

SURFACE VEHICLE INFORMATION REPORT

An American National Standard

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Engine Oil Tests

1. Scope—The purpose of this SAE Information Report is to describe test conditions and performance evaluation factors for both diesel and gasoline engine tests. Specifically, the tests described in this document are used to measure the engine performance requirements for engine oils described by the API Service Categories described in API Publication 1509, ASTM D 4485, SAE J183 and SAE J1423 standards, U.S. military specifications, and ILSAC GF Standards.

2. References

2.1 Applicable Publications—The following publications form a part of the specification to the extent specified herein. Unless otherwise indicated the latest revision of SAE publications shall apply.

2.1.1 SAE PUBLICATIONS—Available from SAE, 400 Commonwealth Drive, Warrendale, PA 15096-0001.

2.1.1.1 SAE J183—Engine Oil Performance and Engine Service Classification (other than “Energy Conserving”)

2.1.1.2 SAE J1423—Passenger Car and Light Duty Truck Energy-Conserving Engine Oil Classification

2.1.2 ASTM PUBLICATIONS—Available from ASTM, 100 Barr Harbor Drive, West Conshohocken, PA 19428-2959.

2.1.2.1 ASTM D 4485—Standard Specification for Performance of Engine Oils

2.1.2.2 ASTM Special Technical Publication 315I, Part I—Multicylinder Test Sequences for Evaluating Automotive Engine Oils

2.1.2.3 Research reports containing the Cummins M-11, Mack T-6, T-7, and T9, and Caterpillar 1K, 1M-PC, 1N, and 1P and the Navistar HEUI procedures are available from ASTM. None of these procedures has been published as an ASTM Standard Test Method.

2.1.2.4 ASTM D 5290—Standard Test Method for Measurement of Oil Consumption, Piston Deposits, and Wear in a Heavy-Duty High-Speed Diesel Engine—NTC-400 Procedure

2.1.2.5 ASTM D 5119—Standard Test Method for Evaluation of Automotive Engine Oils in the CRC L-38 Spark-Ignition Engine

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- 2.1.2.6 ASTM D 5302—Standard Test Method for Evaluation of Automotive Engine Oils for Inhibition of Deposit Formation and Wear in a Spark-Ignition Internal Combustion Engine Fueled with Gasoline and Operated Under Low-Temperature, Light-Duty Conditions—Sequence VE Procedure
- 2.1.2.7 ASTM D 5533—Standard Test Method for Evaluation of Automotive Engine Oils in the Sequence IIIE, Spark-Ignition Engine
- 2.1.2.8 ASTM D 5862—Test Method for Evaluation of Engine Oils in the Two-Stroke Cycle Turbo-Supercharged 6V-92TA.
- 2.1.2.9 ASTM D 5966—Test Method for Evaluation of Engine Oils for Roller Follower Wear in Light-Duty Diesel Engine
- 2.1.2.10 ASTM D 5967—Test Method for Evaluation of Diesel Engine Oils in the T-8 Diesel Engine
- 2.1.2.11 ASTM D 6202—Standard Test Method for Measurement of the Effects of Automotive Engine Oils on the Fuel Economy of Passenger Cars and Light Duty Trucks in the Sequence VIA Spark Ignition Engine
- 2.1.3 API PUBLICATION—Available from American Petroleum Institute, 1220 L Street NW, Washington, DC 20005.

API 1509—Engine Oil Licensing and Certification System
- 2.1.4 INTERNATIONAL LUBRICANT STANDARDIZATION AND APPROVAL COMMITTEE (ILSAC) STANDARDS—Available from the Alliance of Automobile Manufacturers

2.2 Related Publications

- 2.2.1 MILITARY SPECIFICATIONS AND COMMERCIAL ITEM DESCRIPTIONS—Available from Standardization Documents Order Desk, Building 4D, 700 Robbins Avenue, Philadelphia, PA 19111-5094.

MIL-PRF-2104G—Lubricating Oil—Internal Combustion Engine—Tactical Service
MIL-L-6082E—Lubricating Oil—Aircraft Reciprocating Engine
MIL-PRF-21260E—Lubricating Oil—Internal Combustion Engine—Preservative and Break-in
MIL-L-22851D—Lubricating Oil—Aircraft Piston Engine (Ashless Dispersant)
MIL-PRF-46167C—Lubricating Oil—Internal Combustion Engine—Arctic Service
CID A-A-52039B—Lubricating Oil—Automotive Engine—API Service SH
CID A-A-52306A—Lubricating Oil—Heavy-Duty Diesel Engine

- 3. **Test Applicability**—Engine tests have been used for many years to determine performance characteristics of engine oils, and the development of new engine tests is an ongoing process. The included API service categories based on current tests are the SH, SJ, CF, CF-2, CF-4, CG-4, CH-4, and Energy Conserving categories. The current U.S. military specifications included are the MIL-PRF-2104G, MIL-L-6082E, MIL-PRF-21260E, MIL-L-22851D, and MIL-L-46167B specifications. The included current ILSAC Standard is GF-2.
- 4. **Diesel Engine Tests**—Many tests for piston ring sticking, piston ring and cylinder wear, valve train wear, oil consumption, oil thickening, and general deposit accumulation have been developed using single-cylinder and multicylinder compression ignition (diesel) engines. Current single-cylinder tests in use include the Caterpillar 1K, 1M-PC, 1N, and 1P. Current multicylinder tests include the Cummins M-11, Detroit Diesel 6V-92TA, Mack T-6, T-7, T-8, T-9, General Motors 6.5L (Roller Follower Wear Test) and the Navistar HEUI. (See Tables 1A, 1B, and 2.)

TABLE 1A—DIESEL ENGINE TEST CONDITIONS

	Engine Displacement cm ³	Engine Displacement in ³	Test Duration, h total	Test Duration, h each phase	Engine Speed, rpm	Fuel Rate, kW	Fuel Rate, btu/min	Load bmep, kPa	Load bmep, psi
6V-92TA	9 046	552	100	8.0	1200	≥653	≥37 326	2062	299
				8.0	2300	≥1130	≥64 265	1076	156
T-6	11 000	672	600	4.0	1400	523	29 756	1531	222
				4.0	1800	628	35 762	1420	206
				4.0	2100	697	39 641	1262	183
T-7	11 000	672	150		1200	514	29 235	1655	240
T-8	12 000	728	300 ⁽¹⁾		1800	800	45 692	1459	212
T-9	11 931	728	500	75	1800	756	43 012	1475	214
				425	1250	657	37 370	2316	336
NTC-400 ⁽²⁾	14 000	855	200		2100	865	49 237	1289	187
M-11	10 824	660	200	50	1800	634	36 075	1575	228
				50	1600	634	36 075	1916	278
1K	2 400	149	252		2100	140.7 ⁽³⁾	7 995	1240	180
1M-PC	2 200	134	120		1800	102.8	5 850	972	141
1N	2 400	149	252		2100	140.7 ⁽²⁾	7 995	1 240	180
1P	2400	146	360		1800	132	7545	1496	217
RFWT	6 500	397	50		1000	106.1	6 033	620	90
HEUI	7300	444	20		3000	155	29 000	855	124

1. The test duration for category CG-4 is 250 h.
2. This test is obsolete and is included for historical purposes only.
3. Within the test this parameter is expressed in metric units, and the specified fuel rate is 8430 kJ/min.



TABLE 1B—DIESEL ENGINE TEST CONDITIONS

	Air-to-Engine Temperature °C	Air-to-Engine Temperature °F	Air-to-Engine Pressure Abs., kPa	Air-to-Engine Pressure Abs., inch Hg	Water Outlet Temperature °C	Water Outlet Temperature °F	Oil-to-Bearing Temperature °C	Oil-to-Bearing Temperature °F	Fuel Sulfur, % mass
6V-92TA	35	95	N/S	N/S	84	172–190	102	216	0.1–0.4
	35	95	97	29	84	172–190	111	232	0.1–0.4
T-6	66	150	98	29	87.8	190	112.8	235 max	0.1–0.3
	85	185	139	41	87.8	190	112.8	235 max	0.1–0.3
	99	210	156	46	87.8	190	112.8	235 max	0.1–0.3
T-7	113	135	102	30	85.0	185	112.8	235 max	0.40 max
T-8	43	109	186–199	55–59	85	185	100–107	212–225	0.03–0.05
T-9	43	110	287–300	85–89	85	185	100–107	212–225	0.03–0.05
	43	110	260–274	77–81	85	185	99–107	210–225	0.03–0.05
NTC-400 ⁽¹⁾	143	290	142–169	42–50	85.0	185	121.1	250	0.40
M-11	46	115	280	83	88	190	115	239	0.03–0.05
	46	115	265	78	88	190	115	239	0.03–0.05
1K	127	260	240	71	93	199.4	107	224.6	0.38–0.42 ⁽²⁾
1M-PC	124	255	179	53	87.8	190	96	205	0.38–0.42 ⁽²⁾
1N	127	260	240	71	93	200	107	225	0.03–0.05
1P	60	140	272	81	90	194	130	266	0.03–0.05
RFWT	32	90	97	29	120	248	120	248	0.03–0.05
HEUI	29	84	235	70	100	212	120	248	0.03–0.05

1. This test is obsolete and is included for historical purposes only.
 2. Sulfur must be of "Natural Origin."
- N/S = not specified

TABLE 2—DIESEL ENGINE TEST REFERENCES, PERFORMANCE EVALUATION FACTORS, AND APPLICATIONS

Test	Procedure Reference See Section 2.1.2	Evaluation Deposits	Evaluation Wear	Evaluation Oil Consumption	Evaluation Other	Test Application (See 2.1.1 and 2.1.2.1)
6V-92TA	ASTM D 5862	X	X			API CF-2, MIL-PRF-2104G, MIL-PRF-46167C ⁽¹⁾
T-6	ASTM Research Report RR:D02:1219	X	X	X	Oil Thickening	API CF-4
T-7	ASTM Research Report RR:D02:1220				Oil Thickening	API CF-4
T-8	ASTM D 5967			X	Oil Thickening, Filter Plugging	API CG-4
T-9	ASTM Research Report RR:D02:1439		X			API CH-4
NTC-400 ⁽²⁾	ASTM D 5290	X	X	X		API CF-4 ⁽³⁾
M-11	ASTM Research Report RR:D02:1440	X	X		Filter Plugging	API CH-4
1K	ASTM Research Report RR:D02:1273	X		X		API CF-4
1M-PC	ASTM Research Report RR:D02:1320	X				API CF, CF-2, MIL-PRF-2104G, MIL-PRF-46167C, MIL-PRF-21260E
1N	ASTM Research Report RR:D02:1321	X		X		API CG-4, MIL-PRF-2104G, MIL-PRF-46167C, MIL-PRF-21260E
1P	ASTM Research Report RR:D02:1441	X			Oil Consumption	API CH-4
RFWT	ASTM D 5966		X			API CG-4, MIL-PRF-2104G, MIL-PRF-46167C, MIL-PRF-21260E
HEUI	ASTM Research Report RR:D02:1379				Oil Aeration	API CG-4, CH-4

1. A passing 6V-53T test may be substituted for the 6V-92TA requirement for MIL-PRF-46167C.
2. This test is obsolete and is included for historical purposes only.
3. Back-to-back passing 1K tests may be substituted for the NTC-400 requirement for API CF-4.

TABLE 3—GASOLINE ENGINE TEST CONDITIONS

Test	Engine Type	Engine Displacement cm ³	Engine Displacement in ³	Time Total, h	Time Each Phase	Air-Fuel Ratio	Load kW	Load bhp	Fuel Flow kg/h	Fuel Flow lb/h	Speed, rpm	Temperature Coolant °C	Temperature Coolant °F	Temperature Oil °C	Temperature Oil °F
L-38	Single	700	42.5	40		14.0	Not Controlled	Not Controlled	2.04/2.27	4.5–5.0	3150	93.3	200	143.3 ⁽¹⁾	290 ⁽¹⁾
Sequence IID	V8	5740	350	32	28 h	13.0	18.6	25			1500	43.3	110	48.9	120
					2 h	13.0	18.6	25			1500	43.3	110	48.9	120
					2 h	16.5	74.6	100			3600	93.3	200	126.7	260
Sequence IIIE	V6	3800	231	64		16.5	50.6	67.8			3000	115.0	239	149.0	300.2
Sequence VE	OHC4	2290	140	288	2 h	(2)	24.98	33.5			2500	51.7	125	68.3	155
					75 min		24.98	33.5			2500	85.0	185	98.9	210
					45 min		0.75	1.0			750	46.1	115	46.1	115
Sequence VIA	V8	4600	280	50 ⁽³⁾	1.5 h	14.25–15.25	2.18	2.92			800	95	203	105	221
					1.5 h		2.18	2.92			800	60	140	70	158
					1.5 h		5.81	7.79			1500	60	140	70	158
					1.5 h		15.39	20.63			1500	60	140	70	158
					1.5 h		15.39	20.63			1500	45	113	45	113
					1.5 h		2.18	2.92			800	45	113	45	113

1. For MIL-L-6082E and MIL-L-22851D, the oil temperature is 135 °C (275 °F).
2. Equivalence ratio is controlled by monitoring carbon monoxide and oxygen concentrations.
3. Candidate oil testing alternates with reference and flush oils.



TABLE 4—GASOLINE ENGINE TEST REFERENCES, PERFORMANCE EVALUATION FACTORS, AND APPLICATIONS

Test	Procedure Reference (Reference 2.1.2)	Evaluation Rust and Corrosion	Evaluation Sludge	Evaluation Varnish	Evaluation Wear	Evaluation Other	Test Application (See References 2.1.1, 2.1.1.1, 2.1.1.2, 2.1.2.1)
L-38	ASTM D 5119					Bearing Weight Loss	API SH, API SJ, API CF, API CF-4, API CG-4, MIL-PRF-2104G, ILSAC GF-2, MIL-PRF-46167C, MIL-PRF-21260E
Sequence IID	ASTM STP 315I, Part I	X				Lifter Sticking	API SH, MIL-PRF-2104G, MIL-PRF-46167C, MIL-PRF-21260E, ILSAC GF-2
Sequence IIIE	ASTM D 5533		X	X	X	Oil Thickening, Ring Sticking	API SH, API SJ, ILSAC GF-2, MIL-L-2104F
Sequence IIIE	ASTM D 5533					Oil Thickening	API CG-4, API CH-4
Sequence IIIE	ASTM Research Report RR:D02:1225				X		MIL-PRF-2104G, MIL-PRF-21260E, MIL-PRF-46167G
Sequence VE	ASTM D 5302		X	X	X		API SH, MIL-PRF-2104G, MIL-PRF-46167C, ILSAC GF-2, MIL-PRF-21260E
Sequence VIA	ASTM Research Report RR:D02:1364					Fuel Efficiency	Energy Conserving, ILSAC GF-2

SAE J304 Revised JUN1999



5. **Gasoline Engine Tests**—Lubricant performance is evaluated in gasoline engine tests in terms of rust and corrosion, sludge, varnish, piston ring zone deposits and condition, wear, bearing corrosion, and fuel efficiency. For those tests listed in SAE J183 and J1423, Table 3 gives the test conditions and Table 4 gives procedure references, evaluation factors, and the API performance categories, U.S. military specifications, and ILSAC Standards in which the tests are included.
6. **Military Specifications and CIDs**—MIL-L specifications have historically been used as both primary performance specifications, including engine testing, as well as a part of the procurement via Qualified Products Lists. Recently, there has been some movement to adopt a CID (Commercial Item Description) system in place of the MIL-L Specification/QPL system. The first example of this was the adoption of CID A-A-52039B for API Service Category SG oils, and the concurrent cancellation of MIL-L-46152E and the corresponding QPL-46152-14. CID-A-A-52039B defines oil requirements in terms of API Service Category SH, SAE viscosity grades, and various other bench tests. A similar example was the adoption of CID A-A-52306 for heavy-duty diesel oils used in wheeled vehicles (only) which formerly would have required MIL-L-2104 products. With the exception of L-38 stay-in-grade viscosity tests, these CIDs do not specify engine test requirements per se, other than via API categories. For this reason, CID information is not listed in this document in the tables concerned with test applications, Tables 2 and 4.
7. **Notes**
 - 7.1 **Marginal Indicia**—The change bar (I) located in the left margin is for the convenience of the user in locating areas where technical revisions have been made to the previous issue of the report. An (R) symbol to the left of the document title indicates a complete revision of the report.

PREPARED BY THE SAE FUELS AND LUBRICANTS TECHNICAL COMMITTEE 1—
AUTOMOTIVE ENGINE OILS

SAE J301—EFFECTIVE DATES OF NEW OR REVISED TECHNICAL REPORTS

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SAE J304 Revised JUN1999

Rationale—This revision differs from the previous SAE J304 in the inclusion of the Mack T-9, Cummins M-11, and Caterpillar 1P tests, and the API category CH-4. Fuel Efficiency Categories for API SH have been dropped. Several ASTM test method, research report, and test application updates have been made as well.

Relationship of SAE Standard to ISO Standard—Not applicable.

Application—The purpose of this SAE Information Report is to describe test conditions and performance evaluation factors for both diesel and gasoline engine tests. Specifically, the tests described in this document are used to measure the engine performance requirements for engine oils described by the API Service Categories described in API Publication 1509, the ASTM D 4485, SAE J183 and SAE J1423 standards, U.S. Military specifications, and ILSAC GF Standards.

Reference Section

SAE J183—Engine Oil Performance and Engine Service Classification (other than “Energy Conserving”)

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API 1509—Engine Oil Licensing and Certification System



SAE J304 Revised JUN1999

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MIL-PRF-21260E—Lubricating Oil—Internal Combustion Engine—Preservative and Break-in

MIL-L-22851D—Lubricating Oil—Aircraft Piston Engine (Ashless Dispersant)

MIL-L-46167B—Lubricating Oil—Internal Combustion Engine—Arctic Service

CID A-A-52039B—Lubricating Oil—Automotive Engine—API Service SG

CID A-A-52306—Lubricating Oil—Heavy-Duty Diesel Engine

Developed by the SAE Fuels and Lubricants Technical Committee 1—Automotive Engine Oils

SAE J301—Effective Dates of New or Revised Technical Reports—The final approval date for Fuels and Lubricants technical reports is shown following the J-report number. This approval date is the date of final approval by the Fuels and Lubricants Division. It is effective immediately subsequent to divisional approval for *newly issued Standards, Recommended Practices, and Information Reports*, and also for *revised Information Reports* and the *SAE J1146 Recommended Practice*. In the case of *revised or cancelled Standards or Recommended Practices* (used to define product quality), an 18-month optional grace period exists before they become fully effective.