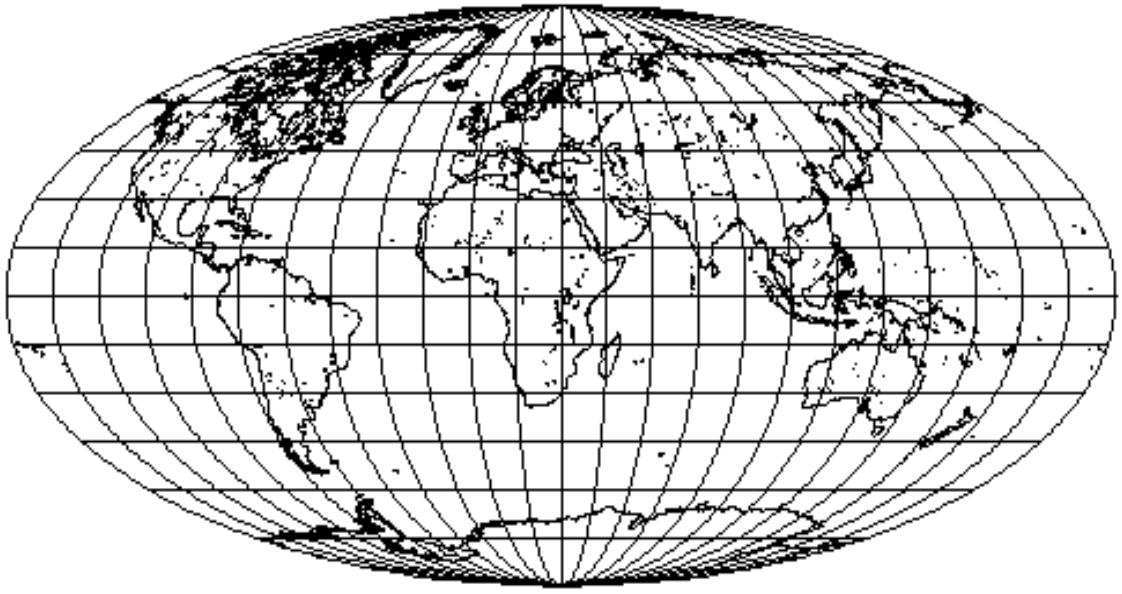
This ILSAC standard is being developed with input from automobile manufacturers, lubricant producers and lubricant additive companies in a process that is open to public review.

INTERNATIONAL LUBRICANT STANDARDIZATION AND APPROVAL COMMITTEE



ILSAC GF-5 STANDARD FOR PASSENGER CAR ENGINE OILS

DRAFT

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Jointly developed and approved by

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

JAMA DAIMLERCHRYSLER Ford GM

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

The Japan Automobile Manufacturers Association, Inc. and representatives from DaimlerChrysler Corporation, 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. 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 which 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 which 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 which have proven to have satisfactory performance in service, and which are in widespread use at this time. The introduction of base oils or additive technologies which 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 which are licensed as ILSAC GF-5 with the API.

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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 D 5133

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 D 7320

Kinematic Viscosity Increase @ 40°C, %	150 maximum
Average Weighted Piston Deposits, merits	5.0 minimum
Hot Stuck Rings	None
Average Cam plus Lifter Wear, µm	60 maximum

2.b Wear, Sludge, and Varnish Test: Sequence VG, ASTM D 6593

Average Engine Sludge, merits	8.3 minimum
Average Rocker Cover Sludge, merits	8.5 minimum
Average Engine Varnish, merits	8.9 minimum
Average Piston Skirt Varnish, merits	7.5 minimum
Oil Screen Sludge, % area	5 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 D 6891

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

2.d Bearing Corrosion: Sequence VIII, ASTM D 6709

Bearing Weight Loss, mg	26 maximum

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2.e Fuel Efficiency, Sequence VID

SAE 0W-20 viscosity grade:
X+1.7% FEI 1 minimum after ? hours aging
Y+1.7% FEI 2 minimum after ? hours aging

SAE 5W-20 viscosity grade:
X+1.2% FEI 1 minimum after ? hours aging
Y+1.2% FEI 2 minimum after ? hours aging

SAE 0W-30 viscosity grade:
X+1.0% FEI 1 minimum after ? hours aging
Y+1.0% FEI 2 minimum after ? hours aging

SAE 5W-30 viscosity grade:
X+0.7% FEI 1 minimum after ? hours aging
Y+0.7% FEI 2 minimum after ? hours aging

SAE 10W-30 and all other viscosity grades not listed above:
X% FEI 1 minimum after ? hours aging
Y% FEI 2 minimum after ? hours aging

X and Y are expected to be at least 0.5% FEI higher than GF-4 limits for comparable viscosity grades.

2.f Used Engine Oil Aeration Test, ASTM D 6894

Aeration Volume, %	6 , max

3. BENCH TEST REQUIREMENTS

3.a Catalyst Compatibility

Phosphorus Content, ASTM D 4951	0.07% (mass) maximum
Phosphorus Volatility, Test TBD	TBD, Reduction in phosphorus volatility equivalent to what would be achieved by reducing the phosphorus content in oil containing higher volatility ZDDP from 0.07% to 0.05%.
Sulfur Content, ASTM D 4951 or D 2622	0.5% (mass) maximum

3.b Wear

Phosphorus Content, ASTM D 4951	0.06% (mass) minimum

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3.c Volatility

Evaporation Loss, ASTM D 5800	15% maximum, 1 h at 250°C (Note: Calculated conversions specified in D 5800 are allowed.)
Simulated Distillation, ASTM D 6417	10% maximum at 371°C

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

Deposit Weight, mg	30 maximum

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

Total Deposit Weight, mg	25 maximum

3.f Filterability

EOWTT, ASTM D 6794	
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 D 6795	50% maximum flow reduction

3.g Fresh Oil Foaming Characteristics, ASTM D 892 (Option A)

	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 D 6082 (Option A)

Tendency	Stability*
100 mL maximum	0 mL maximum

*After 1-minute settling period

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3.i Aged Oil Low Temperature Viscosity, ROBO Test

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.

3.j Shear Stability, Sequence VIII, ASTM D 6709

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

3.k Homogeneity and Miscibility, ASTM D 6922

	Shall remain homogeneous and, when mixed with SAE reference oils, shall remain miscible.

3.l Engine Rusting, Ball Rust Test, ASTM D 6557

Average Gray Value	100 minimum

3.m Emulsion Retention (DCX provide procedure): Oil Mixed with 10% Water, 10% E85

The oil when blended* with a mixture of 10% distilled and 10% E85 shall rtetain a fluid emulsion for the time and temperature specified.

0°C, 24 Hours	No separation
25°C, 24 Hours	No separation

* Waring blender or equivalent – 1 minute maximum at room temperature

E85 solution = 85% ethanol, 15% gasoline

Note: Additives in the emulsified oil must not precipitate out when heated above 110°C

3.n Rust Protection Test, ASTM D1748

100 hours, sandblasted panel No Rust

3.o Candidate oil testing for elastomer compatibility shall be performed using the four Standard Reference Elastomers (SREs) referenced herein and defined in SAE J2643. Candidate oil testing shall be performed according to ASTM D7216, which includes 336 hours of immersion at 100°C for HNBR, and 150°C for ACM, VMQ, and FKM. 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, 5
	ASTM D2240	Hardness	pts.	-10, 10
	ASTM D412	Tensile Strength	% Δ	-30, 30
	ASTM D412	Elongation at Break	% Δ	-45, 5
	ASTM D412	Tensile Stress at 50% Elongation	% Δ	-20, 65
Hydrogenated Nitrile Rubber (HNBR-1)	ASTM D471	Volume	% Δ	-5, 5
	ASTM D2240	Hardness	pts.	-5, 5
	ASTM D412	Tensile Strength	% Δ	-20, 10
	ASTM D412	Elongation at Break	% Δ	-35, 0
	ASTM D412	Tensile Stress at 50% Elongation	% Δ	-10, 35
Silicone Rubber (VMQ-1)	ASTM D471	Volume	% Δ	-5, 40
	ASTM D2240	Hardness	pts.	-20, 10
	ASTM D412	Tensile Strength	% Δ	-45, 0
	ASTM D412	Elongation at Break	% Δ	-40, 0
	ASTM D412	Tensile Stress at 50% Elongation	% Δ	-50, 10
Fluorocarbon Rubber (FKM-1)	ASTM D471	Volume	% Δ	-2, 3
	ASTM D2240	Hardness	pts.	-4, 6
	ASTM D412	Tensile Strength	% Δ	-65, 10
	ASTM D412	Elongation at Break	% Δ	-60, 10
	ASTM D412	Tensile Stress at 50% Elongation	% Δ	-30, 40
Ethylene Acrylic Rubber (AEM)	ASTM D471	Volume	% Δ	0, 30
	ASTM D2240	Hardness	pts.	-10, 10
	ASTM D412	Tensile Strength	% Δ	-30, 30
	ASTM D412	Elongation at Break	% Δ	-45, 5
	ASTM D412	Tensile Stress at 50% Elongation	% Δ	-20, 65

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.