A Program of ASTM International

Test Monitoring Center

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412-365-1000

ASTM REFERENCE OILS

2009

This information was compiled using data from various sources. Part I contains oil code(s), viscosity grade, performance classification(s), year introduced, and average test performance for each reference oil by test area. Part II presents reference oil field data, where available, by test area. Part III contains the *Policies for the Use and Analysis of ASTM Reference Oils*. Finally, Part IV is a compilation of reference oil analytical data as permitted in the policy statement.

The ASTM Test Monitoring Center wishes to acknowledge those companies that supply reference oils for the ASTM calibration system.

ASTM REFERENCE OILS

PART I

Performance Classification

Oil Code Cross-Reference

Test Performance

SEQUENCE IIIF

Oil Code		Viscosity Grade	Performance Classification	Year[a] Introduced	Engine Test Data			
					Viscosity Increase @ 60h (Percent)	Viscosity Increase @ 80h (Percent)	Average Piston Varnish (CRC Merit)	Weighted Piston Deposits (CRC Merit)
TMC	CRC							
1006		5W-30	SJ	1997	235	515	9.35	3.94
433		5W-30	SL	2000	35	37	9.30	4.59

SEQUENCE IIIG

Oil Code		Viscosity Grade	Performance Classification	Year[a] Introduced	Engine Test Data		
					Viscosity Increase (Percent)	Average Cam Plus Lifter Wear (Microns)	Weighted Piston Deposits (CRC Merit)
TMC	CRC						
434		5W-30	na[b]	2003	113	32	4.80
435		5W-20	na[b]	2003	178	33	3.59
438,538		5W-20	SL	2002	97	18	3.20

SEQUENCE IVA

Oil Code		Viscosity Grade	Performance Classification	Year[a] Introduced	Engine Test Data
					Average Camshaft Wear (Microns)
TMC	CRC				
1006		5W-30	SJ	1997	91.15
1007		5W-30	na[b]	1999	84.76
1009		5W-30	SL/GF-3	2002	18.76

SEQUENCE VG

Oil Code		Viscosity Grade	Performance Classification	Year[a] Introduced	Engine Test Data				
					Average Engine Sludge (CRC Merit)	Rocker Cover Sludge (CRC Merit)	Average Engine Varnish (CRC Merit)	Average Piston Varnish (CRC Merit)	Oil Screen Clogging (Percent)
TMC	CRC								
925		5W-30	SF	1987	6.49	7.43	8.56	7.38	53
1006		5W-30	SJ	1997	8.65	9.40	9.24	8.52	1
1007		5W-30	na[b]	1999	8.93	8.99	9.24	8.57	2
1009		5W-30	SL/GF-3	2002	7.94	9.29	8.99	7.79	8

SEQUENCE VIB

Oil Code		Viscosity Grade	Performance Classification	Year[a] Introduced	Engine Test Data	
					FEI1 (Percent)	FEI2 (Percent)
TMC	CRC					
538,438		5W-20	SL	2002	2.02	1.53
539		10W-30	SL/GF-3	2002	0.91	0.38
1006		5W-30	SJ	1997	1.40	0.50

SEQUENCE VIII

Oil Code		Viscosity Grade	Performance Classification	Year[a] Introduced	Engine Test Data	
					Total Bearing Weight Loss (Milligrams)	10-Hour Stripped Viscosity (Centistokes)
TMC	CRC					
704		10W-30	SF	1990	8.3	10.27
1006		5W-30	SJ	1997	17.5	9.37
1009		5W-30	SL/GF-3	2002	13.8	9.51

1M-PC

Oil Code		Vicsocity Grade	Performance Classification	Year[a] Introduced	Engine Test Data	
					Top Groove Fill (Percent)	Weighted Total Demerits (CRC Demerit)
TMC	CRC					
873		40	CD	1993	41.0	232.5

1K

Oil Code		Viscosity Grade	Performance Classification	Year[a] Introduced	Engine Test Data				
					Top Groove Fill (Percent)	WDK (CRC Demerit)	Top Land Heavy Carbon (Percent)	Brake Specific Oil Consumption (g/KW-hr)	EOT Oil Consumption (g/kW-hr)
TMC	CRC								
809,1001	217	15W-40	SE/CD	1990	17.5	216.4	0.8	0.268	1.711
810,1003	212	15W-40	CD	1990	55.3	261.3	5.9	0.375	0.407
811		15W-40	SF/CE	1990	27.3	327.7	1.4	0.267	1.208

1N

Oil Code		Viscosity Grade	Performance Classification	Year[a] Introduced	Engine Test Data			
					Top Groove Fill (Percent)	WDN (CRC Demerit)	Top Land Heavy Carbon (Percent)	Oil Consumption (g/kW-hr)
TMC	CRC							
809,1001	217	15W-40	SE/CD	1990	33.9	198.1	2.9	0.322
810,1003	212	15W-40	CD	1990	70.8	273.3	11.8	0.540
811		15W-40	SF/CE	1990	24.7	281.5	0.4	0.223
1004		15W-40	SH/CG-4/ CF/CF-4/CD	1993	23.9	190.7	0.2	0.148

1P

Oil Code		Viscosity Grade	Performance Classification	Year[a] Introduced	Engine Test Data				
TMC	CRC				Top Groove Carbon (CRC Demerit)	Top Land Carbon (CRC Demerit)	Average Oil Consumption (g/hr)	WDP (CRC Demerit)	EOT Oil Consumption (g/hr)
1004		15W-40	SH/CG-4/CF/CF-4/CD	1993	29.5	28.1	6.2	319.6	7.8
1005		15W-40	na[b]	1997	28.7	30.9	6.5	285.3	5.0

1R

Oil Code		Viscosity Grade	Performance Classification	Year[a] Introduced	Engine Test Data				
TMC	CRC				Top Groove Carbon (CRC Demerit)	Top Land Carbon (CRC Demerit)	Initial Oil Consumption (g/hr)	WDP (CRC Demerit)	EOT Oil Consumption (g/hr)
820, PC-9A		15W-40	na[b]	2001	34.11	22.82	8.3	341.2	7.9
1005		15W-40	na[b]	1993	34.51	18.61	10.0	327.9	8.3

T-8/T-8E

Oil Code		Viscosity Grade	Performance Classification	Year[a] Introduced	Engine Test Data		
TMC	CRC				Viscosity Increase @ 3.8% Soot (cSt)	Relative Viscosity @ 4.8% Soot (50% DIN) (cSt)	Relative Viscosity @ 4.8% Soot (100% DIN) (cSt)
1005		15W-40	na[b]	1993	5.11	1.78	2.03

T-11

Oil Code		Viscosity Grade	Performance Classification	Year[a] Introduced	Engine Test Data			
TMC	CRC				Soot @ 4 cSt Viscosity Increase (Percent)	Soot @ 12 cSt Viscosity Increase (Percent)	Soot @ 15 cSt Viscosity Increase (Percent)	MRV Viscosity (cP)
820, PC-9A		15W-40	na[b]	2001	3.95	5.92	6.51	14981

T-12

Oil Code		Viscosity Grade	Performance Classification	Year[a] Introduced	Engine Test Data				
					Cylinder Liner Wear (Micrometres)	Top Ring Weight Loss (Milligrams)	Oil Consumption (g/h)	Delta Pb EOT (ppm)	Delta Pb 250-300 hr (ppm)
TMC	CRC								
821, PC10E		15W-40	na[b]	2005	15.1	62.0	59.9	22	8

ROLLER FOLLOWER WEAR TEST

Oil Code		Viscosity Grade	Performance Classification	Year[a] Introduced	Engine Test Data
					Avg. Roller Follower Shaft Wear (Mils)
TMC	CRC				
1004		15W-40	SH/CG-4/CF/CF-4/CD	1993	0.44
1005		15W-40	na[b]	1997	0.20

ISB

Oil Code		Viscosity Grade	Performance Classification	Year[a] Introduced	Engine Test Data	
					Average Camshaft Wear (Micrometres)	Average Tappet Weight Loss (Milligrams)
TMC	CRC					
831, PC10B		15W-40	na[b]	2005	42.5	97.2

ISM

Oil Code		Viscosity Grade	Performance Classification	Year[a] Introduced	Engine Test Data			
					Crosshead Wear @ 3.9% Soot (Milligrams)	Oil Filter ΔP (kPa)	Average Sludge (CRC Merit)	Injector Adjusting Screw Wear @ 3.9% Soot (Milligrams)
TMC	CRC							
830, PC-9E		15W-40	na[b]	2001	5.1	11.4	9.00	29.5

C13

Oil Code		Viscosity	Performance	Year[a]	Engine Test Data			
					Top Groove Carbon	Top Land Carbon	Oil Consumption Delta	2nd Ring Top Carbon
TMC	CRC	Grade	Class	Introduced	(Demerits)	(Demerits)	(g/h)	(Demerits)
831, PC10B		15W-40	na[b]	2005	46.02	21.87	30.35	17.86

ENGINE OIL AERATION TEST

Oil Code		Viscosity	Performance	Year[a]	Engine Test Data
TMC	CRC	Grade	Class	Introduced	Average Engine Oil Aeration (Percent)
1004		15W-40	SH/CG-4/CF/CF-4/CD	1993	9.46
1005		15W-40	na[b]	1997	7.80

L-33-1

Oil Code		Viscosity	Year[a]	Gear Rig Test Data
TMC	CRC	Grade	Introduced	Total Rust (CRC Merit)
123		90	1995	8.74
151		80W-90	1993	9.64
155		90	2006	9.58

L-37

Oil Code		Viscosity Grade	Year[a] Introduced	Gear Rig Test Data							
				Pinion Ridging (CRC Merit)		Pinion Rippling (CRC Merit)		Pinion Pitting/Spalling (CRC Merit)		Pinion Wear (CRC Merit)	
TMC	CRC			Lubrited Gears	Non-Lubrited Gears	Lubrited Gears	Non-Lubrited Gears	Lubrited Gears	Non-Lubrited Gears	Lubrited Gears	Non-Lubrited Gears
128		80W-90	1993	7.74	8.30	6.88	7.67	8.84	9.80	5.82	6.44
152		75W-90	2004	6.16	9.64	9.28	9.44	9.33	9.92	6.25	8.16
153		75W-90	2004	6.85	9.09	7.87	8.71	9.46	9.87	6.88	7.60
155		90	2006	8.76	9.84	8.64	9.52	9.46	9.93	5.81	7.88

L-42

Oil Code		Viscosity Grade	Year[a] Introduced	Gear Rig Test Data					
				Coast Side Pinion Scoring (Percent)					
TMC	CRC			Batch P8L123	Batch P8L205	Batch P8L737	Batch P8L327	Batch P8L604	Batch P4L806
114		90	1994	23.2	23.4	20.2	--	--	--
115		80W-90	2003	23.2	23.4	20.2	25.3	25.3	--
116		80W-90	2005	22.9	22.9	--	22.9	22.9	25.1

L-60-1

Oil Code		Viscosity Grade	Year[a] Introduced	Gear Rig Test Data				
				Viscosity Increase (Percent)	Pentane Insolubles (Percent)	Toluene Insolubles (Percent)	Average Carbon/Varnish (CRC Merit)	Average Sludge (CRC Merit)
TMC	CRC							
131		90	1991	75.9	2.56	0.92	1.05	9.48
148		80W-90	1993	37.0	0.39	0.26	8.31	9.53
151		80W-90	1993	37.3	2.12	1.30	8.59	9.42

HIGH TEMPERATURE CYCLIC DURABILITY TEST

Oil Code		Viscosity Grade	Year[a] Introduced	Gear Rig Test Data
				Cycles to Unsynchronized Shifts
TMC	CRC			(Number of Cycles)
150		80W-90	1993	24271
151		80W-90	1993	74489
155		90	2006	74489

FOOTNOTES

a Indicates the year of introduction of the reference oil into the Test Monitoring System.
b na = Information not available.

ASTM REFERENCE OILS

PART II

Field Data

FIELD DATA
ASTM REFERENCE OILS

TEST	SEQUENCE II			SEQUENCE IIIE		SEQ. III (400 SERIES) SEQ. VE (900 SERIES)	
OIL	1A	7I	8C	72A 472	404	424 924	425 925
Type of Service	Short Trip			Field	Taxicab	Taxicab	
No. of Vehicles per Oil							
Vehicle Mileage					100,000 mi.	60,000 - 100,000 mi.	
Engine Model and Size					3.8L - V6 BUICK	3.8L - V6 CHEVY	
Oil Change Interval, Miles					5,000 mi	7,500 mi	
Filter Change Interval, Miles					5,000 mi	7,500 mi.	
Fuel						Unleaded	
Deposits & Wear							
Rust	9.7	7.7	5.2				
Ring Land Deposits					--	4.8	5.6
Piston Skirt Varnish					5.9	7.4	6.9
Sludge					9.4	9.2	8.5
Cam & Lifter Wear				Unacceptable			
Avg. (10 - 4 IN.)					32-111	58	76
Max. (10 - 4 IN.)					81-175	164	200
Viscosity Increase, %					20-170	--	--

FIELD DATA
ASTM REFERENCE OILS

TEST	SEQUENCE VE					
OIL	200				200	200
Type of Service	Taxicab				Taxicab	Taxicab
No. of Vehicles per Oil	2	2	2	2	3	3
Vehicle Mileage	60,000	104,000	70,000	105,000	50,000	60,000
Engine Model and Size	350 CID Chevy V-8				225 CID Six Cyl. Dodge	3.8L Chevy V-6
Oil Change Interval, Miles	12,000		3,000		7,500	7,500
Filter Change Interval, Miles	12,000		3,000		7,500	7,500
Fuel	Leaded	Unleaded	Leaded	Unleaded	Unleaded	Unleaded
Deposits & Wear						
Sludge	5.8	5.6	8.4	9.3	9.4	9.7
Varnish	5.5	4.8	5.8	6.0	7.5	5.5
Piston Skirt Varnish	7.2	7.2	6.6	6.6	6.4	6.1
Cam & Lifter Wear Avg. (10 -3 IN.)	20.4	5.8	10.2	5.2	8.0	5.3

FIELD DATA
ASTM REFERENCE OILS

TESTS	SEQUENCE V (900 SERIES) L-38 (700 SERIES)										
OIL	901 702	907 703	903	911	915	916	914	921		923	
Type of Service	Taxicab		Taxicab		Factory Full Oils		Taxicab	Taxicab	Highway	Delivery Vans	
No. of Vehicles	5	5	3	3	20	Field Service	5	4	4	2	2
Vehicle Mileage	48,000		45,000		Up To 63,000		57,000	83,000		45,000	
Engine Model and Size	Ford L-6 4.1L (240 CID)		Chrysler L-6 3.7L (225 CID)		Ford Engines	Ford Engines	Chevrolet L-6 4.2L (250 CID)	Plymouth L-6 3.7L (225 CID)	Chrysler V-8 7.2 (440 CID)	Ford L-6 4.9L (300 CID)	
Oil Change Interval, Miles	6,000		6,000		5,000 & 10,000		12,000	6,000		6,000	15,000
Filter Change Interval Miles	12,000		6,000		5,000 & 10,000		12,000	6,000		6,000	15,000
Fuel	Unleaded		Leaded		Unleaded	Unleaded	Unleaded	Leaded		Unleaded	
Deposits & Wear											
Sludge	9.7	9.1	8.5	6.1	7.9+	Good	8.7	8.5	8.7	9.6	9.6
Varnish	7.8	6.4	4.9	3.6	4.5+	History	6.3	6.7	5.8	9.2	8.7
Piston Shirt Varnish	7.4	7.3	5.6	5.9	5.6+	In Field Service	6.3	6.2		8.8	7.7
Average Wear											
Cam (10 -3 IN.)	1.2	2.1	2.0*	3.4*	Border-line		2.8	1.8*		Low	Low
Lifter (10 -3 IN.)	1.4	2.5			Fail		0.2				

***** Cylinder Bore Wear

FIELD DATA
ASTM REFERENCE OILS

TESTS	SEQUENCE V (900 SERIES)														
	SEQUENCE III (400 SERIES)														
OIL	923	924 424	923	924 424	924 424	925 425	925-2 425-2	926	927	923	928	929	930	930-1
Type of Service	Taxicab		Suburban Police		Taxicab		Taxicab	Taxicab		Short Trip Commuter (European)			Taxicab	Taxicab
No. of Vehicles per Oil	2	2	3	2	2	2	3	3	2	2	4	2	5	4
Vehicle Mileage	50,000		23,000-48,000	30,000-57,000	60,000		105,000	62,000		18,000			100,000	105,000
Engine Model and Size	Chevrolet 1981 V-6 3.8L (229 CID)		Ford V-8 5.8L (351 CID)	Ford V-8 5.8L (351 CID)	Chevrolet 1983 V-6 3.8L (229 CID)		Chevrolet 1995 V-8 4.3L (260 CID)	Chevrolet 1983 V-6 3.8L (229 CID)		Ford L-4 1.3L CVH (79 CID)			GM 1990 V-6 4.3L (260 CID)	Chevrolet 1996 V-8 4.3L (260 CID)
Oil Change Interval, Miles	7500		3,500	3,500	7,500 to 8,500		10,000	7,500		None			7,500	12,000
Filter Change Interval Miles	7,500		3,500	3,500	7,500 to 8,500		10,000	7,500		None			7,500	9,000
Fuel	Unleaded		Unleaded	Unleaded	Unleaded		Unleaded	Unleaded		Leaded			Unleaded	Unleaded
Deposits & Wear														
Sludge (Average)	7.6	9.3	6.8**	9.3	9.2	8.5	8.82	9.5	7.6	6.4	9.2	6.2	9.57	9.18
Sludge (Rocker Cover)													9.28	
Varnish	5.3	5.7			5.7	5.0	5.61	5.0	4.5				6.27	5.66
Piston Skirt Varnish	7.3	6.5			7.4	6.9	6.08	5.9	5.8				6.28	6.42
										Mean of Top Cover Valve Deck & Oil Pan				
Cam & Lifter Wear														
Avg. (10-3 IN.)	2.1*	1.1*			5.8	7.6		5.0	3.2					
Max. (10-3 IN.)					16.4	20.0		10.5	7.2					

* Camshaft only
** All engines lost oil pressure due to sludge blocking oil screen.

ASTM 5 CAR TEST DATA

	MAKE	TYPICAL MODEL	ENGINE TYPE	DISPLACEMENT IN LIFTERS
	1. Ford	Mustang	L-4	2.3
	2. Ford	LTD	V-8	5.0
	3. Chevrolet	Citation	V-6	2.8
	4. Buick	Century	V-6	3.8
	5. Plymouth	Volare	L-6	3.7

OIL	502	513	515	516	517	518	519	521
Number of Car Tests	1	3	2	5	3	3	2	2
Vehicle Mileage	>10,000							
Oil Change Interval Miles	2,000							
Filter Change Interval Miles	2,000							
Fuel	AMOCO 91							
5 Car Test Result Combined FE %	3.25	1.95	2.70	1.19	2.22	2.70	2.70	3.10
Sequence VI EFEI %	3.17	2.18	2.79	0.74	2.13	2.23	2.50	3.10

FIELD DATA

ASTM REFERENCE OILS

TEST	SG CATEGORY TESTS
OIL	1002*
TYPE OF SERVICE	TAXICAB
VEHICLE MILEAGE	60,000
ENGINE MODEL AND SIZE	4.3L CHEVY V-8
OIL CHANGE INTERVAL, MILES	7,500
DEPOSIT AND WEAR	
SLUDGE	8.33
VARNISH	4.43
AVG. RING WT. LOSS (grams)	0.698
AVG. CAM LOBE WEAR (in x 10,000)	4.3
AVG. LIFTER WEAR (in x 10,000)	4.8
AVG. MAIN BEARING WT. LOSS (grams)	0.162
AVG. CYLINDER BORE WEAR (in x 10,000)	19.2
AVG. MAIN BEARING JOURNAL WEAR (in x 10,000)	2.4
AVG. CRANKSHAFT ROD JOURNAL WEAR (in x 10,000)	3.2
AVG. ROD BEARING WT. LOSS (grams)	0.147

***** 1002 DI package blended in an alternate Category I base stock. Viscosity grade is 5W-30.

FIELD DATA

ASTM REFERENCE OILS

TEST	SJ CATEGORY TESTS
OIL	1006
TYPE OF SERVICE	TAXICAB
NUMBER OF VEHICLES	4
VEHICLE MILEAGE	105,000
ENGINE MODEL AND SIZE	CHEVROLET 4.3L V-8
OIL CHANGE/FILTER CHANGE INTERVAL, MILES	12,000/9,000
FUEL	UNLEADED
DEPOSITS	
SLUDGE (AVERAGE)	9.38
VARNISH	5.92
PISTON SKIRT VARNISH	5.96

ASTM REFERENCE OILS

PART III

Policies for the Use and Analysis

of ASTM Reference Oils

POLICIES FOR THE USE AND ANALYSIS OF ASTM REFERENCE OILS

The primary use of ASTM reference oils is for calibration of test stands used to conduct tests monitored by the ASTM Test Monitoring Center (TMC) at laboratories participating in the ASTM Test Monitoring System. The System shall attempt to provide reference oils for other testing purposes provided that such use does not interfere with test stand calibration. The following policies are divided into three categories of reference oil use: Test Stand Calibration, New Test Development, and Bench Performance Test Development and Correlation.

Test Stand Calibration

Each reference oil sample distributed by the TMC for test stand calibration bears a CMIR code and a test area designation. These samples are to be used only for test stand calibration. No alternative use of these oil samples is permitted without TMC approval. The TMC will decode reference oil samples for use in diagnosing problems on a normally calibrated stand or for use in evaluating new stands and new laboratories when an intention to enter the ASTM Test Monitoring System has been indicated. Samples will also be available for industry test programs for fuel batch and hardware approval. Redistribution of reference oil samples, including retains, is not permitted without TMC approval. These reference oil samples shall not be analyzed for physical or chemical properties beyond what is permitted in the ASTM test procedure for which a sample is designated. The TMC will publish, with the permission of the supplier, the following physical and chemical properties for each batch of crankcase reference oil:

Property	Method
Metals (Ca, Mg, Mo, Zn, P, Ba, Na, S, B)	ASTM D 5185
Kinematic Viscosity @ 40°C and 100°C	ASTM D 445
HTHS @ 150°C	ASTM D 4683
CCS	ASTM D 5293
MRV	ASTM D 4684
Scanning Brookfield	ASTM D 5133
Shear Stability Index	ASTM D 6278
Sulfated Ash	ASTM D 874
TBN	ASTM D 4739
Volatility	ASTM D 6417

The cost per gallon of reference oil used for test stand calibration is established by the ASTM Test Monitoring Board according to the *Regulations Governing the ASTM Test Monitoring System.*

New Test Development

Reference oil samples are available for use in the development of new tests that are intended to become ASTM standard methods. These uses include primary hardware screening by test developers as well as industry approved designed experiments for estimating levels of test discrimination and precision. A request for such reference oil samples shall be made to the TMC and shall include the specific oil(s) with estimated quantities needed and a description of the intended use of the oil(s). Policies for alternative use, redistribution, and analysis are the same as for test stand calibration samples. The cost per

gallon of reference oil used for new test development shall be the same as the cost estimated for test stand calibration.

Bench Performance Test Development and Correlation

Crankcase reference oil samples in one-gallon quantities are available for use in the development and correlation of bench performance tests. A written request for such reference oil samples shall be submitted to the TMC and shall include the specific oil(s) needed and a description of the intended use of the oil(s). Availability is limited to one gallon/reference oil/year/company. Analyses of physical or chemical properties of these samples are limited to those types and methods published by the TMC (see list in Test Stand Calibration section). The supplier(s) of the specific reference oil(s) must also have granted permission of these analyses to be performed. Users are urged to share any data obtained using these reference oil samples with the TMC and the appropriate ASTM surveillance panel(s). The cost per gallon of reference oil used for bench performance test development and correlation shall be ten (10) times the cost established for test stand calibration. Gear reference oils are only available for ASTM bench performance test development and correlation.

ASTM REFERENCE OILS

PART IV

Reference Oil Analytical Data

REFERENCE OIL ANALYTICAL DATA

Oil	Vis Grade	D5480	D6417	D5133	D5133	D4683	D3945*	D4684
		mass %	mass %	Deg C @30,000 cP	Deg C @40,000 cP	cP @150 Deg C	Vis. Loss %	cP / Deg C
433	5W-30	3.7	- -	-33.7	-35.2	3.12	14.55	yield stress/-35
433-1	5W-30	- -	5.4	-33.3	-34.9	3.12	12.34	yield stress/-35
434	5W-30	- -	5.1	-35.4	-37.0	2.91	7.19	21,800/-35
538 (438)	5W-20	- -	3.9	-39.3	-39.3	2.56	15.02	13,800/-35
539	10W-30	- -	6.1	-25.4	-27.7	2.99	13.97	23,600/-30
704-1	10W-30	13.8	- -	-15.4	-17.4	3.20	9.66	yield stress/-25
811-1	15W-40	8.0	- -	-28.7	-30.1	3.91	21.75	7,500/-20
811-2	15W-40	9.0	- -	-27.4	-28.9	3.77	21.55	10,400/-20
820 (PC-9A)	15W-40	- -	11.6	-25.7	-27.5	4.27	9.77	27500/-25
820-2	15W-40	- -	8.3	-25.8	-27.6	4.11	10.42	25,600/-25
820-3	15W-40	- -	7.0	-25.8	-27.6	4.15	8.58	23,600/-25
821 (PC10E)	15W-40	- -	5.6	-26.1	-27.9	4.15	3.63	22,400/-25
830 (PC-9E)	15W-40	- -	7.9	-18.6	-19.3	4.27	9.16	yield stress/-25
830-2	15W-40	- -	6.7	-26.1	-27.8	4.23	14.67	24,600/-25
925-3	5W-30	16.1	- -	-25.8	-27.1	2.66	29.20	37,900/-30
1001	15W-40	14.1	- -	-26.8	-28.5	3.64	2.53	8,900/-20
1004-2	15W-40	8.6	- -	-27.0	-28.5	4.10	17.71	9,600/-20
1004-3	15W-40	7.0	- -	-26.6	-28.2	4.07	18.74	11,500/-20
1005	15W-40	9.6	- -	-26.5	-28.0	4.31	20.64	9,000/-20
1005-1	15W-40	- -	14.7	-26.9	-28.4	4.34	20.23	17,700/-25
1006	5W-30	18.5	- -	-34.5	-35.9	3.03	17.16	54,200/-35
1006-1	5W-30	- -	20.5	-34.7	-36.3	3.00	10.67	49,000/-35
1006-2	5W-30	- -	20.2	-34.4	-35.9	3.04	15.6	52,400/-35
1007	5W-30	6.0	- -	-35.4	-37.0	3.13	11.19	9,500/-30
1009	5W-30	- -	6.0	-31.1	-33.5	3.01	18.08	59,200/-35

* Modified or D6278

Oil	Vis Grade	D5185								
		Ba ppm	B ppm	Ca ppm	Mg ppm	Mo ppm	P ppm	Na ppm	Zn ppm	S wt%
433	5W-30	1	67	2095	<1	112	976	<5	1030	0.237
433-1	5W-30	<1	62	2047	4	110	933	<5	1010	0.229
434	5W-30	<1	<1	1871	4	54	732	<5	780	0.233
538 (438)	5W-20	<1	89	1400	555	<1	937	<5	1024	0.394
539	10W-30	<1	3	1795	6	54	980	<5	1057	0.232
704-1	10W-30	0	0	2349	4	0	963	20	1103	0.308
811-1	15W-40	0	173	33	1151	0	1072	0	1137	0.677
811-2	15W-40	0	214	5	1444	0	1361	10	1419	0.601
820 (PC-9A)	15W-40	<1	410	3473	12	<1	1309	6	1437	0.405
820-2	15W-40	<1	406	3532	15	<1	1317	<5	1438	0.425
820-3	15W-40	<1	392	3423	11	<1	1215	<5	1366	0.476
821 (PC10E)	15W-40	<1	<1	1529	659	<1	1123	<5	1263	0.390
830 (PC-9E)	15W-40	<1	146	3108	297	<1	1219	<5	1302	0.330
830-2	15W-40	<1	149	3145	298	<1	1232	<5	1315	0.338
925-3	5W-30	<1	45	5	1426	<1	878	16	956	0.425
1001	15W-40	0	0	2070	7	0	1139	8	1244	0.418
1004-2	15W-40	0	141	2078	8	99	871	0	979	0.516
1004-3	15W-40	0	151	2275	7	110	998	3	1101	0.535
1005	15W-40	0	217	586	1256	0	1314	2	1306	0.512
1005-1	15W-40	<1	240	546	1278	<1	1273	5	1343	0.510
1006	5W-30	0	123	1115	474	0	960	159	1049	0.506
1006-1	5W-30	<1	135	1084	498	<1	972	180	1047	0.492
1006-2	5W-30	<1	137	1084	513	<1	992	181	1065	0.490
1007	5W-30	0	57	74	1552	1	992	<25	1053	0.275
1009	5W-30	<1	<1	1790	3	54	983	<5	1044	0.238

Oil	Vis Grade	Vis@40 Deg C	Vis@100 Deg C	CCS	Sul Ash	TBN
		cSt	cSt	cP / Deg C	wt%	mgKOH/g
433	5W-30	59.9	10.3	2388/-25	0.94	6.78
433-1	5W-30	59.9	10.3	5538/-30	1.02	6.67
434	5W-30	57.4	10.1	4542/-30	1.05	5.76
538 (438)	5W-20	48.8	8.7	4027/-30	0.99	6.34
539	10W-30	69.1	10.3	5430/-25	0.81	5.42
704-1	10W-30	71.7	10.9	3214/-20	0.96	7.61
811-1	15W-40	100.8	14.2	2840/-15	0.74	7.23
811-2	15W-40	100.9	13.7	2741/-15	0.94	7.26
820 (PC-9A)	15W-40	116.6	15.2	6013/-20	1.59	9.48
820-2	15W-40	115.1	15.1	5727/-20	1.64	9.86
820-3	15W-40	116.8	15.1	6591/-20	- -	9.82
821 (PC10E)	15W-40	118.9	15.6	6984/-20	1.03	8.84
830 (PC-9E)	15W-40	113.9	15.3	6056/-20	- -	10.99
830-2	15W-40	120.8	16.2	5538/-20	1.56	10.40
925-3	5W-30	72.0	11.3	2569/-25	0.73	6.90
1001	15W-40	98.0	13.8	3250/-15	0.92	7.55
1004-2	15W-40	106.0	14.6	3283/-15	0.88	6.14
1004-3	15W-40	109.2	14.6	3314/-15	0.94	5.94
1005	15W-40	116.6	15.8	2966/-15	1.00	8.06
1005-1	15W-40	120.1	15.8	3128/-15	1.11	8.02
1006	5W-30	59.8	10.1	3081/-25	0.79	6.50
1006-1	5W-30	59.0	10.1	6424/-30	0.83	6.90
1006-2	5W-30	58.8	10.1	6328/-30	0.77	6.99
1007	5W-30	61.6	10.2	2894/-25	0.81	6,94
1009	5W-30	63.7	10.5	6235/-30	0.82	5.46