# REPORT ON
# SEQUENCE IIIG EVALUATION

VERSION *20030331*

CONDUCTED FOR

*TSTSPON1*
*TSTSPON2*

| | |
|---|---|
| *LABVALID* | V = VALID |
| | I = INVALID |
| | N = RESULTS CANNOT BE INTERPRETED AS REPRESENTATIVE OF OIL PERFORMANCE (NON-REFERENCE OIL) AND SHALL NOT BE USED FOR MULTIPLE TEST ACCEPTANCE |

| | |
|---|---|
| *TSTOIL* | NR = Non-Reference Oil Test |
| | RO = Reference Oil Test |

| Test Number | | | | | |
|---|---|---|---|---|---|
| Test Stand | *STAND* | Stand Test Number | *STRUN* | Lab Test Number | *LABRUN* |
| Oil Code | *OILCODE* | | | | |
| Formulation/Stand Code | *FORM* | | | | |
| Alternate Codes | *ALTCODE1* | *ALTCODE2* | *ALTCODE3* | | |
| EOT Date | *DTCOMP* | EOT Time | *EOTTIME* | | |

In my opinion this test *OPVALID* been conducted in a valid manner in accordance with the latest draft of Sequence IIIG procedure and the appropriate amendments through the information letter system. The remarks included in the report describe the anomalies associated with this test.

SUBMITTED BY: *SUBLAB*

Testing Laboratory

*SUBSIGIM*

Signature

*SUBNAME*

Typed Name

*SUBTITLE*

Title

# Form 2

## Sequence IIIG

Table of Contents

# 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 multiviscosity grade oils that are used in spark-ignition, gasoline-fueled engines, as well as diesel engines.

The Sequence IIIG Test utilizes a 1996 model General Motors 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 | 365 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 |
| Breather Tube Coolant Outlet Temperature | 40 ˚C |

**SEQUENCE IIIG**
**FORM 4**
**TEST RESULT SUMMARY**

| | | | |
|---|---|---|---|
| LAB | *LAB* | OIL CODE | *OILCODE* |
| TEST STAND NO. | *STAND* | TEST NO. | *STAND - STRUN - LABRUN* |
| LABORATORY OIL CODE | *LABOCODE* | | |
| FORMULATION STAND CODE | *FORM* | | |

| | | | |
|---|---|---|---|
| DATE STARTED | *DTSTRT* | ENGINE NO. | *ENGINENO* |
| TIME STARTED | *STRTTIME* | FUEL BATCH | *FUELBTID* |
| DATE COMPLETED | *DTCOMP* | SAE VISCOSITY | *SAEVISC* |
| TIME COMPLETED | *EOTTIME* | TMC OIL CODE [A] | *IND* |
| TEST LENGTH | *TESTLEN* | | |

| **Pass/Fail Results** | | | | | | |
|---|---|---|---|---|---|---|
| | Viscosity Increase (%) | Average Cam + Lifter Wear (µm) | Average Weighted Piston Deposits (merits) | Average Piston Skirt Varnish (merits) | Number of Hot-Stuck Rings | Oil Consumption (L) [B] |
| Original Units | *PVIS* | *ACLW* | *WPD* | *APV* | *HSTUKT* | *OILCON* |
| Transformed Results | *TPVIS* | *TACLW* | | | | |
| Industry Correction Factor | *PVIS_CF* | *ACLW_CF* | *WPD_CF* | *APV_CF* | | |
| Corrected Transformed Result | *PVIS_COR* | *ACLW_COR* | | | | |
| Severity Adjustment | *PVIS_SA* | *ACLW_SA* | *WPD_SA* | *APV_SA* | | |
| Final Transformed Result | *TPVISFNL* | *TACLWFNL* | | | | |
| Final Original Unit Result | *PVISFNL* | *ACLWFNL* | *WPDFNL* | *APVFNL* | | |

| **Additional Results** | | | |
|---|---|---|---|
| Oil Consumption Hours, h [B] | *OCONHRS* | Average Oil Ring Plugging , % | *ORPAVG* |
| Maximum Cam + Lifter Wear, µm | *MCLW* | Number of Cold-Stuck Rings | *CSTUKT* |

| **Most Recent Stand Reference Oil Test History** [C] | | | |
|---|---|---|---|
| Test Number | *RSTAND - RSTRUN - RLABRUN* | | |
| Oilcode | *ROILCODE* | | |
| Date Completed | *RDTCOMP* | TMC Oil Code | *RIND* |
| Final Viscosity Increase, % | *RPVISFNL* | Fuel Batch | *RFUELBID* |
| Final Average Piston Skirt Varnish, merits | *RAPVFNL* | | |
| Final Average Cam + Lifter Wear, µm | *RACLWFNL* | | |
| Final Maximum Cam + Lifter Wear, µm | *RMCLWFNL* | | |
| Final Average Weighted Piston Deposit, merits | *RWPDFNL* | | |

[A] Reference Oil Tests Only

[B] Test Hours at which Oil Consumption was calculated

[C] Non-Reference Oil Tests Only

**SEQUENCE IIIG**
**FORM 5**
**OPERATIONAL SUMMARY**

| | | | |
|---|---|---|---|
| LAB | *LAB* | OIL CODE | *OILCODE* |
| TEST STAND NO. | *STAND* | TEST NO. | *STAND - STRUN - LABRUN* |
| LABORATORY OIL CODE | *LABOCODE* | | |
| FORMULATION STAND CODE | *FORM* | | |

| | Parameter | Units | QI Threshold | EOT QI | Target | Average | Standard Deviation | Number Of | |
|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | Samples | BQD |
| Controlled Parameters | Speed | r/min | 0.000 | *QRPM* | 3600 | *ARPM* | *SRPM* | *NRPM* | *BRPM* |
| | Load | Nm | 0.000 | *QLOAD* | 250 | *ALOAD* | *SLOAD* | *NLOAD* | *BLOAD* |
| | Oil Filter Block | ˚C | 0.000 | *QOTEMP* | 150.0 | *AOTEMP* | *SOTEMP* | *NOTEMP* | *BOTEMP* |
| | Engine Coolant Out | ˚C | 0.000 | *QCOLOUT* | 115.0 | *ACOLOUT* | *SCOLOUT* | *NCOLOUT* | *BCOLOUT* |
| | Condenser Coolant Out | ˚C | 0.000 | *QCCOLOUT* | 40.0 | *ACCOLOUT* | *SCCOLOUT* | *NCCOLOUT* | *BCCOLOUT* |
| | Left Air-to-Fuel Ratio | | 0.000 | *QLAFR* | 15.0 | *ALAFR* | *SLAFR* | *NLAFR* | *BLAFR* |
| | Right Air-to-Fuel Ratio | | 0.000 | *QRAFR* | 15.0 | *ARAFR* | *SRAFR* | *NRAFR* | *BRAFR* |
| | Left Exhaust Back Pressure | kPa | 0.000 | *QLEXBP* | 6.0 | *ALEXBP* | *SLEXBP* | *NLEXBP* | *BLEXBP* |
| | Right Exhaust Back Pressure | kPa | 0.000 | *QREXBP* | 6.0 | *AREXBP* | *SREXBP* | *NREXBP* | *BREXBP* |
| | Intake Air | kPa | 0.000 | *QINAIR* | 0.05 | *AINAIR* | *SINAIR* | *NINAIR* | *BINAIR* |
| | Engine Coolant Flow | L/min | 0.000 | *QCOLFLO* | 160.0 | *ACOLFLO* | *SCOLFLO* | *NCOLFLO* | *BCOLFLO* |

| | Parameter | Units | Average | Standard Deviation | Number Of | |
|---|---|---|---|---|---|---|
| | | | | | Samples | BQD |
| Non-controlled Parameters | Oil Sump | ˚C | *AOSUMP* | *SOSUMP* | *NOSUMP* | *BOSUMP* |
| | Pump Outlet Pressure | kPa | *APOUTP* | *SPOUTP* | *NPOUTP* | *BPOUTP* |
| | Gallery Pressure | kPa | *AOILPRS* | *SOILPRS* | *NOILPRS* | *BOILPRS* |
| | Engine Coolant In | ˚C | *AECOLIN* | *SECOLIN* | *NECOLIN* | *BECOLIN* |
| | Fuel Inlet | ˚C | *AFUELIN* | *SFUELIN* | *NFUELIN* | *BFUELIN* |
| | Intake Air | ˚C | *AINAT* | *SINAT* | *NINAT* | *BINAT* |
| | Intake Air Dew Point | ˚C | *AINDEW* | *SINDEW* | *NINDEW* | *BINDEW* |
| | Intake Vacuum | kPa | *AINVAC* | *SINVAC* | *NINVAC* | *BINVAC* |
| | Crankcase | kPa | *ACCASEP* | *SCCASEP* | *NCCASEP* | *BCCASEP* |
| | Fuel Pressure | kPa | *APFUEL* | *SPFUEL* | *NPFUEL* | *BPFUEL* |

| OIL CONSUMPTION DATA | | | | | | |
|---|---|---|---|---|---|---|
| HOURS | Initial Run-in | *OCONH020* | *OCONH040* | *OCONH060* | *OCONH080* | *OCONH100* |
| LEVEL (ml) low | *OILLINI* | *OILLH020* | *OILLH040* | *OILLH060* | *OILLH080* | *OILLH100* |

| $NO_x$ Measurement | | | |
|---|---|---|---|
| Hours | *NOXHH019* | *NOXHH049* | *NOXHH099* |
| $NO_x$, ppm | *NOX_H019* | *NOX_H049* | *NOX_H099* |

**SEQUENCE IIIG**
**FORM 6**
**USED OIL ANALYSIS RESULTS**

| | | | |
|---|---|---|---|
| LAB | *LAB* | OIL CODE | *OILCODE* |
| TEST STAND NO. | *STAND* | TEST NO. | *STAND - STRUN - LABRUN* |
| LABORATORY OIL CODE | *LABOCODE* | | |
| FORMULATION STAND CODE | *FORM* | | |

| **VISCOSITY INCREASE DATA (cSt AT 40˚C)** | | | |
|---|---|---|---|
| HOURS | VISCOSITY [A] | CHANGE | PERCENT |
| NEW OIL | *VNEW* | | |
| INITIAL [B] | *VINI* | | |
| *VISTH020* | *VIS_H020* | *DVISH020* | *PVISH020* |
| *VISTH040* | *VIS_H040* | *DVISH040* | *PVISH040* |
| *VISTH060* | *VIS_H060* | *DVISH060* | *PVISH060* |
| *VISTH080* | *VIS_H080* | *DVISH080* | *PVISH080* |
| *VISTH100* | *VIS_H100* | *DVISH100* | *PVISH100* |
| *TESTLEN* | *VISEOT* | *DVISEOT* | *PVIS* |

[A] 8000 cSt is maximum allowable viscosity

[B] At end of leveling run

| **Results of ICP Analysis of Used Oil** | | | |
|---|---|---|---|
| Hours | Iron | Copper | Lead |
| Initial | *FEWMINI* | *CUWMINI* | *PBWMINI* |
| *TST_H020* | *FEWMH020* | *CUWMH020* | *PBWMH020* |
| *TST_H040* | *FEWMH040* | *CUWMH040* | *PBWMH040* |
| *TST_H060* | *FEWMH060* | *CUWMH060* | *PBWMH060* |
| *TST_H080* | *FEWMH080* | *CUWMH080* | *PBWMH080* |
| *TST_H100* | *FEWMH100* | *CUWMH100* | *PBWMH100* |
| *TESTLEN* | *FEWMEOT* | *CUWMEOT* | *PBWMEOT* |

| **Cold Crank Simulator Results, D 5293** | |
|---|---|
| Specified Temperature, ˚C | *CCSTEMP* |
| Cold-Crank Simulator Viscosity at Specifield Temperature, cP | *CCS* |
| Second Temperatue, ˚C | *CCSTEMP2* |
| Cold-Crank Simulator Viscosity at Second Temperature, cP | *CCS2* |

| **Mini-Rotary Viscometer Results, D 4684** | |
|---|---|
| MRV Temperature, ˚C | *MRVTEMP* |
| MRV Result, cP | *MRV* |
| Yield Stress, cP | *YSTRESS* |

**SEQUENCE IIIG**
**FORM 7**
**VALVE LIFTER AND CAMSHAFT WEAR RESULTS**

| | | | |
|---|---|---|---|
| LAB | *LAB* | OIL CODE | *OILCODE* |
| TEST STAND NO. | *STAND* | TEST NO. | *STAND - STRUN - LABRUN* |
| LABORATORY OIL CODE | *LABOCODE* | | |
| FORMULATION STAND CODE | *FORM* | | |

| NUMBER | CAMSHAFT LOBE, µm | VALVE LIFTER, µm | CAM & LIFTER WEAR, µm |
|---|---|---|---|
| 1 | *CAMW01* | *LFTW01* | *CLW01* |
| 2 | *CAMW02* | *LFTW02* | *CLW02* |
| 3 | *CAMW03* | *LFTW03* | *CLW03* |
| 4 | *CAMW04* | *LFTW04* | *CLW04* |
| 5 | *CAMW05* | *LFTW05* | *CLW05* |
| 6 | *CAMW06* | *LFTW06* | *CLW06* |
| 7 | *CAMW07* | *LFTW07* | *CLW07* |
| 8 | *CAMW08* | *LFTW08* | *CLW08* |
| 9 | *CAMW09* | *LFTW09* | *CLW09* |
| 10 | *CAMW10* | *LFTW10* | *CLW10* |
| 11 | *CAMW11* | *LFTW11* | *CLW11* |
| 12 | *CAMW12* | *LFTW12* | *CLW12* |
| | | | |
| MAXIMUM | *MAXCW* | *MAXLFTW* | *MCLW* |
| MINIMUM | *MINCW* | *MINLFTW* | *MINCLW* |
| AVERAGE | *AVGCW* | *AVGLFTW* | *ACLW* |

**SEQUENCE IIIG**
**FORM 8**
**SUMMARY OF OIL RING LAND DEPOSIT RATING**

| | | | |
|---|---|---|---|
| LAB | *LAB* | OIL CODE | *OILCODE* |
| TEST STAND NO. | *STAND* | TEST NO. | *STAND - STRUN - LABRUN* |
| LABORATORY OIL CODE | *LABOCODE* | | |
| FORMULATION STAND CODE | *FORM* | | |
| RATER | *RLDRATER* | RATING DATE | *RLDRTDT* |

| PISTON | OIL RING LAND DEPOSIT, MERITS | % CHIPPED |
|---|---|---|
| 1 | *ORLD1* | *ORCHIP1* |
| 2 | *ORLD2* | *ORCHIP2* |
| 3 | | *ORCHIP3* |
| 4 | | *ORCHIP4* |
| 5 | | *ORCHIP5* |
| 6 | | *ORCHIP6* |
| Average | | *AVGORCHP* |

| PISTON | % OIL RING PLUGGING | RING STICKING [A] | |
|---|---|---|---|
| | | HOT-STUCK RINGS | COLD-STUCK RINGS |
| 1 | *ORP1* | *HSTUK1* | *CSTUK1* |
| 2 | *ORP2* | *HSTUK2* | *CSTUK2* |
| 3 | *ORP3* | *HSTUK3* | |
| 4 | | | |
| 5 | | | |
| 6 | | | |
| Total | | *HSTUKT* | *CSTUKT* |
| Average | *ORPAVG* | | |

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

**SEQUENCE IIIG**
**FORM 9**
**SUMMARY OF PISTON DEPOSITS**

| | | | |
|---|---|---|---|
| LAB | *LAB* | OIL CODE | *OILCODE* |
| TEST STAND NO. | *STAND* | TEST NO. | *STAND - STRUN - LABRUN* |
| LABORATORY OIL CODE | *LABOCODE* | | |
| FORMULATION STAND CODE | *FORM* | | |
| RATER | | RATING DATE | |

**NOTE: CRC Manual 14 used for ALL Ratings**

NOTE: These are unweighted ratings.

| | Grooves, merits | | | Lands, merits | | Undercrown, merits |
|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 2 | 3 | |
| Piston 1 | | | | | *ORLD1* | |
| Piston 2 | | | | | *ORLD2* | |
| Piston 3 | | | | | | |
| Piston 4 | | | | | | |
| Piston 5 | | | | | | |
| Piston 6 | | | | | | |
| WF | 0.05 | 0.10 | 0.20 | 0.15 | 0.30 | 0.10 |

NOTE: These are unweighted ratings.

| | Piston Skirt Varnish, merits | | |
|---|---|---|---|
| | Thrust | Anti-Thrust | Average |
| Piston 1 | | | |
| Piston 2 | | | |
| Piston 3 | | | |
| Piston 4 | | | |
| Piston 5 | | | |
| Piston 6 | | | |
| Average | | | *APV* |
| WF | | | 0.10 |

PSVAVx = (PSVTx + PSVAx)/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 | |
| Piston 2 | |
| Piston 3 | |
| Piston 4 | |
| Piston 5 | |
| Piston 6 | |

WPDx=(WF*G1Px)+(WF*G2Px)+(WF*G3Px)+(WF*L2Px)+
(WF*ORLDx)+(WF*UCPx)+(WF*PSVAVx)
*where: x=Number of Piston*
*WF=Appropriate Weighting Factor (WF) for part, from table.*

| | |
|---|---|
| Average Weighted Piston Deposits, merits | *WPD* |

WPD=(WPD1+WPD2+WPD3+WPD4+WPD5+WPD6)/6

**SEQUENCE IIIG**
**FORM 10**
**BLOWBY VALUES & PLOT**

| | | | |
|---|---|---|---|
| LAB | *LAB* | OIL CODE | *OILCODE* |
| TEST STAND NO. | *STAND* | TEST NO. | *STAND - STRUN - LABRUN* |
| LABORATORY OIL CODE | *LABOCODE* | | |
| FORMULATION STAND CODE | *FORM* | | |

Blowby Plot

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

**SEQUENCE IIIG**
**FORM 11**
**VISCOSITY INCREASE PLOT**

| | | | |
|---|---|---|---|
| LAB | *LAB* | OIL CODE | *OILCODE* |
| TEST STAND NO. | *STAND* | TEST NO. | *STAND - STRUN - LABRUN* |
| LABORATORY OIL CODE | *LABOCODE* | | |
| FORMULATION STAND CODE | *FORM* | | |

**SEQUENCE IIIG**
**FORM 12**
**HARDWARE INFORMATION**

| | | | |
|---|---|---|---|
| LAB | *LAB* | OIL CODE | *OILCODE* |
| TEST STAND NO. | *STAND* | TEST NO. | *STAND - STRUN - LABRUN* |
| LABORATORY OIL CODE | *LABOCODE* | | |
| FORMULATION STAND CODE | *FORM* | | |

| | | | | |
|---|---|---|---|---|
| Build Completion Date | | Piston Batch (Code) | | |
| Block Serial Number | | Piston Size (Grade) | | |
| Crankshaft Serial Number | | Piston Ring Batch Code | | |
| Camshaft Serial Number | | Oil Filter Batch Code | | |
| Cylinder Head Serial Number, Left | | Intake Valve Seals Batch Code | | |
| Cylinder Head Serial Number, Right | | Valve Springs Batch Code | | |
| Bearing Kit Serial Number | | Lifter Serial Number | 1 | |
| Top Ring Gap, mils | | | 2 | |
| Bottom Ring Gap, mils | | | 3 | |
| | | | 4 | |
| | | | 5 | |
| | | | 6 | |
| | | | 7 | |
| | | | 8 | |
| | | | 9 | |
| | | | 10 | |
| | | | 11 | |
| | | | 12 | |

**SEQUENCE IIIG**
**FORM 13**
**DOWNTIME & OUTLIER REPORT FORM**

| | | | |
|---|---|---|---|
| LAB | *LAB* | OIL CODE | *OILCODE* |
| TEST STAND NO. | *STAND* | TEST NO. | *STAND - STRUN - LABRUN* |
| LABORATORY OIL CODE | *LABOCODE* | | |
| FORMULATION STAND CODE | *FORM* | | |

| Downtime Occurrences | |
|---|---|

| Test Hours | Date | Total Downtime | Reasons |
|---|---|---|---|
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |
| Total Downtime | | | Maximum allowable downtime: 24 hours |

| Other Comments & Outliers | |
|---|---|