



Test Monitoring Center

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ASTM REFERENCE OILS

2002

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 | | | Weighted Piston Deposits (CRC Merit) |
|----------|-----------------|----------------------------|------------------------------|------------------------------------|------------------------------------|------------------------------------|--------------------------------------|
| | | | | Viscosity Increase @ 60h (Percent) | Viscosity Increase @ 80h (Percent) | Average Piston Varnish (CRC Merit) | |
| TMC | CRC | | | | | | |
| 1006 | 5W-30 | SJ | 1997 | 202 | 405 | 9.35 | 4.18 |
| 1008 | 5W-30 | SJ | 1999 | 68 | 124 | 9.74 | 4.52 |
| 433 | 5W-30 | SL | 2000 | 35 | 35 | 9.27 | 4.27 |

SEQUENCE IVA

| Oil Code | Viscosity Grade | Performance Classification | Year ^a Introduced | Engine Test Data | |
|----------|-----------------|----------------------------|------------------------------|-----------------------------------|---------------------------------|
| | | | | Average Engine Sludge (CRC Merit) | Average Camshaft Wear (Microns) |
| TMC | CRC | | | | |
| 1006 | 5W-30 | SJ | 1997 | | 90.72 |
| 1007 | 5W-30 | na ^c | 1999 | | 92.12 |

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 | 6.23 | 7.38 | 8.57 | 7.40 | 62 | |
| 1006 | 5W-30 | SJ | 1997 | 8.43 | 9.35 | 9.27 | 8.49 | 3 | |
| 1007 | 5W-30 | na ^c | 1999 | 8.93 | 8.99 | 9.24 | 8.57 | 2 | |
| 1009 | 5W-30 | SL/GF-3 | 2002 | 8.00 | 9.25 | 8.93 | 7.80 | 5 | |

SEQUENCE VIB

| Oil Code | | Viscosity Grade | Performance Classification | Year ^a Introduced | Engine Test Data | |
|----------|-----|-----------------|----------------------------|------------------------------|------------------|----------------|
| TMC | CRC | | | | FEI1 (Percent) | FEI2 (Percent) |
| 538 | | 5W-20 | SL | 2002 | 1.90 | 1.57 |
| 1006 | | 5W-30 | SJ | 1997 | 1.40 | 0.50 |
| 1008 | | 5W-30 | SJ | 1999 | 1.88 | 1.27 |

SEQUENCE VIII

| Oil Code | | Viscosity Grade | Performance Classification | Year ^a Introduced | Engine Test Data | |
|----------|-----|-----------------|----------------------------|------------------------------|--|--|
| TMC | CRC | | | | Total Bearing Weight Loss (milligrams) | 10-Hour Stripped Viscosity (centistokes) |
| 704 | | 10W-30 | SF | 1990 | 8.3 | 10.27 |
| 1006 | | 5W-30 | SJ | 1997 | 15.9 | 9.00 |

1M-PC

| Oil Code | | Viscosity Grade | Performance Classification | Year ^a Introduced | Engine Test Data | |
|----------|-----|-----------------|----------------------------|------------------------------|---------------------------|---------------------------------------|
| TMC | CRC | | | | Top Groove Fill (Percent) | Weighted Total Demerits (CRC Demerit) |
| 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 | 30.4 | 204.0 | 0.6 | 0.206 |

1P

| Oil Code | | Viscosity Grade | Performance Classification | Year ^a Introduced | Engine Test Data | | | | |
|----------|-----|-----------------|----------------------------|------------------------------|---------------------------------|-------------------------------|-----------------------------------|-------------------|-------------------------------|
| | | | | | Top Groove Carbon (CRC Demerit) | Top Land Carbon (CRC Demerit) | Average Oil Consumption (g/kW-hr) | WDP (CRC Demerit) | EOT Oil Consumption (g/kW-hr) |
| TMC | CRC | | | | | | | | |
| 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 ^c | 1997 | 28.7 | 30.9 | 6.5 | 285.3 | 5.0 |

1R

| Oil Code | | Viscosity Grade | Performance Classification | Year ^a Introduced | Engine Test Data | | | | EOT Oil Consumption (g/kW-hr) |
|----------|------------|-----------------|----------------------------|------------------------------|---------------------------------|-------------------------------|-----------------------------------|-------------------|-------------------------------|
| | | | | | Top Groove Carbon (CRC Demerit) | Top Land Carbon (CRC Demerit) | Initial Oil Consumption (g/kW-hr) | WDP (CRC Demerit) | |
| TMC | 820, PC-9A | 15W-40 | na ^c | 2001 | 34.11 | 22.82 | 8.3 | 341.2 | 7.9 |
| | 1005 | 15W-40 | SH/CG-4/CF/CF-4/CD | 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 | |
|----------|-----------------|----------------------------|------------------------------|--------------------------------------|--|
| | | | | Viscosity Increase @ 3.8% Soot (cSt) | Relative Viscosity @ 4.8% Soot (50% DIN) (cSt) |
| TMC | 15W-40 | SH/CG-4/CF/CF-4/CD | 1993 | 4.57 | 2.07 |
| | 1004 | SH/CG-4/CF/CF-4/CD | 1993 | 4.57 | 2.21 |

T-9

| Oil Code | Viscosity Grade | Performance Classification | Year ^a Introduced | Engine Test Data | | |
|----------|-----------------|----------------------------|------------------------------|-------------------------------|-----------------------------------|------------------|
| | | | | Adjusted Liner Wear (Microns) | Top Ring Weight Loss (Milligrams) | Δ Pb @ EOT (ppm) |
| TMC | 15W-40 | na ^c | 1997 | 24.6 | 93.7 | 53 |
| | 1005 | na ^c | 1997 | 24.6 | 93.7 | 53 |

T-10

| Oil Code | Viscosity Grade | Performance Classification | Year ^a Introduced | Engine Test Data | | |
|----------|-----------------|----------------------------|------------------------------|-------------------------------|-----------------------------------|------------------------------|
| | | | | Adjusted Liner Wear (Microns) | Top Ring Weight Loss (Milligrams) | Oil Consumption (grams/hour) |
| TMC | 15W-40 | na ^c | 2001 | 30.4 | 111 | 50.6 |
| | 820, PC-9A | na ^c | 2001 | 30.4 | 111 | 50.6 |

6V92TA

| Oil Code | | Viscosity Grade | Performance Classification | Year ^a Introduced | Engine Test Data | | |
|----------|-----|-----------------|----------------------------|------------------------------|-------------------------------|---|--------------------|
| | | | | | Fire Ring Distress (Demerits) | 2 nd & 3 rd Ring Avg. Distress (Demerits) | Liner Scuffing (%) |
| TMC | CRC | | | | | | |
| 861,1001 | 217 | 15W-40 | SE/CD | 1990 | 0.301 | 0.225 | 58.6 |
| 862 | | 30 | CD-II/SF | 1990 | 0.128 | 0.120 | 24.4 |

ROLLER FOLLOWER WEAR TEST

| Oil Code | | Viscosity Grade | Performance Classification | Year ^a Introduced | Engine Test Data |
|----------|-----|-----------------|----------------------------|------------------------------|------------------|
| | | | | | |
| TMC | CRC | | | | |
| 1004 | | 15W-40 | SH/CG-4/CF/CF-4/CD | 1993 | 0.33 |
| 1005 | | 15W-40 | na ^c | 1997 | 0.20 |

M11

| Oil Code | | Viscosity Grade | Performance Classification | Year ^a Introduced | Engine Test Data | |
|----------|--------|-----------------|----------------------------|------------------------------|---|----------------------------|
| | | | | | Adjusted Crosshead Wear (Transformed Units) | Average Sludge (CRC Merit) |
| TMC | CRC | | | | | |
| 1005 | 15W-40 | na ^c | | 1997 | 4.53 | 8.40 |
| | | | | | Oil Filter Δ P (kPa) | 122.3 |

M11 EGR

| Oil Code | | Viscosity Grade | Performance Classification | Year ^a Introduced | Engine Test Data | | |
|------------|--------|-----------------|----------------------------|------------------------------|--------------------------------------|----------------------|----------------------------|
| | | | | | Adjusted Crosshead Wear (Milligrams) | Oil Filter Δ P (kPa) | Average Sludge (CRC Merit) |
| TMC | CRC | | | | | | |
| 830, PC-9E | 15W-40 | na ^c | | 2001 | 13.0 | 138.1 | 8.30 |
| | | | | | | | 131.3 |

ENGINE OIL AERATION TEST

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

L-33

| Oil Code | Viscosity Grade | Year ^a Introduced | Gear Rig Test Data | |
|----------|-----------------|------------------------------|------------------------|------------------------------|
| | | | Total Rust (CRC Merit) | Year ^a Introduced |
| TMC | CRC | | | |
| 123 | 90 | 1995 | 8.43 | |
| 151 | 80W-90 | 1993 | 9.69 | |

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 | Lubrited Gears | Non-Lubrited Gears |
| 127 | 80W-90 | 1993 | - | 6.89 | - | 7.98 | - | 9.18 | - | - | - | 5.80 |
| 128 | 80W-90 | 1993 | 6.63 | 7.83 | 7.21 | 7.96 | 9.90 | 9.77 | 5.80 | 6.40 | 5.80 | 6.40 |
| 151 | 80W-90 | 1993 | 6.86 | 9.36 | 9.00 | 8.85 | 9.87 | 9.93 | 6.83 | 7.63 | 6.83 | 7.63 |

L-42

| Oil Code | Viscosity Grade | Year ^a Introduced | Gear Rig Test Data | | |
|----------|-----------------|------------------------------|--------------------|-------------------|-------------------|
| | | | Gear Batch P8L205 | Gear Batch P8L737 | Gear Batch P8L327 |
| TMC | CRC | | | | |
| 114 | 90 | 1994 | 23.433 | 20.167 | 25.333 |

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 |
| 133 | | 85W-140 | 2000 | 93.7 | 2.80 | 1.40 | 6.55 | 9.38 |
| 143 | | 80W-90 | 1989 | 31.5 | 1.27 | 0.91 | 9.00 | 9.50 |
| 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 (Number of Cycles) |
| TMC | CRC | | | | |
| 150 | | 80W-90 | 1993 | | 28,932 |
| 151 | | 80W-90 | 1993 | | 80,294 |

FOOTNOTES

- a Indicates the year of introduction of the Reference Oil to the Test Monitoring System or by the Test Sponsor for years prior to 1976.
- b The performance classification relates only to the Rust parameter.
- c 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) | |
|-------------------------------|-------------|-----|-----|---------------|--------------------|---|------------|
| | 1A | 7I | 8C | 72A 472 | 404 | 424 924 | 425 925 |
| Type of Service | Short Trip | | | Field | Taxicab | Taxicab | |
| No. of Vehicles per Oil | | | | | 100,000 mi. | 60,000 - 100,000 mi. | |
| Vehicle Mileage | | | | | | | |
| 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 | | -- | 4.8 | 5.6 |
| Ring Land Deposits | | | | | 5.9 | 7.4 | 6.9 |
| Piston Skirt Varnish | | | | | 9.4 | 9.2 | 8.5 |
| Sludge | | | | | | | |
| Cam & Lifter Wear | | | | | | 58 | 76 |
| Avg. (10 - 4 IN.) | | | | Unacceptable | 32-111 | 164 | 200 |
| Max. (10 - 4 IN.) | | | | | 81-175 | | |
| Viscosity Increase, % | | | | | 20-170 | -- | -- |

**FIELD DATA
ASTM REFERENCE OILS**

| TEST | SEQUENCE VE | | | | | |
|------------------------------------|----------------------|----------|---------------------------|----------|-------------------|----------|
| | 200 | | 200 | | 200 | 200 |
| OIL | 200 | | 200 | | Taxicab | Taxicab |
| 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) | | | | | | | | | |
|------------------------------|--|------------|--------------------------------------|------|-------------------|-----------------|---------------------------------------|--------------------------------------|-------------------------------------|----------------------------------|
| | 901 702 | 907 703 | 903 | 911 | 915 | 916 | 914 | 921 | 923 | |
| Type of Service | Taxicab | | Taxicab | | Factory Full Oils | | Taxicab | Taxicab | | Delivery Vans |
| No. of Vehicles | 5 | 5 | 3 | 3 | 20 | Field Service | 5 | 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 Varnish | 9.7 | 9.1 | 8.5 | 6.1 | 7.9+ | Good | 8.7 | 8.5 | 8.7 | 9.6 |
| Piston Shirt Varnish | 7.8 | 6.4 | 4.9 | 3.6 | 4.5+ | History In | 6.3 | 6.7 | 5.8 | 8.7 |
| Average Wear | 7.4 | 7.3 | 5.6 | 5.9 | 5.6+ | Field Service | 6.3 | 6.2 | | 7.7 |
| 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

ASTM 5 CAR TEST DATA

| MAKE | | TYPICAL MODEL | | | ENGINE TYPE | | DISPLACEMENT IN LITERS | |
|---------------------------------|-----|---------------|------|------|-------------|------|------------------------|------|
| 1. Ford | 502 | 513 | 515 | 516 | 517 | 518 | 519 | 521 |
| 2. Ford | 1 | 3 | 2 | 5 | 3 | 3 | 2 | 2 |
| 3. Chevrolet | | | | | | | | |
| 4. Buick | | | | | | | | |
| 5. Plymouth | | | | | | | | |
| OIL | | | | | | | | |
| Number of Car Tests | | | | | | | | |
| Vehicle Mileage | | | | | | | | |
| Oil Change Interval Miles | | | | | | | | |
| Filter Change Interval Miles | | | | | | | | |
| Fuel | | | | | | | | |
| 5 Car Test Result Combined FE % | | 3.25 | 2.70 | 1.19 | 2.22 | 2.70 | 2.70 | 3.10 |
| Sequence VI | | | | | | | | |
| EFEI % | | 3.17 | 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 four categories of reference oil use: Test Stand Calibration, New Test Development, Bench Performance Test Development and Correlation, and Fleet Testing and Other Bulk Use.

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 5480 |

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.

Fleet Testing and Other Bulk Use

Due to the uncertainty of the volumes of reference oils needed for fleet testing and other bulk uses, arrangements will be made for CRC to supply reference oils for these purposes. Requesters and suppliers will be referred to CRC as specific needs arise. Further, suppliers will be encouraged to blend additional reference oil for distribution by CRC when they are producing blends for the TMC. Every effort will be made to protect the identity of suppliers and to maintain the same limitations on analyses of physical or chemical properties that may be performed.

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 |
| 529 | 5W-30 | 9.5 | -- | -30.1 | -31.6 | 2.94 | 12.46 | 7,000/-30 |
| 529-1 | 5W-30 | 6.1 | -- | -35.0 | -35.5 | 2.97 | 12.74 | 10,200/-30 |
| 534 | 5W-30 | 17.2 | -- | -34.1 | -35.5 | 3.09 | 13.40 | 11,700/-30 |
| 535-1 | 5W-20 | 4.3 | -- | -31.0 | -32.0 | 2.61 | 10.14 | 6,200/-30 |
| 535-2 | 5W-20 | 5.2 | -- | -32.4 | -33.3 | 2.70 | 16.94 | 8,600/-30 |
| 536 | 5W-30 | 18.3 | -- | -34.8 | -36.4 | 2.88 | 18.00 | 12,700/-30 |
| 536-1 | 5W-30 | 14.9 | -- | -33.6 | -35.3 | 2.94 | 20.37 | 25,600/-30 |
| 538 | 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 |
| 600 | 20 | -- | -- | -- | -- | -- | -- | -- |
| 600-1 | 20 | -- | -- | -- | -- | -- | -- | -- |
| 602-1 | 30 | 4.0 | -- | -9.1 | -9.5 | 3.77 | -0.16 | -- |
| 604-1 | 20 | -- | -- | -- | -- | -- | -- | -- |
| 606 | 20 | -- | -- | -- | -- | -- | -- | -- |
| 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 |
| 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 |
| 862-1 | 30 | 2.5 | -- | -19.1 | -20.3 | 3.72 | -0.08 | -- |
| 873-1 | 40 | -- | -- | -- | -- | 4.14 | -- | -- |
| 873-2 | 40 | -- | 8.3 | -- | -- | 4.16 | -- | -- |
| 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 | 17700/-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 | 49000/-35 |
| 1006-2 | 5W-30 | -- | 20.2 | -34.4 | -35.9 | 3.04 | 15.6 | 52400/-35 |
| 1007 | 5W-30 | 6.0 | -- | -35.4 | -37.0 | 3.13 | 11.19 | 9500/-30 |
| 1008 | 5W-30 | 8.1 | -- | -34.7 | -35.8 | 3.02 | 17.94 | 6800/-30 |
| 1008-1 | 5W-30 | -- | 6.1 | -32.6 | -33.4 | 2.91 | 17.08 | 14,900/-35 |
| 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 |
| 529 | 5W-30 | 0 | 269 | 2074 | 8 | 327 | 598 | 0 | 632 | 0.306 |
| 529-1 | 5W-30 | 0 | 309 | 2197 | 10 | 388 | 552 | 2 | 574 | 0.244 |
| 534 | 5W-30 | 0 | 112 | 155 | 916 | 0 | 1000 | 0 | 1079 | 0.499 |
| 535-1 | 5W-20 | 0 | 1011 | 2091 | 12 | 680 | 1007 | 0 | 1108 | 0.371 |
| 535-2 | 5W-20 | 1 | 1142 | 2291 | 12 | 707 | 1009 | 2 | 1088 | 0.355 |
| 536 | 5W-30 | 0 | 76 | 1212 | 265 | 0 | 885 | 230 | 962 | 0.359 |
| 536-1 | 5W-30 | 0 | 93 | 1432 | 328 | 1 | 1029 | 246 | 1100 | 0.344 |
| 538 | 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 |
| 600 | 20 | 0 | 0 | 3 | 3 | 0 | 2 | 0 | 0 | 0.099 |
| 600-1 | 20 | 0 | 0 | 0 | 0 | 0 | 1 | <25 | 0 | 0.105 |
| 602-1 | 30 | 0 | 0 | 2350 | 4 | 0 | 1 | 5 | 2 | 0.615 |
| 604-1 | 20 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0.093 |
| 606 | 20 | <1 | 87 | 366 | <1 | <1 | 1 | <5 | <1 | 0.357 |
| 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 |
| 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 |
| 862-1 | 30 | 0 | 7 | 12 | 1284 | 0 | 1129 | 1 | 1234 | 0.698 |
| 873-1 | 40 | 10 | 0 | 3880 | 10 | 0 | 0 | 10 | 0 | 0.260 |
| 873-2 | 40 | <1 | <1 | 3960 | 14 | <1 | <1 | <5 | <1 | 0.263 |
| 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 |
| 1008 | 5W-30 | 0 | 23 | 1811 | 15 | 738 | 1000 | 14 | 1099 | 0.371 |
| 1008-1 | 5W-30 | <1 | 23 | 1830 | 17 | 720 | 1029 | 7 | 1113 | 0.311 |
| 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 |
| 529 | 5W-30 | 50.8 | 9.8 | 3148/-30 | 0.89 | 6.89 |
| 529-1 | 5W-30 | 51.5 | 9.8 | 3415/-30 | 0.80 | 7.04 |
| 534 | 5W-30 | 59.9 | 10.1 | 3052/-25 | 0.68 | 5.77 |
| 535-1 | 5W-20 | 42.8 | 8.4 | 2261/-25 | 1.17 | 7.74 |
| 535-2 | 5W-20 | 42.6 | 8.4 | 2280/-25 | 1.25 | 7.89 |
| 536 | 5W-30 | 61.3 | 10.3 | 2992/-25 | 0.83 | 6.24 |
| 536-1 | 5W-30 | 61.0 | 10.3 | 2477/-25 | 0.78 | 6.44 |
| 538 | 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 |
| 600 | 20 | 37.0 | 6.5 | -- | 0.00 | 3.40 |
| 600-1 | 20 | 37.4 | 6.5 | -- | 0.00 | 6.22 |
| 602-1 | 30 | 107.2 | 12.3 | -- | 0.84 | 2.86 |
| 604-1 | 20 | 55.6 | 8.1 | -- | 0.00 | 4.35 |
| 606 | 20 | 53.8 | 8.0 | -- | 0.34 | 2.99 |
| 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 |
| 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 |
| 862-1 | 30 | 107.2 | 12.1 | -- | 0.78 | 5.04 |
| 873-1 | 40 | 194.8 | 14.9 | -- | 1.41 | 13.90 |
| 873-2 | 40 | 192.0 | 15.0 | -- | 1.34 | 12.97 |
| 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 |
| 1008 | 5W-30 | 51.4 | 10.5 | 1980/-25 | 0.78 | 5.78 |
| 1008-1 | 5W-30 | 51.6 | 10.4 | 3987/-30 | 0.84 | 5.66 |
| 1009 | 5W-30 | 63.7 | 10.5 | 6235/-30 | 0.82 | 5.46 |