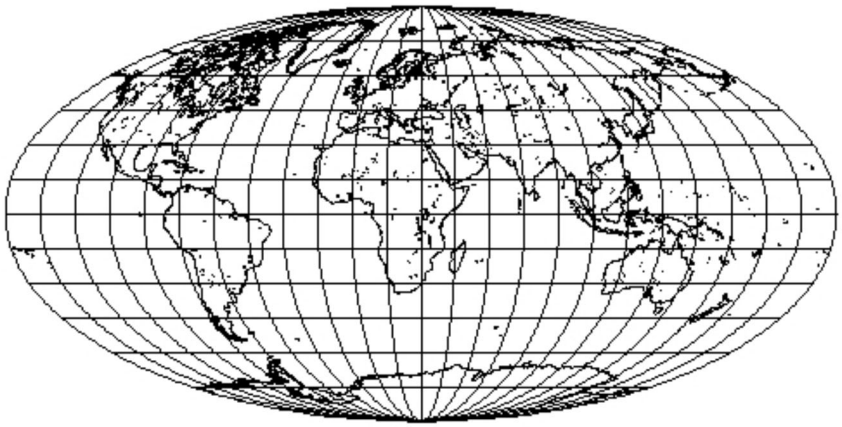
This ILSAC standard is being developed with input from automobile manufacturers, lubricant producers and lubricant additive companies in a process that is open to public review.

INTERNATIONAL LUBRICANT STANDARDIZATION AND APPROVAL COMMITTEE



# ILSAC GF-5 STANDARD FOR PASSENGER CAR ENGINE OILS

December 22, 2009

Jointly developed and approved by

Japan Automobile Manufacturers Association, Chrysler LLC,
Ford Motor Company and General Motors Corporation.

## THE ILSAC MINIMUM PERFORMANCE STANDARD FOR PASSENGER CAR ENGINE OILS – ILSAC GF-5

The Japan Automobile Manufacturers Association, Inc. and representatives from Chrysler LLC, Ford Motor Company and General Motors Corporation, through an organization called the International Lubricants Standardization and Approval Committee (ILSAC), jointly developed and approved an ILSAC GF-5 minimum performance standard for engine oils for spark-ignited internal combustion engines.

This standard specifies the minimum performance requirements (both engine sequence and bench tests) and chemical and physical properties for engine oils for spark-ignited internal combustion engines. It is expected that many engine manufacturers will recommend ILSAC GF-5 oil. However, performance parameters other than those covered by the tests included or more stringent limits on those tests included in this standard may be required by individual OEMs.

In addition to meeting the requirements of the standard, it is the oil marketer's responsibility to be aware of and comply with all applicable legal and regulatory requirements on substance use restrictions, labeling, and health and safety information when marketing products meeting the ILSAC GF-5 standard. It is also the marketer's responsibility to conduct its business in a manner that represents minimum risk to consumers and the environment.

The ultimate assessment of an engine oil's performance must include a variety of vehicle fleet tests that simulate the full range of customer driving conditions. The engine sequence tests listed in this document have been specified instead of fleet testing to minimize testing time and costs. This simplification of test requirements is only possible because the specified engine sequence tests have been judged to be predictive of a variety of vehicle tests.

The relationships between engine sequence tests and vehicle fleet tests are judged valid based only on the range of base oils and additive technologies investigated — generally those that have proven to have satisfactory performance in service and that are in widespread use at this time. The introduction of base oils or additive technologies that constitute a significant departure from existing practice requires sufficient supporting vehicle fleet testing data to ensure there is no adverse effect to vehicle components or to emission control systems. This vehicle fleet testing should be conducted in addition to the other performance requirements listed in this specification.

It is the responsibility of any individual or organization introducing a new technology to perform this vehicle fleet testing, and the responsibility of the oil marketer to ensure the testing of new technology was satisfactorily completed. No marketer can claim to be acting in a reasonable and prudent manner if they knowingly use a new technology based only on the results of engine sequence testing without verifying the

suitability of the new technology in vehicle fleet testing that simulates the full range of customer operation.

The ILSAC GF-5 Minimum Performance Standard includes tests for which Viscosity Grade Read Across and Base Oil Interchange Guidelines have been developed by the appropriate groups. It should be pointed out, however, that when oil marketers use the Guidelines, they do so based on their own judgment and at their own risk. The use of any guidelines does not absolve the marketer of the responsibility for meeting all specified requirements for any products the marketer sells in the marketplace that are licensed as ILSAC GF-5 with the API.

# ILSAC GF-5 REQUIREMENTS

## 1. FRESH OIL VISCOSITY REQUIREMENTS

1.a SAE J300

Oils shall meet all of the requirements of SAE J300. Viscosity grades are limited to SAE 0W, 5W, and 10W multigrade oils.

1.b Gelation Index: ASTM D5133 — 12 maximum

To be evaluated from –5°C to the temperature at which 40,000 cP is attained or –40°C, or 2 Celsius degrees below the appropriate MRV TP-1 temperature (defined by SAE J300), whichever occurs first.

## 2. ENGINE TEST REQUIREMENTS

2.a Wear and Oil Thickening: ASTM Sequence IIIG Test, ASTM D7320

| | |
|---|---|
| Kinematic Viscosity Increase @ 40°C, % | 150 maximum |
| Average Weighted Piston Deposits, merits | 4.0 minimum |
| Hot Stuck Rings | None |
| Average Cam plus Lifter Wear, µm | 60 maximum |

2.b Wear, Sludge, and Varnish Test: Sequence VG, ASTM D6593

| | |
|---|---|
| Average Engine Sludge, merits | 8.0 minimum |
| Average Rocker Cover Sludge, merits | 8.3 minimum |
| Average Engine Varnish, merits | 8.9 minimum |
| Average Piston Skirt Varnish, merits | 7.5 minimum |
| Oil Screen Sludge, % area | 15 maximum |
| Oil Screen Debris, % area | Rate and report |
| Hot Stuck Compression Rings | None |
| Cold Stuck Rings | Rate and report |
| Oil Ring Clogging, % area | Rate and report |

2.c Valvetrain Wear: Sequence IVA, ASTM D6891

| | |
|---|---|
| Average Cam Wear (7 position average), µm | 90 maximum |

2.d Bearing Corrosion: Sequence VIII, ASTM D6709

| | |
|---|---|
| Bearing Weight Loss, mg | 26 maximum |

2.e Fuel Efficiency, Sequence VID, ASTM D7589

| | |
|---|---|
| SAE XW-20 viscosity grade: | |
| FEI SUM | 2.6% minimum |
| FEI 2 | 1.2% minimum after 100 hours aging |
| SAE XW-30 viscosity grade: | |
| FEI SUM | 1.9% minimum |
| FEI 2 | 0.9% minimum after 100 hours aging |
| SAE 10W-30 and all other viscosity grades not listed above: | |
| FEI SUM | 1.5% minimum |
| FEI 2 | 0.6% minimum after 100 hours aging |

## 3. BENCH TEST REQUIREMENTS

3.a Catalyst Compatibility

| | |
|---|---|
| Phosphorus Content, ASTM D4951 | 0.08% (mass) maximum |
| Phosphorus Volatility, ASTM D7320 (Sequence IIIGB, phosphorus retention) | 79% minimum |
| Sulfur Content, ASTM D4951 or D2622 | |
| 0W-XX, 5W-XX | 0.5% (mass) maximum |
| 10W-30 | 0.6% (mass) maximum |

3.b Wear

| | |
|---|---|
| Phosphorus Content, ASTM D4951 | 0.06% (mass) minimum |

3.c Volatility

| | |
|---|---|
| Evaporation Loss, ASTM D5800 | 15% maximum, 1 h at 250°C (Note: Calculated conversions specified in D5800 are allowed.) |
| Simulated Distillation, ASTM D6417 | 10% maximum at 371°C |

3.d High Temperature Deposits, TEOST MHT, ASTM D7097

| | |
|---|---|
| Deposit Weight, mg | 35 maximum |

3.e High Temperature Deposits, TEOST 33C, ASTM D6335

| | |
|---|---|
| Total Deposit Weight, mg | 30 maximum |

Note: No TEOST 33C limit for SAE 0W-20.

3.f Filterability

| | |
|---|---|
| EOWTT, ASTM D6794 | |
| with 0.6% $H_2O$ | 50% maximum flow reduction |
| with 1.0% $H_2O$ | 50% maximum flow reduction |
| with 2.0% $H_2O$ | 50% maximum flow reduction |
| with 3.0% $H_2O$ | 50% maximum flow reduction |

Test formulation with highest additive (DI/VI) concentration. Read across results 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.

| | |
|---|---|
| EOFT, ASTM D6795 | 50% maximum flow reduction |

3.g Fresh Oil Foaming Characteristics,
ASTM D892 (Option A and excluding paragraph 11)

| | Tendency | Stability* |
|---|---|---|
| Sequence I | 10 mL maximum | 0 mL maximum |
| Sequence II | 50 mL maximum | 0 mL maximum |
| Sequence III | 10 mL maximum | 0 mL maximum |

*After 1 minute settling period

3.h Fresh Oil High Temperature Foaming Characteristics,
ASTM D6082 (Option A)

| | Tendency | Stability* |
|---|---|---|
| | 100 mL maximum | 0 mL maximum |

*After 1-minute settling period

3.i Aged Oil Low Temperature Viscosity, ROBO Test, ASTM D7528

Measure CCS viscosity of the EOT ROBO sample at the CCS temperature corresponding to original viscosity grade.

a) If CCS viscosity measured is less than or equal to the maximum CCS viscosity specified for the original viscosity grade, run ASTM D4684 (MRV TP-1) at the MRV temperature specified in SAE J300 for the original viscosity grade.
b) If CCS viscosity measured is higher than the maximum viscosity specified for the original viscosity grade in J300, run ASTM D4684 (MRV TP-1) at 5°C higher temperature (i.e., at MRV temperature specified in SAE J300 for the next higher viscosity grade).
c) The EOT ROBO sample must show no yield stress in the D4684 test and its D4684 viscosity must be below the maximum specified in SAE J300 for the original viscosity grade or the next higher viscosity grade, depending on the CCS viscosity, as outlined in a) or b) above.

or

Aged Oil Low Temperature Viscosity, ASTM Sequence IIIGA Test, ASTM D7320

a) If CCS viscosity measured is less than or equal to the maximum CCS viscosity specified for the original viscosity grade, run ASTM D4684 (MRV TP-1) at the MRV temperature specified in SAE J300 for the original viscosity grade.
b) If CCS viscosity measured is higher than the maximum viscosity specified for the original viscosity grade in J300, run ASTM D4684 (MRV TP-1) at 5°C higher temperature (i.e., at MRV temperature specified in SAE J300 for the next higher viscosity grade).
c) The EOT IIIGA sample must show no yield stress in the D4684 test and its D4684 viscosity must be below the maximum specified in SAE J300 for the original viscosity grade or the next higher viscosity grade, depending on the CCS viscosity, as outlined in a) or b) above.

3.j Shear Stability, Sequence VIII, ASTM D6709

| | |
|---|---|
| 10-hour stripped KV @ 100°C | Kinematic viscosity must remain in original SAE viscosity grade. |

3.k Homogeneity and Miscibility, ASTM D6922

| | |
|---|---|
| | Shall remain homogeneous and, when mixed with ASTM Test Monitoring Center (TMC) reference oils, shall remain miscible. |

3.l Engine Rusting, Ball Rust Test, ASTM D6557

| | |
|---|---|
| Average Gray Value | 100 minimum |

3.m Emulsion Retention, ASTM D7563

| | |
|---|---|
| 0°C, 24 Hours | No water separation |
| 25°C, 24 Hours | No water separation |

3.o Candidate oil testing for elastomer compatibility shall be performed using the five Standard Reference Elastomers (SREs) referenced herein and defined in SAE J2643. Candidate oil testing shall be performed according to ASTM D7216 Annex A2, The post-candidate-oil-immersion elastomers shall conform to the specification limits detailed herein.

| Elastomer Material (SAE J2643) | Test Procedure | Material Property | Units | Limits |
|---|---|---|---|---|
| Polyacrylate Rubber (ACM-1) | ASTM D471 | Volume | % Δ | -5, 9 |
| | ASTM D2240 | Hardness | pts. | -10, 10 |
| | ASTM D412 | Tensile Strength | % Δ | -40, 40 |
| Hydrogenated Nitrile Rubber (HNBR-1) | ASTM D471 | Volume | % Δ | -5, 10 |
| | ASTM D2240 | Hardness | pts. | -10, 5 |
| | ASTM D412 | Tensile Strength | % Δ | -20, 15 |
| Silicone Rubber (VMQ-1) | ASTM D471 | Volume | % Δ | -5, 40 |
| | ASTM D2240 | Hardness | pts. | -30, 10 |
| | ASTM D412 | Tensile Strength | % Δ | -50, 5 |
| Fluorocarbon Rubber (FKM-1) | ASTM D471 | Volume | % Δ | -2, 3 |
| | ASTM D2240 | Hardness | pts. | -6, 6 |
| | ASTM D412 | Tensile Strength | % Δ | -65, 10 |
| Ethylene Acrylic Rubber (AEM-1) | ASTM D471 | Volume | % Δ | -5, 30 |
| | ASTM D2240 | Hardness | pts. | -20, 10 |
| | ASTM D412 | Tensile Strength | % Δ | -30, 30 |

## 4. APPLICABLE DOCUMENTS

4.a SAE Standard, Engine Oil Viscosity Classification - SAE J300, *SAE Handbook*.

4.b SAE Standard, Standard Reference Elastomers (SRE) for Characterizing the Effects on Vulcanized Rubbers, Proposed Draft 2003-5 - SAE J2643, *SAE Handbook*

4.c ASTM Annual Book of Standards, Volume 5, Petroleum Products and Lubricants, current edition.

4.d M. Batko and D. F. Florkowski, “Low Temperature Rheological Properties of Aged Crankcase Oils,” SAE Paper 2000-01-2943.

4.e M. Batko and D. F. Florkowski, “Lubricant Requirements of an Advanced Designed High Performance, Fuel Efficient Low Emissions V-6 Engine,” SAE Paper 01FL-265.