

Form 2

Sequence III G

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Sequence IIIG

Form 3

Summary of Test Method

The Sequence IIIG Test is a fired-engine, dynamometer lubricant test for evaluating automotive engine oils for certain high-temperature performance characteristics, including oil thickening, varnish deposition, oil consumption, and engine wear. Such oils include both single viscosity grade and multi-viscosity grade oils that are used in spark-ignition, gasoline-fueled engines, as well as diesel engines. The Sequence IIIG Test utilizes a 1996 General Motors Powertrain 3800 Series II, water-cooled, 4 cycle, V-6 engine as the test apparatus. The Sequence IIIG test engine is an overhead valve design (OHV) and uses a single camshaft operating both intake and exhaust valves via pushrods and hydraulic valve lifters in a sliding-follower arrangement. The engine uses one intake and one exhaust valve per cylinder. Induction is handled by a modified GM port fuel injection system setting the Air-to-Fuel ratio at 15:1. The test engine is overhauled prior to each test, during which critical engine dimensions are measured and rated or measured parts (pistons, camshaft, valve lifters, etc.) are replaced.

The Sequence IIIG Test consists of a 10-minute operational check, followed by 100 hours of engine operation at moderately high speed, load, and temperature conditions. The 100-hour segment is broken down into five 20-hour test segments. Following each 20-hour segment, and the 10-minute operational check, oil samples are drawn from the engine. The kinematic viscosities of the 20-hour segment samples are compared to the viscosity of the 10-minute sample to determine the viscosity increase of the test oil.

The Sequence IIIG Test is operated at the following test states during the 100-hour portion of the test:

| Parameter | Set Point |
|--------------------------------------|------------|
| Engine Speed | 3600 r/min |
| Engine Load | 250 N-m |
| Oil Filter Block Temperature | 150 °C |
| Coolant Outlet Temperature | 115 °C |
| Fuel Pressure | 377.5 kPa |
| Intake Air Temperature | 35 °C |
| Intake Air Pressure | 0.05 kPa |
| Intake Air Dew Point | 16.1 °C |
| Exhaust Back Pressure | 6 kPa |
| Engine Coolant Flow | 160 L/min |
| Breather Tube Coolant Flow | 10 L/min |
| Air-to-Fuel Ratio | 15.0:1 |
| Condenser Coolant Outlet Temperature | 40 °C |

**Sequence III G
Form 4**

Test Result Summary

| | | | |
|------------------------|-----------------------------------|----------|--------------------------------------|
| Lab | CC | Oil Code | CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCC |
| Stand | CCCCC | Test No. | CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCC |
| Laboratory Oil Code | CCCCCCCCCCCCCCCCCCCC | | |
| Formulation Stand Code | CC-CCCCCCCCC-C-C-CCCCC-CC-CC-CCCC | | |

| | | | |
|----------------|----------|---------------|------------------|
| Date Started | YYYYMMDD | Engine No. | CCCCCCCCCCCCCCCC |
| Time Started | HH:MM | Fuel Batch | CCCCCCCCCCCCCCCC |
| Date Completed | YYYYMMDD | SAE Viscosity | CCCCCC |
| Time Completed | HH:MM | TMC Oil Code | CCCCCC |
| Test Length | S1234 | | |

| Pass/Fail Results | | | |
|----------------------------|-------------------------------|---------------------------------------|--|
| | Viscosity Increase (%) | Average Cam + Lifter Wear (µm) | Average Weighted Piston Deposits (merits) |
| Original Units | S1234.12 | S1234.1 | S12.12 |
| Transformed Results | S12.123456 | S1.1234 | |
| Industry Correction Factor | S12.123456 | S1.1234 | S1.1234 |
| Corrected Transformed | S12.123456 | S1.1234 | |
| Severity Adjustment | S12.123456 | S1.1234 | S1.1234 |
| Final Transformed Result | S12.123456 | S1.1234 | |
| Final Original Unit Result | S1234.1 | S1234.1 | S12.12 |

| Additional Results | | | |
|---------------------------------------|--------|----------------------------|--------|
| Oil Consumption Hours, h ^B | S12 | Oil Consumption, L | S12.12 |
| Maximum Cam + Lifter Wear, µm | S12345 | Number of Cold-Stuck Rings | S12 |
| Average Oil Ring Plugging, % | S1234 | Number of Hot-Stuck Ring | S12 |
| Average Piston Varnish, merits | S12.12 | | |

| Most Recent Stand Reference Oil Test History^C | | | |
|---|----------------------------------|------------|------------------|
| Test Number | CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCC | | |
| Oil Code | CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCC | | |
| Date Completed | YYYYMMDD | TMC Oil | CCCCCC |
| Final Viscosity Increase, % | S1234.1 | Fuel Batch | CCCCCCCCCCCCCCCC |
| Final Average Cam + Lifter Wear, µm | S1234.1 | | |
| Final Average Weighted Piston Deposit, merits | S12.12 | | |
| Maximum Cam + Lifter Wear, µm | S12345 | | |
| Average Piston Varnish, merits | S12.12 | | |

^AReference Oil Tests Only
^BTest Hours at which Oil Consumption was calculated
^CNon-Reference Oil Tests Only

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Form 5

Operational Summary

| | | | |
|------------------------|-------|-----------------------------------|--|
| Lab | CC | Oil Code | CC |
| Stand | CCCCC | Test No. | CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCC |
| Laboratory Oil Code | | CCCCCCCCCCCCCCCCCCCC | |
| Formulation Stand Code | | CC-CCCCCCCCC-C-C-CCCCC-CC-CC-CCCC | |

| Controlled Parameters | Parameter | Units | QI Threshold | EOT QI | Target | Average | Standard Deviation | Number of | |
|-----------------------|-----------------------------|-------|--------------|---------|--------|---------|--------------------|-----------|--------|
| | | | | | | | | Samples | BQD |
| | Speed | r/min | 0.000 | S12.123 | 3600 | S12345 | S12.123 | S12345 | S12345 |
| | Load | Nm | 0.000 | S12.123 | 250 | S12345 | S12.123 | S12345 | S12345 |
| | Oil Filter Block | °C | 0.000 | S12.123 | 150.0 | S12345 | S12.123 | S12345 | S12345 |
| | Engine Coolant Out | °C | 0.000 | S12.123 | 115.0 | S123.1 | S12.123 | S12345 | S12345 |
| | Condenser Coolant Out | °C | 0.000 | S12.123 | 40.0 | S123.1 | S12.123 | S12345 | S12345 |
| | Left Air-to-Fuel | | 0.000 | S12.123 | 15.0 | S12.1 | S12.123 | S12345 | S12345 |
| | Right Air-to-Fuel | | 0.000 | S12.123 | 15.0 | S12.1 | S12.123 | S12345 | S12345 |
| | Left Exhaust Back Pressure | kPa | 0.000 | S12.123 | 6.0 | S1.12 | S12.123 | S12345 | S12345 |
| | Right Exhaust Back Pressure | kPa | 0.000 | S12.123 | 6.0 | S1.12 | S12.123 | S12345 | S12345 |
| | Intake Air | kPa | 0.000 | S12.123 | 0.05 | S1.12 | S12.123 | S12345 | S12345 |
| | Engine Coolant Flow | L/min | 0.000 | S12.123 | 160.0 | S123.1 | S12.123 | S12345 | S12345 |

| Non-controlled Parameters | Parameter | Units | Average | Standard Deviation | Number of | |
|---------------------------|----------------------|-------|---------|--------------------|-----------|--------|
| | | | | | Samples | BQD |
| | Oil Sump | °C | S123.1 | S12.123 | S12345 | S12345 |
| | Pump Outlet Pressure | kPa | S123.1 | S12.123 | S12345 | S12345 |
| | Gallery Pressure | kPa | S1234 | S12.123 | S12345 | S12345 |
| | Engine Coolant In | °C | S1234 | S12.123 | S12345 | S12345 |
| | Fuel Inlet | °C | S12345 | S12.123 | S12345 | S12345 |
| | Intake Air | °C | S12345 | S12.123 | S12345 | S12345 |
| | Intake Air Dew Point | °C | S123.1 | S12.123 | S12345 | S12345 |
| | Intake Vacuum | kPa | S12345 | S12.123 | S12345 | S12345 |
| | Crankcase | kPa | S1.123 | S12.123 | S12345 | S12345 |
| | Fuel Pressure | kPa | S1234 | S12.123 | S12345 | S12345 |

| Oil Consumption Data | | | | | | |
|------------------------|----------------|--------|--------|--------|--------|--------|
| Hours | Initial Run-in | S12 | S12 | S12 | S12 | S12 |
| Level (ml) low | S123 | S123 | S123 | S123 | S123 | S123 |
| Total Oil Consumed (L) | | S12.12 | S12.12 | S12.12 | S12.12 | S12.12 |

| NO _x Measurement | | | |
|-----------------------------|--------|--------|--------|
| Hours | S12 | S12 | S12 |
| NO _x , ppm | S12345 | S12345 | S12345 |

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Form 6

Used Oil Analysis Results

| | | | |
|------------------------|-------|-----------------------------------|--|
| Lab | CC | Oil Code | CC |
| Stand | CCCCC | Test No. | CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCC |
| Laboratory Oil Code | | CCCCCCCCCCCCCCCCCCCC | |
| Formulation Stand Code | | CC-CCCCCCCCC-C-C-CCCCC-CC-CC-CCCC | |

| Viscosity Increase Data (cSt at 40°C) | | | |
|---------------------------------------|------------------------|----------|----------|
| Hours | Viscosity ^A | Change | Percent |
| New Oil | S1234.12 | | |
| Initial ^B | S1234.12 | | |
| S12 | S1234.12 | S1234.12 | S1234.12 |
| S12 | S1234.12 | S1234.12 | S1234.12 |
| S12 | S1234.12 | S1234.12 | S1234.12 |
| S12 | S1234.12 | S1234.12 | S1234.12 |
| S12 | S1234.12 | S1234.12 | S1234.12 |
| S12 | S1234.12 | S1234.12 | S1234.12 |
| S1234 | S1234.12 | S1234.12 | S1234.12 |

| Results of ICP Analysis of Used Oil | | | |
|-------------------------------------|--------|--------|--------|
| Hours | Iron | Copper | Lead |
| Initial | AAAAAA | AAAAAA | AAAAAA |
| S12 | AAAAAA | AAAAAA | AAAAAA |
| S12 | AAAAAA | AAAAAA | AAAAAA |
| S12 | AAAAAA | AAAAAA | AAAAAA |
| S12 | AAAAAA | AAAAAA | AAAAAA |
| S12 | AAAAAA | AAAAAA | AAAAAA |
| S12 | AAAAAA | AAAAAA | AAAAAA |
| S1234 | AAAAAA | AAAAAA | AAAAAA |

^A 8000 cSt is maximum allowable viscosity
^B At end of leveling run

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Form 7

Valve Lifter and Camshaft Wear Results

| | | | |
|------------------------|-------|-----------------------------------|--|
| Lab | CC | Oil Code | CC |
| Stand | CCCCC | Test No. | CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCC |
| Laboratory Oil Code | | CCCCCCCCCCCCCCCCCCCC | |
| Formulation Stand Code | | CC-CCCCCCCCC-C-C-CCCCC-CC-CC-CCCC | |

| Number | Camshaft Lobe, μm | Valve Lifter, μm | Cam & Lifter Wear, μm |
|---------|---------------------------------|-----------------------------|-------------------------------------|
| 1 | S1234 | S1234 | S1234 |
| 2 | S1234 | S1234 | S1234 |
| 3 | S1234 | S1234 | S1234 |
| 4 | S1234 | S1234 | S1234 |
| 5 | S1234 | S1234 | S1234 |
| 6 | S1234 | S1234 | S1234 |
| 7 | S1234 | S1234 | S1234 |
| 8 | S1234 | S1234 | S1234 |
| 9 | S1234 | S1234 | S1234 |
| 10 | S1234 | S1234 | S1234 |
| 11 | S1234 | S1234 | S1234 |
| 12 | S1234 | S1234 | S1234 |
| | | | |
| Maximum | S1234 | S1234 | S12345 |
| Minimum | S1234 | S1234 | S12345 |
| Average | S1234 | S1234 | S1234.1 |

Sequence III G

Form 8

Summary of Oil Ring Land Deposit Rating

| | | | | |
|------------------------|-------|-----------------------------------|--------------------------------------|--|
| Lab | CC | Oil Code | CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCC | |
| Stand | CCCCC | Test No. | CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCC | |
| Laboratory Oil Code | | CCCCCCCCCCCCCCCCCCCC | | |
| Formulation Stand Code | | CC-CCCCCCCCC-C-C-CCCCC-CC-CC-CCCC | | |
| Rater | CCC | Rating Date | YYYYMMDD | |

| Piston | Oil Ring Land Deposit, Merits | % Chipped |
|---------|-------------------------------|-----------|
| 1 | S12.12 | S1234 |
| 2 | S12.12 | S1234 |
| 3 | S12.12 | S1234 |
| 4 | S12.12 | S1234 |
| 5 | S12.12 | S1234 |
| 6 | S12.12 | S1234 |
| Average | S12.12 | S1.12 |

| Piston | % Oil Ring Plugging | Ring Sticking ^A | |
|---------|---------------------|----------------------------|------------------|
| | | Hot-Stuck Rings | Cold-Stuck Rings |
| 1 | S1234 | CCC | CCC |
| 2 | S1234 | CCC | CCC |
| 3 | S1234 | CCC | CCC |
| 4 | S1234 | CCC | CCC |
| 5 | S1234 | CCC | CCC |
| 6 | S1234 | CCC | CCC |
| Total | | S12 | S12 |
| Average | S1234 | | |

^A Possible values T = top compression ring
 B = bottom compression ring
 O = oil ring
 N = none

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Form 9

Summary of Piston Deposits

| | | | |
|------------------------|------|---------------------------------|--------------------------------------|
| Lab | CC | Oil Code | CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCC |
| Stand | CCCC | Test No. | CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCC |
| Laboratory Oil Code | | CCCCCCCCCCCCCCCC | |
| Formulation Stand Code | | CC-CCCCCCCC-C-C-CCCC-CC-CC-CCCC | |
| Rater | CCC | Rating Date | YYYYMMDD |

Note: CRC Manual 20 used for ALL Ratings

NOTE: These are un-weighted ratings

| | Grooves, merits | | | Lands, merits | | Undercrown, merits |
|----------|-----------------|--------|--------|---------------|--------|--------------------|
| | 1 | 2 | 3 | 2 | 3 | |
| Piston 1 | S12.12 | S12.12 | S12.12 | S12.12 | S12.12 | S12.12 |
| Piston 2 | S12.12 | S12.12 | S12.12 | S12.12 | S12.12 | S12.12 |
| Piston 3 | S12.12 | S12.12 | S12.12 | S12.12 | S12.12 | S12.12 |
| Piston 4 | S12.12 | S12.12 | S12.12 | S12.12 | S12.12 | S12.12 |
| Piston 5 | S12.12 | S12.12 | S12.12 | S12.12 | S12.12 | S12.12 |
| Piston 6 | S12.12 | S12.12 | S12.12 | S12.12 | S12.12 | S12.12 |
| WF | 0.05 | 0.10 | 0.20 | 0.15 | 0.30 | 0.10 |

Note: These are un-weighted ratings

| | Piston Skirt Varnish, merits | | |
|----------|------------------------------|-------------|---------|
| | Thrust | Anti-Thrust | Average |
| Piston 1 | S12.12 | S12.12 | S1.12 |
| Piston 2 | S12.12 | S12.12 | S1.12 |
| Piston 3 | S12.12 | S12.12 | S1.12 |
| Piston 4 | S12.12 | S12.12 | S1.12 |
| Piston 5 | S12.12 | S12.12 | S1.12 |
| Piston 6 | S12.12 | S12.12 | S1.12 |
| Average | S12.12 | S12.12 | S12.12 |
| WF | | | 0.10 |

$PSVAV_x = (PSVT_x + PSVA_x)/2$ where x = Number of Piston
 PSVTAV = average of six Thrust Piston Skirt ratings.
 PSVAAV = average of six Anti-Thrust Piston Skirt ratings.
 APV = average of all 12 Piston Skirt ratings.

| | Total Weighted Deposits, merits |
|----------|---------------------------------|
| Piston 1 | S12.12 |
| Piston 2 | S12.12 |
| Piston 3 | S12.12 |
| Piston 4 | S12.12 |
| Piston 5 | S12.12 |
| Piston 6 | S12.12 |

$$WPD_x = (WF \cdot G1P_x) + (WF \cdot G2P_x) + (WF \cdot G3P_x) + (WF \cdot L2P_x) + (WF \cdot ORLD_x) + (WF \cdot UCP_x) + (WF \cdot PSVAV_x)$$

where: x = Number of Piston
 WF = Appropriate Weighting Factor (WF) for part, from table.

| | |
|--|--------|
| Average Weighted Piston Deposits, merits | S12.12 |
|--|--------|

$$WPD = (WPD_1 + WPD_2 + WPD_3 + WPD_4 + WPD_5 + WPD_6) / 6$$

Sequence III G
Form 10
Blowby Values & Plot

| | | | |
|------------------------|------------------------------------|----------|--------------------------------------|
| Lab | CC | Oil Code | CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCC |
| Stand | CCCCC | Test No. | CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCC |
| Laboratory Oil Code | CCCCCCCCCCCCCCCCCCCC | | |
| Formulation Stand Code | CC-CCCCCCCCC-C-C-CCCCC-CC-CC-CCCCC | | |

Blowby Plot



| | | | | | | | | | | |
|----------------|-------|---------|-------|-------|-------|-------|-------|-------|-------|-------|
| Test Hours | S12 | S12 | S12 | S12 | S12 | S12 | S12 | S12 | S12 | S12 |
| Blowby, L/min. | S12.1 | S12.1 | S12.1 | S12.1 | S12.1 | S12.1 | S12.1 | S12.1 | S12.1 | S12.1 |
| Test Hours | S12 | S12 | S12 | S12 | S12 | S12 | S12 | S12 | S12 | S12 |
| Blowby, L/min. | S12.1 | S12.1 | S12.1 | S12.1 | S12.1 | S12.1 | S12.1 | S12.1 | S12.1 | S12.1 |
| Test Hours | S12 | Average | | | | | | | | |
| Blowby, L/min. | S12.1 | S12.1 | | | | | | | | |

Sequence III G
Form 12
Hardware Information

| | | | |
|------------------------|-----------------------------------|----------|--------------------------------------|
| Lab | CC | Oil Code | CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCC |
| Stand | CCCCC | Test No. | CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCC |
| Laboratory Oil Code | CCCCCCCCCCCCCCCCCCCC | | |
| Formulation Stand Code | CC-CCCCCCCCC-C-C-CCCCC-CC-CC-CCCC | | |

| | | | |
|------------------------------------|-----------|----------------------------|----------------|
| Build Completion Date | YYYYMMDD | Piston Batch (Code) | CCCCC |
| Block Serial Number | CCCCCC | Piston Size (Grade) | CC |
| Crankshaft Serial Number | CCCCC | Piston Ring Batch Code | CCCCC |
| Camshaft Serial Number | CCCCCC | Oil Filter Batch Code | CCCCC |
| Camshaft Batch Code | CCCCCC | Oil Cooler Batch Code | CCCCCC |
| Cylinder Head Serial Number, Left | CCCCCCCCC | Valve Springs Batch Code | CCCCC |
| Cylinder Head Serial Number, Right | CCCCCCCCC | Lifter Serial Number | 1 CCCCCCCC |
| Bearing Kit Serial Number | CCCCCC | | 2 CCCCCCCC |
| Top Ring Gap, mils | S12 | | 3 CCCCCCCC |
| Bottom Ring Gap, mils | S12 | | 4 CCCCCCCC |
| Intake Valve Seals Batch Code | CCCCC | | 5 CCCCCCCC |
| Exhaust Valve Seals Batch Code | CCCCC | | 6 CCCCCCCC |
| Rocker Arm Batch Code | CCCCC | | 7 CCCCCCCC |
| Connecting Rod Type (CAST or PM) | CCCC | | 8 CCCCCCCC |
| | | | 9 CCCCCCCC |
| | | | 10 CCCCCCCC |
| | | | 11 CCCCCCCC |
| | | | 12 CCCCCCCC |

