PCO specifications and 7 Critical Areas claims

October 2025

Safety First! Phishing, Vishing and Smishing

Industry Specification Upgrades
ILSAC GF-7 and API SQ

New North American PCO specifications

- ILSAC GF-7
- API SQ

First License Date: March 31, 2025

infineum-api-engine-oil-classification-brochure-2024.pdf

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API and ILSAC

API

- API = American Petroleum Institute
- Industry body made up of members from companies that make base oils, additives and also companies that make finished motor oil products
- Group works to ensure quality lubricants are in the market to protect engines
- Support development of new specifications and engine tests

ILSAC

- ILSAC = International Lubricants Standardization and Approval Committee
- Industry body made up of auto makers from North America and Japan
- Goals are to ensure motor oil is maximizing vehicle performance, fuel economy and durability

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What is API SQ? ILSAC GF-7?

Passenger Vehicle Engine Oil Requirements For API SQ-RC and ILSAC GF-7A/B Categories

Requirements	Test Method	Properties	Unit	Limits – API SQ-RC/GF-7
1. LABORATORY/BENCH TESTS				
1.1 Viscosity Grades	SAE J300	ILSAC Grades are 0W-16, 0W-20, 5W-20, 0W-30, 5W-30 and 10W-30. API allows all eligible grades.	cSt (mm2/s) & cP (mPa-s)	As defined by SAE J300
1.2 New Oil MRV	ASTM D4684	Low temperature Pumping Viscosity	cP (mPa-s)	40,000 max, no yield stress [33]
1.3 Foam Tests	ASTM D892 [34] ASTM D6082 [34]	Sequence I [35], [36] Sequence II [35], [36] Sequence III [35], [36] Sequence IV [35]	tendency/stability, ml	10/0 max 50/0 max 10/0 max 100/0 max
1.4 EOFT	ASTM D6795	Flow Reduction	%	50 max
1.5 EOWTT	ASTM D6794	with 0.6% Water with 1.0% Water with 2.0% Water with 3.0% Water	% flow reduction % flow reduction % flow reduction % flow reduction	50 max 50 max 50 max 50 max
1.6 Aged Oil Low-Temperature Pumpability [37]	ASTM D8111 or ASTM D7528 [38]	MRV TP-1 Apparent Viscosity and Yield Stress	cP and mPa-s	60,000 cP with no yield stress [39]
1.7 TEOST 33C	ASTM D6335	High temperature deposits	total deposit weight, mg	30 max [40], [46]
1.8 Emulsion Retention	ASTM D7563	Oil mixed with 10% Water and 10% E85	0°C and 25°C @ 24 hours	No water separation
1.9 Homogeneity & Miscibility	ASTM D6922	Oil Compatibilty	None	Pass [41]
1.10 Gelation Index [42]	ASTM D5133	Scanning Brookfield Viscosity, Yield Stress	Calculated	12 max [43]
1.11 Volatility	ASTM D5800	Evaporation Loss (Noack)	% off 250°C	15.0 max [44]
1.12 Ball Rust Test [42]	ASTM D6557	Rust rating	Avg Gray Value	100 min
1.13 Elastomer Compatibility	ASTM D7216, Annex A2	Volume Change, %	Hardness, pts	Tensile strength change, %
	Polyacrylate Rubber (ACM-1)	-5, 9	-10, 10	-40, 40
	Hydrogenated Nitrile (HNBR-1)	-5, 10	-10, 5	-20, 15
	Silicone Rubber (VMQ-1)	-5, 40	-30, 10	-50, 5
	Fluorocarbon Rubber (FKM-1)	-2, 3	-6, 6	-65, 10
	Ethylene Acrylic Rubber (AEM-1)	-5, 30	-20, 10	-30, 30
	Polyacrylate Rubber (ACM-2)	Rate & Report	Rate & Report	Rate & Report
	Ethylene Acrylic Rubber (AEM-2)	Rate & Report	Rate & Report	Rate & Report
	Ethylene Acrylic Rubber (AEM-3)	Rate & Report	Rate & Report	Rate & Report
	Fluoroelastomer Rubber (FKM-3)	Rate & Report	Rate & Report	Rate & Report
1.14 Shear Stability	ASTM D6278 or D7109 (30 passes) ASTM D6709 (Sequence VIII)	Diesel Injector, SAE XW-16 only Diesel Injector, 0W-8 & 0W-12 10-hour stripped Kinematic Viscosity	KV @ 100°C after 30 passes cSt KV @ 100°C after 30 passes cSt @ 100°C	5.8 min 0W-8=4.0 min, 0W-12=5.0 min Stay in original visc grade [45]
1.15 Sequence IIIHB	ASTM D8111	Phosphorus retention	%	81 min [46]
1.16 Phosphorus [47]	ASTM D4951 or D5185	Phosphorus content	%	0.06 - 0.08 [48], [49]
1.17 Sulfur [47]	ASTM D4951, D5185 or ASTM D2622	Sulfur content of SAE 0W and 5W multigrades	%	0.5 max [48]
		SAE 10W-30 and all other grades	%	0.6 max [48]
1.18 Engine Oil Gelation Test [50]	WK86363	Flow Reduction	%	Rate and Report
1.19 Sulfated Ash	ASTM D874	Sulfated Ash Content	%	0.9 max [51]

Passenger Vehicle Engine Oil Requirements For API SQ-RC and ILSAC GF-7A/B Categories *continued*

Requirements	Test Method	Properties	Unit	Limits – API SQ-RC/GF-7		
2. ENGINE TESTS						
2.1 Sequence IIIH	ASTM D8111	Kinematic viscosity increase, Average Weighted piston deposits, Average Hot stuck rings	% @ 40°C after 100 hours Merits #	0W-8/ 0W-12 150 max 3.7 min None	xW-16 100 max 4.2 min None	Other 100 max 4.6 min None
2.2 Sequence IVA [52]	ASTM D6891	Average cam wear SAE 0W-8 and 0W- 12 only	µm	90 max		
2.3 Sequence IVB [52]	ASTM D8350	Average intake lifter volume loss (8 position avg.) End of test iron	mm^3 ppm	2.7 max 400 max		
2.4 Sequence VH [42]	ASTM D8256	Average engine sludge Average rocker cover sludge Average engine varnish Average piston skirt varnish Oil screen sludge Oil screen debris Hot stuck compression rings Cold stuck rings Oil ring clogging	Merits Merits Merits Merits % area % area # # % area	7.6 min 7.7 min 8.6 min 7.6 min Rate & report Rate & report None Rate & report Rate & report		
2.5 Sequence VIE [51], [53]	ASTM D8114	SAE XW-20	%FEI SUM %FEI2	4.3 min 2.1 min		
		SAE XW-30	%FEI SUM %FEI2	3.6 min 1.8 min		
		SAE 10W-30 and all other grades not listed above	%FEI SUM %FEI2	3.0 min 1.4 min		
2.6 Sequence VIF [51]	ASTM D8226	SAE XW-16 only	%FEI SUM %FEI2	4.3 min 2.1 min		
2.7 Sequence VIII [45]	ASTM D6709	Bearing weight loss	mg	26 max		
2.8 Sequence IX and Sequence IX Aged [54]	ASTM D8291 Including Appendix X2	Average number of events for 4 iterations Number of events per iteration	# #	5 max 8 max		
2.9 Sequence X	ASTM D8279	EOT chain elongation	% increased	0W-8/0W-12 0.085 max	Others 0.080 max	
2.10 JASO M365 [55]		SAE 0W-8 and 0W-12 only	% FEI	0W-8 2.0	0W-12 1.7	
2.11 JASO M366 [55]		SAE 0W-8 and 0W-12 only	% FEI	0W-8 1.1	0W-12 1.1	

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Sequence IIIH Deposit test

- Tests for ability of an oil to prevent piston deposits plus oil does not oxidize (increase in viscosity over time)
- Confirms finished oil has proper detergents and antioxidants
- Piston deposit cleanliness requirement has increased with category upgrade to API SQ and ILSAC GF-7

Sequence IIIH Engine Test

(ASTM D8111)

Specifications

- API Category – SN, SN PLUS, SP
- ILSAC category – GF-5, GF-6

Objective

Measure lubricant thickening and piston deposits under high-temperature conditions.

Field Service Simulated

High-speed service under relatively high ambient conditions.

Test Fixture

2014 Chrysler 3.6 L Pentastar port fuel-injected gasoline engine.

Test Parameters

Using unleaded gasoline, the engine runs an 8-minute initial lubricant leveling procedure followed by a 15-minute slow ramp-up to speed and load conditions. It then operates at 137 bhp, 3900 rpm, and 151°C lubricant temperature for 90 hours, interrupted at 20-hour intervals for lubricant level checks.

Test Parts Evaluation

- Inspect all six pistons for deposits, varnish, and stuck piston rings.

Used Lubricant Analysis

- Using ASTM D445, compare kinematic viscosity increase at 40°C to a new lubricant baseline (% increase) every 20 hours.
- Wear metals (ASTM D5185)
- Total base number (ASTM D4739)
- Total acid number (ASTM D664)
- Oxidation and nitration by Infrared Spectra (IR 5.8_6.1)

Pass/Fail Criteria

GF-6 Pass Limit	
Parameter	Pass Limit
Viscosity increase	100 % maximum
Weighted piston deposits	4.2 minimum
Hot stuck rings	None

IIIH to IIIG Equivalency SN/SN PLUS/GF-5	
Parameter	Pass Limit
Viscosity increase	150% maximum
Weighted piston deposits	3.7 minimum
Hot stuck rings	None

PASS

FAIL

Information from SwRI website

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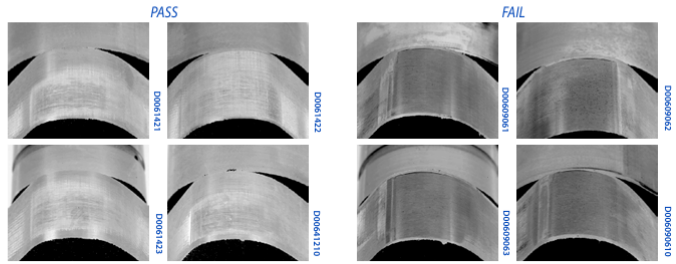
Sequence IVA Wear test

- Tests for ability of an oil to prevent wear and metal-to-metal contact in the engine
- Confirms finished oil has proper anti-wear ingredients
- Wear is common in the cam shaft area of the engine.

Sequence IVA Engine Test

(ASTM D6891)



Specifications

- API SL/SM/SN
- ILSAC GF-3/GF-4/GF-5

Objective

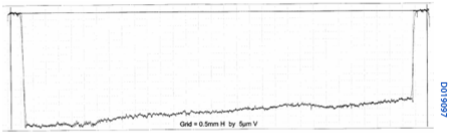
- Evaluate the effect of an automotive lubricant on controlling cam lobe wear for overhead cam engines equipped with sliding cam followers.

Field Service Simulated

- Taxi, light-delivery truck, or commuter service.

Test Fixture

- 1994 Nissan KA24E 2.4 L fuel-injected, four-cylinder in-line gasoline engine with overhead camshaft, two intake valves, and one exhaust valve per cylinder.



Test Parameters

- The test duration is 100 hours involving 100 hourly cycles, each cycle consisting of two operating stages.
- Unleaded Haltermann KA24E Green fuel is used.

Test Condition	Stage 1	Stage 2
Time, minutes	50	10
Engine speed, rpm	800	1500
Engine torque, Nm	25	25
Cylinder head lubricant temp, °C	49	59
Coolant temp, °C	50	55

Test Parts Evaluation

- The 12 cam lobes are each measured at seven locations, using a surface profilometer to measure maximum wear depth.
- The wear on all seven positions of each lobe is added, then all 12 lobes are averaged for the wear result. This result is the primary evaluation for the test.

Used Lubricant Analysis

- Viscosity @ 40°C (ASTM D445)
- Fuel dilution (ASTM D3525)
- Wear metals (ASTM D5185)

Pass/Fail Criteria

Parameter		Pass Limit
GF-3	Average cam wear, µm	120 maximum
GF-4/5	Average cam wear, µm	90 maximum

Information from SwRI website

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Sequence VH Sludge test

- Tests for ability of an oil to prevent sludge formation on a number of engine parts (rocker arm covers, oil pan, valve decks and other areas)
- Confirms finished oil has proper dispersants
- Preventing sludge formation is key to have oil flow properly through the engine and protect metal surfaces

Sequence VH Engine Test
(ASTM D8256)

Specifications

ILSAC, GF-6, SN, SN PLUS, SPObjective

- Evaluate the performance of a lubricant in controlling low-temperature engine deposits under operating conditions deliberately selected to accelerate deposit formation.

Field Service Simulated

- Moderate-temperature taxi service, urban and suburban delivery service, commuter service.

Test Fixture

- 2013 Ford 4.6 L fuel-injected, eight-cylinder, gasoline engine with roller followers, coolant-jacketed rocker covers, and camshaft baffles.

Test Parameters

- The test duration is 216 hours involving 54 cycles, each cycle consisting of three different operating stages.
- Fuel containing sludge precursors is used, and engine blow-by is intentionally increased.
- Rocker cover jacket temperature is cycled.

Test Parts Evaluation

Test Condition	Stage 1	Stage 2	Stage 3
Time, minutes	120	75	45
Engine speed, rpm	1200	2900	700
Intake manifold absolute pressure, kPa	69	66	record
Lubricant temp, °C	68	100	45
Coolant temp, °C	57	85	45
Rocker cover temp, °C	29	85	29

- Sludge deposits are rated on rocker arm covers, rocker arm cover baffles, timing chain cover, oil pan baffle, oil pan, and valve decks.
- Varnish deposits are rated on piston skirts (thrust) and rocker arm cover baffles.
- Piston compression rings are inspected for "hot" and "cold" sticking.
- Clogging of oil pump screen and piston oil rings is rated.

Used Lubricant Analysis

- Viscosity @ 40ºC and 100ºC (ASTM D445)
- Pentane insolubles (ASTM D893 B)
- Fuel dilution (ASTM D3525 modified)
- Total base number (ASTM D4739) Wear metals (ASTM D5185)

Pass/Fail Criteria

Parameter	SP/GF-6 Pass Limit
Average engine sludge	7.6
Rocker cover sludge	7.7
Average engine varnish	8.6
Piston skirt varnish	7.6
Oil screen clogging, %	rate & report
Hot stuck compression rings	none

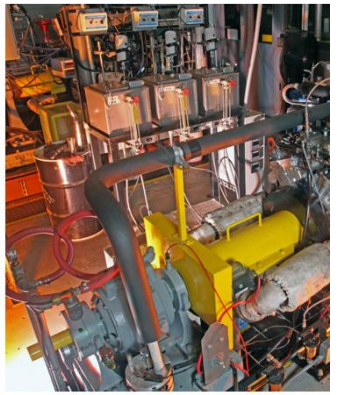
Information from SwRI website

Sequence VI Fuel Economy test

- Tests how motor oil affects fuel economy as compared to a reference oil
- Confirms oil is not negatively affecting fuel economy
- Fuel economy is a key factor that many auto manufacturers push for as part of industry meeting negotiations for new specifications

Sequence VIE Engine Test

(ASTM D8114)



Specifications

- ILSAC GF-6A

Objective

- Provide a comparative fuel economy index (FEI) of the fuel-saving capabilities of automotive engine oils under repeatable laboratory conditions.

Field Service Simulated

- Passenger cars and light-duty trucks.

Test Fixture

- 2012 3.6 L V6 General Motors gasoline engine with external lubricant heating/cooling system and "flying flush" system for changing lubricants without engine shutdown.

Test Parameters

- The test duration is 196 hours.
- Fuel consumption is measured for six speed/load/temperature test conditions compared to an SAE 20W-30 baseline (BL) lubricant to ensure consistent engine response.
- FEI 1, FEI 2 and FEI Sum (FEI 1 plus FEI 2) are calculated from those comparisons.
- The candidate lubricant is introduced and aged for 16 hours at aging conditions and then fuel consumption is measured for six test conditions for FEI 1.
- The candidate lubricant is left in the engine and aged for 109 hours at aging conditions for FEI 2.
- Fuel consumption for each of the six test conditions for BL after.
- Operating targets are as follows:.

Test Condition	Stage 1	Stage 2	Stage 3	Stage 4	Stage 5	Stage 6
Speed, rpm	2000	2000	1500	695	695	695
Torque, Nm	105	105	105	20	20	40
Lubricant temp, °C	115	65	115	115	35	115
Coolant-in temp, °C	109	65	109	109	35	109

Test Parts Evaluation

- None.
- Test results are expressed as a percent change of fuel consumed for the candidate lubricant after Aging Phase I (FEI 1) and after Aging Phase II (FEI 2) relative to the baseline lubricant before and after the candidate lubricant.

Used Lubricant Analysis

Viscosity @ 40°C & 100°C (ASTM D445)

Fuel Efficiency	Test Limit
SEQUENCE VIE XW-20 FEI2 XW-20 FEI SUM	D8114 1.8 3.8
SEQUENCE VIE XW-30 FEI2 XW-30 FEI SUM	D8114 1.5 3.1
SEQUENCE VIE 10W-30 FEI2 10W-30 FEI SUM	D8114 1.3 2.8

Information from SwRI website

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Sequence IX LSPI test

- LSPI – Low Speed Pre-Ignition
- Tests for ability of an oil not to contribute to LSPI and engine “knocking” in GDI engines
- Confirms correct chemistry of detergents in finished oils
- LSPI was a significant issue in the past 10 – 15 years. GDI engines were failing and motor oil chemistry was found to be a contributing factor

Sequence IX Engine Test
(ASTM D8291)

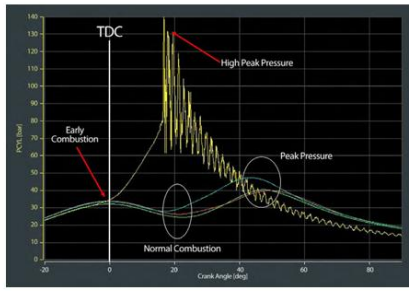
Specifications
- ILSAC GF-6
- API SN+, SP

Objective
- Evaluates the ability of a motor oil to mitigate pre-ignition in the combustion chambers of gasoline, turbocharged, direct-injection (GTDI) engines under low-speed and high-load operating conditions.

Test Fixture
- Ford 2.0L Ecoboost inline four-cylinder engine as found in the 2012 Ford Explorer.

Test Parameters
- The test consists of 4 iterations. Each iteration is 175,000 ignition cycles from each cylinder with the first 170,000 valid cycles evaluated for the number of pre-ignition events.
- Unleaded Haltermann EEE test fuel is used.

Pre-ignition Event Definition
- In-cylinder pressure sensors are used to record the peak pressure of each cycle and the crank angle at which 2% of the mass fraction of fuel is burned (MFB2 calculated from pressure rise).
- A statistical method is applied to find peak pressure (very high) and MFB2 (very early) outliers, and when both conditions are met that is deemed an LSPI event.



Used Lubricant Analysis
- Viscosity @ 40 °C (ASTM D445)
- Viscosity @ 100 °C (ASTM D445)
- Fuel dilution (ASTM D3525)
- Wear metals (ASTM D5185)

Pass/Fail Criteria

	Parameter	Limit
API SN+, SP, GF-6	Average number of pre-ignition events per an iteration over 4 valid iterations (AVPIE)	5 maximum
SP, GF-6	Maximum number of events during any iteration (MAXPIE)	8 maximum

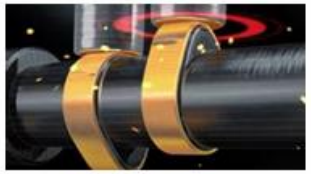
Information from SwRI website

Improved performance – what's changing?
Key upgrades on new specifications

- Better prevention of deposits (Seq. IIIH engine test)
- Improved fuel economy (ILSAC GF-7 only, Seq. VIE/F engine test)
- Better protection against Low-Speed Pre-Ignition (Seq. IX engine test)
- Improved emission system protection – reduced sulfated ash (ASTM D874 bench test)

7 Critical Areas claims

Along with the ILSAC GF-7/API SQ upgrade, our products will now call out our **7 Critical Areas** claim



Pressure
Sequence IVA

Power
Sequence IX

Fuel Economy
Sequence VIE

Hi Temp Perf
Sequence IIIH

Cleanliness
Sequence VH

Wear Protection
Sequence IVA

Endurance
ODI Claims

- Industry regulators (API/ILSAC) measure oil performance in ***6 critical areas with standardized tests***
  - Since these areas are the focus of the tests – they are called out as ***"critical"***
- Performance in these areas along with Castrol's proprietary additive technology increases formula strength to enable best in class ***endurance (the 7th critical area)***

Ultimate Performance + Protection

Exceeds test limits to the point where **no oil can be statistically superior**

Superior Performance + Protection

Exceeds test limits for performance and protection

Superior Protection

Exceeds test limits for protection

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What are 7 Critical Areas claims based on?

Based on API SQ/ILSAC GF-7 engine testing and additional testing in support of new formulas

- Power – Sequence IX
- Wear – Sequence IV
- Pressure – Sequence IV
- High Temperature Deposits – Sequence III
- Sludge – Sequence V
- Fuel Economy – Sequence VI, ACEA and dexos testing
- Endurance – extended drain interval testing

Definition of 7CA

Critical factor	EDGE EP	EDGE (Black)/GTX FS
1 - Power	Unsurpassable result in the Sequence IX + technical link between LSPI performance and temporary and sustained power loss	Passing result in the Sequence IX + same technical link
2 - Wear	Unsurpassable result in the Sequence IVA + technical link of reduced metal to metal contact and wear in a valvetrain wear test	Passing result in the Sequence IVA + same technical link
3 - Pressure	Unsurpassable result in the Sequence IVA + technical link between pressures withstood by the oil in a valvetrain wear test	Passing result in the Sequence IVA + same technical link
4 - High temperature performance	Unsurpassable result in the Sequence IIIH + technical link between conditions in a high temp piston deposit test	Passing result in the Sequence IIIH + same technical link
5 - Sludge	Unsurpassable result in the Sequence VH + technical link with sludge and deposit formation reduction	Passing result in the Sequence VH + same technical link
6 - Fuel Economy	Combination of API, ACEA, Dexos + other OEM specs means it has passed more fuel economy tests than any other oil the category	Passing result in the Sequence VIE
7 - Endurance	Recommended drain interval of 25,000 miles is higher than any other oil in the category	Recommended drain interval superior to other oils in the category

7 Critical Areas – Full Synthetic Laddering

<u>Ultimate</u> Performance + Protection in 7 critical areas

Pressure	Power	Fuel Econ	Hi Temp Per	Cleans	Wear Prot
Seq IVA	Seq IX	Seq VIE	Seq IIIH	Seq VH	Seq IVA

Superior Performance + Protection in 7 critical areas

Pressure	Power	Fuel Econ	Hi Temp Per	Cleans	Wear Prot
Seq IVA	Seq IX	Seq VIE	Seq IIIH	Seq VH	Seq IVA

Superior Protection in 7 critical areas

Pressure	Power	Fuel Econ	Hi Temp Per	Cleans	Wear Prot
Seq IVA	Seq IX	Seq VIE	Seq IIIH	Seq VH	Seq IVA

<u>Front Label Claims</u>

Endurance	**50X Better High Temp Perf**
ODI (25K)	**Highest level of wear protection** (Performance + Protection)
Endurance	**10X Better High Stress Perf** (Performance) Sequence IV Test
ODI (20K)	
Endurance	**6X Better Wear Protection** **1.3x Better Again Sludge** (Protection) Sequence VH Test Sequence
ODI (10K)	

7 Critical Areas – On Pack Messaging

Back Label

Back Label

Back Label

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What about competitor claims?

Claims against the competition are often more difficult to land and keep because the competitor products can change like ours can.

However, based on testing we have done, we can claim:

- 3X stronger vs. the leading synthetic (Mobil 1) – based on industry bench test
- Better piston cleanliness vs. Valvoline Restore & Protect – based on Sequence IIIH testing of EDGE EP vs. Valvoline Restore & Protect

Castrol EDGE EP 5W-30

E2012P/058G/01
IIIH-91-5-37
FRONT
CI-E2012P058-G-1-IIIH-01-EG-91

Valvoline R&P 5W-30

Laboratory:	SR	Oil Code:	SAM616664
Test Stand No.:	69	Test No.:	69-15-333
Laboratory Oil Code:	489571	Test Hours:	90

Piston Front

Product	MF	Sequence IIIH	Average Weighted Pistor Deposits
EDGE Extended Performance 5W-30	A18010WYA	CI-E2012P058-G-1-IIIH-01-EG	5.9
Valvoline Restore & Protect 5W-30	*N/A*	CI-E3032P001-A-1-IIIH-01-SR-69	4.6

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Castrol EDGE

Also suitable for Hybrids

3 oil challenges in hybrids

CONTAMINANTS	INTERMITTENCY	SYSTEM EFFICIENCY
Engine operating temperature is lower and doesn't burn off moisture suspended in the oil	When ICE becomes engaged engine ramps to high speed with reduced oil coverage	Energy lost to friction at low temperature reduces efficiency and increases fuel consumption

→ **24x Protection** Against water contamination*

→ **6x Protection** Against wear**

→ **5x Protection** Against low temperature wear^

* Vs. the leading full synthetic as tested in the E85 Emulsion test
** Cam lobe wear as measured in latest Seq IVA vs. test limit
^ Valvetrain wear as measured in Seq IVB vs. test limit

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JASO GLV-1

New specification developed by JAMA (Japanese OEM's)

- Applies to ultra-low viscosity (0W-8, 0W-12) PCO products
- Requires almost all the same testing as ILSAC GF-7 with the exception of Sequence VI fuel economy test
- Fuel economy test is based on Japanese OEM engine technology
- JAMA driving lower viscosity products and improved fuel economy
- Castrol EDGE 0W-8 will have the following specs
  - API SQ
  - JASO GLV-1

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Questions?

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Let's test your knowledge!

1. What is the latest API Specification?

SQ

2. Name 3 of the 7 Critical Areas?

Power, Wear, Pressure, High Temperature, Sludge,
Fuel Economy, Endurance (Extended Drain Interval)

3. Which Castrol product is unbeaten in all testing areas?

EDGE EP (Extended Performance)

Castrol