

REPORT ON SEQUENCE VG EVALUATION

CONDUCTED FOR

TSTSPON1

TSTSPON2

<i>LABVALID</i>	V = VALID
	I = INVALID
	N = RESULTS CAN NOT BE INTERPRETED AS REPRESENTATIVE OF OIL PERFORMANCE (NON-REFERENCE OIL) AND SHALL NOT BE USED IN DETERMINING AN AVERAGE TEST RESULT USING MULTIPLE TEST ACCEPTANCE CRITERIA.

<i>TSTOIL</i>	NR = Non-reference Oil Test
	RO = Reference Oil Test

Test Number			
Test Stand: <i>STAND</i>	Runs Between Calibration Tests: <i>STRUN</i>	Total Runs on Test Stand: <i>TOTSRUN</i>	
Date Completed: <i>DTCOMP</i>		End of Test Time: <i>EOTIME</i>	
Oil Code: <i>OILCODE</i>			
Formulation/Stand Code: <i>FORM</i>			
Alternate Codes:	<i>ALTCODE1</i>	<i>ALTCODE2</i>	<i>ALTCODE3</i>

In my opinion this test *OPVALID* been conducted in a valid manner in accordance with the VG Test Procedure (RR:) 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 VG

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Sequence VG Sludge and Varnish Deposit Test Form 3

Summary of Test Method

The Sequence VG engine sludge and varnish deposit test is a fired engine-dynamometer test which evaluates the ability of a lubricant to minimize the formation of sludge and varnish deposits. This test method is a cyclic test, with a total running duration of 216 hours.

The test engine is a Ford 4.6L, spark ignition, four stroke, eight cylinder "V" configuration engine. Features of this engine include dual overhead camshafts, a cross-flow fast burn cylinder head design, two valves per cylinder and electronic port fuel injection. A 90 minute break-in schedule is conducted prior to each test, since a new engine build is used for each test.

The Sequence VG test requires a new engine for each test. Each test is run for 216 hours, consisting of 54 cycles of 4 hours each. Each cycle consists of 3 stages. The stages of the test cycle are set at the following conditions:

Condition	Stage I	Stage II	Stage III
Duration, minutes	120	75	45
Engine Speed, r/min	1200	2900	700
Engine Power, kW	Record	Record	1.10 - 1.50
Manifold Abs Press, kPa (abs)	69	66	Record
Engine Oil In, °C	68	100	45
Engine Coolant Out, °C	57	85	45
Engine Coolant Flow, L/min	48	Record	Record
Engine Coolant Pressure, kPa (gauge)	70	70	70
RAC Coolant In, °C	29	85	29
Rocker Cover Flow, L/min	15	15	15
Intake Air, °C	30	30	30
Intake Air Press, kPa (gauge)	0.05	0.05	0.05
Exhaust Gas Analysis			
O ₂ , Vol. %	1.0 Max	1.0 Max	3.0 Max
CO, Vol. %	1.0 Max	2.0 Max	8.5
CO ₂ , Vol. %	13.5 - 15.5	13.5 - 15.5	Record
Blowby Flow Rate Avg, L/min	Record	60 - 70	-----
Air/Fuel Ratio	Stoich	Stoich	11.5:1
Intake Air Humidity, g/kg	11.4	11.4	11.4
Exhaust Back Pressure, kPa abs	104	107	Record
Fuel Flow, kg/h	Record	Record	Record

Upon test completion, the engine is disassembled and rated for sludge and varnish. Average Engine Sludge and Average Engine Varnish are calculated.

**SEQUENCE VG
FORM 4
TEST RESULT SUMMARY
NON-REFERENCE & REFERENCE OIL TESTS**

Laboratory: <i>LAB</i>	Stand: <i>STAND</i>	Stand Runs: <i>STRUN</i>	Oil Code: <i>OILCODE</i>
Date Started: <i>DTSTRT</i>	Time Started: <i>STRTIME</i>	Date Completed: <i>DTCOMP</i>	Time Completed: <i>EOTIME</i>
Formulation/Stand Code: <i>FORM</i>			

Lab Engine Number: <i>ENGINE</i>	SAE Viscosity: <i>SAEVISC</i>
Test Length: <i>TESTLEN</i>	Fuel Batch: <i>FUELBTID</i>
Industry Oil Code: <i>IND</i>	

CRITICAL PARAMETERS						
	Average Engine Sludge, merits	Rocker Cover Sludge, merits	Average Engine Varnish, merits	Average Piston Skirt Varnish, merits	Oil Screen Sludge, % Area	Number of Hot Stuck Rings
Original Result	<i>AES</i>	<i>RACS</i>	<i>AEV3</i>	<i>APV</i>	<i>OSCRNSLG</i>	<i>NHSCMPRG</i>
Transformed Result					<i>TRANOSCR</i>	
Industry Correction Factor	<i>AESCF</i>	<i>RACSCF</i>	<i>AEV3CF</i>	<i>APVCF</i>	<i>TOSCRCF</i>	<i>NHSRCF</i>
Corrected Transformed Result					<i>TOSCRCOR</i>	
Severity Adjustment	<i>AESSA</i>	<i>RACSSA</i>	<i>AEV3SA</i>	<i>APVSA</i>	<i>TOSCRSA</i>	<i>NHSRSA</i>
Final Transformed Result					<i>TOSCRFNL</i>	
Final Original Unit Result	<i>AESFNL</i>	<i>RACSFNL</i>	<i>AEV3FNL</i>	<i>APVFNL</i>	<i>OSCRFNL</i>	<i>NHSRFNL</i>

Clogging Information		Additional Information	
Oil Screen Debris, % Area	<i>OSCRNDEB</i>	Number of Cold Stuck Rings	<i>NCSCMPRG</i>
Oil Ring Clogging, % Area	<i>OILRING</i>	Average Blowby Stage II, L/min	<i>ACBLWRT2</i>
PCV Valve @ 25 kPa, %	<i>PCV25</i>	Oil Consumption, grams	<i>TOILCONS</i>
PCV Valve @ 60 kPa, %	<i>PCV60</i>		

Last Reference Oil Test Calibrating Stand Information - Fill Out For Non-reference Oil Tests Only						
Stand: <i>RSTAND</i>	Total Runs on Test Stand: <i>RTOTSRUN</i>	Oilcode: <i>ROILCODE</i>				
Industry Oil Code: <i>RIND</i>	Engine Number: <i>RENGINE</i>	SAE Viscosity: <i>RSAEVISC</i>	Date Completed: <i>RDTCOMP</i>			
Test Length: <i>RTESTLEN</i>	Fuel Batch: <i>RFUELBTID</i>	Calibration Expiration Date: <i>RDTCALEX</i>				
Clogging Information		Additional Information				
Oil Screen Debris, % Area	<i>ROSCRDEB</i>	Number of Cold Stuck Rings		<i>RCSCMPRG</i>		
Oil Ring Clogging, % Area	<i>ROILRING</i>	Average Blowby Stage II, L/min		<i>RACBLWR2</i>		
PCV Valve @ 25 kPa, %	<i>RPCV25</i>	Oil Consumption, grams		<i>RTOILCON</i>		
PCV Valve @ 60 kPa, %	<i>RPCV60</i>					
	Average Engine Sludge, merits	Average Rocker Cover Sludge, merits	Average Engine Varnish, merits	Average Piston Skirt Varnish, merits	Oil Screen Sludge, % Area	Number of Hot Stuck Rings
Final Original Unit Result	<i>RAESFNL</i>	<i>RRACSFNL</i>	<i>RAEV3FNL</i>	<i>RAPVFNL</i>	<i>ROSCRSLG</i>	<i>RHSCMPRG</i>

FIG A7.4 Test Result Summary

**SEQUENCE VG
FORM 5
TEST RESULT SUMMARY
NON-REFERENCE & REFERENCE OIL TESTS**

Laboratory: <i>LAB</i>	Stand: <i>STAND</i>	Stand Runs: <i>STRUN</i>	Oil Code: <i>OILCODE</i>
Date Started: <i>DTSTRT</i>	Time Started: <i>STRTIME</i>	Date Completed: <i>DTCOMP</i>	Time Completed: <i>EOTTIME</i>
Formulation/Stand Code: <i>FORM</i>			

Hardware Identification	Production Number <i>PRODNUM</i>	Serial Number <i>SERNUM</i>	
Casting Numbers	Block <i>BLKCAST</i>	Cam, Left <i>CAMCASTL</i>	Cam, Right <i>CAMCASTR</i>
Piston Part Number <i>PISTPART</i>	Piston Ring Casting Number <i>PRINGNUM</i>		
Cylinder Head Casting Number	Left <i>CYLHCSTL</i>	Right <i>CYLHCSTR</i>	

Sludge Deposits	
Area	Merit
Rocker Arm Cover, Left	<i>RACLSRT</i>
Rocker Arm Cover, Right	<i>RACRSRT</i>
Camshaft Baffle, Left	<i>CAMBLSRT</i>
Camshaft Baffle, Right	<i>CAMBRST</i>
Timing Chain Cover	<i>TCCSRT</i>
Oil Pan Baffle	<i>OILPBSRT</i>
Oil Pan	<i>OILPNSRT</i>
Valve Deck Area, Left	<i>VLVDSRT</i>
Valve Deck Area, Right	<i>VLVDRSRT</i>
Average Engine Sludge	<i>AES</i>

Varnish Deposits	
Area	Merit
Piston Skirt, Thrust	<i>APV</i>
Rocker Arm Cover, Left	<i>RACLVRT</i>
Rocker Arm Cover, Right	<i>RACRVRT</i>
Average Engine Varnish	<i>AEV3</i>

Wear Measurements		
Ring Wear	Units	Value
Follower Pin Wear, cyl #8, Intake.	µm	<i>CFPIN8I</i>
Follower Pin Wear, cyl #8, Exhaust.	µm	<i>CFPIN8E</i>
Cylinder Bore Wear, cyl #1 & #8 Max.	µm	<i>MXCYLB18</i>
Cylinder Bore Wear, cyl #1 & #8 Avg.	µm	<i>ACYLBW18</i>
Ring Gap Increase, cyl #1 & #8, Max	µm	<i>MXRGINC</i>
Ring Gap Increase, cyl #1 & #8, Avg	µm	<i>ARGINC</i>

Piston Varnish Deposits, Thrust Side	
Piston Number	Merit
1	<i>PSVTH1</i>
2	<i>PSVTH2</i>
3	<i>PSVTH3</i>
4	<i>PSVTH4</i>
5	<i>PSVTH5</i>
6	<i>PSVTH6</i>
7	<i>PSVTH7</i>
8	<i>PSVTH8</i>
Average	<i>APV</i>

FIG A7.5 Deposit Breakdown

**SEQUENCE VG
FORM 6
OPERATIONAL SUMMARY**

Laboratory: <i>LAB</i>	Date Completed: <i>DTCOMP</i>	Time Completed: <i>EOTTIME</i>
Stand: <i>STAND</i>	Stand Runs: <i>STRUN</i>	Total Runs on Stand: <i>TOTSRUN</i>
Oil Code: <i>OILCODE</i>		
Formulation/Stand Code: <i>FORM</i>		

Controlled Parameters	Parameter	Units	QI Threshold	EOT QI	Target			Average			Samples	BQD	Over/Under Range
					Stage 1	Stage 2	Stage 3	Stage 1	Stage 2	Stage 3			
	Speed	r/min	0.000	<i>QRPM</i>	1200	2900	700	<i>ARPM1</i>	<i>ARPM2</i>	<i>ARPM3</i>	<i>NRPM</i>	<i>BRPM</i>	<i>ORPM</i>
	Manifold Abs Press	kPa	0.000	<i>QMANABP</i>	69	66	Record	<i>AMANABP1</i>	<i>AMANABP2</i>	<i>AMANABP3</i>	<i>NMAP</i>	<i>BMAP</i>	<i>OMAP</i>
	Engine Oil, In	°C	0.000	<i>QENGOIN</i>	68	100	45	<i>AENGOIN1</i>	<i>AENGOIN2</i>	<i>AENGOIN3</i>	<i>NEOIN</i>	<i>BEOIN</i>	<i>OEOIN</i>
	Engine Coolant, Out	°C	0.000	<i>QCOLOUT</i>	57	85	45	<i>ACOLOUT1</i>	<i>ACOLOUT2</i>	<i>ACOLOUT3</i>	<i>NCOUT</i>	<i>BCOUT</i>	<i>OCOUT</i>
	Engine Coolant Flow	L/min	0.000	<i>QCOLFRT</i>	48	Record	Record	<i>ACOLFRT1</i>	<i>ACOLFRT2</i>	<i>ACOLFRT3</i>	<i>NCFRT</i>	<i>BCFRT</i>	<i>OCFRT</i>
	Engine Coolant Pressure	kPa	0.000	<i>QCOLPRE</i>	70	70	70	<i>ACOLPRE1</i>	<i>ACOLPRE2</i>	<i>ACOLPRE3</i>	<i>NCPRE</i>	<i>BCPRE</i>	<i>OCPRE</i>
	RAC Coolant, In	°C	0.000	<i>QRACCTP</i>	29	85	29	<i>ARACCTP1</i>	<i>ARACCTP2</i>	<i>ARACCTP3</i>	<i>NRACC</i>	<i>BRACC</i>	<i>ORACC</i>
	RAC Flow	L/min	0.000	<i>QRACCFR</i>	15	15	15	<i>ARACCFR1</i>	<i>ARACCFR2</i>	<i>ARACCFR3</i>	<i>NRACF</i>	<i>BRACF</i>	<i>ORACF</i>
	Intake Air	°C	0.000	<i>QINAIRT</i>	30	30	30	<i>AINAIRT1</i>	<i>AINAIRT2</i>	<i>AINAIRT3</i>	<i>NINAT</i>	<i>BINAT</i>	<i>OINAT</i>
	Intake Air Pressure	kPa	0.000	<i>QINAIRP</i>	0.05	0.05	0.05	<i>AINAIRP1</i>	<i>AINAIRP2</i>	<i>AINAIRP3</i>	<i>NINAP</i>	<i>BINAP</i>	<i>OINAP</i>
	Intake Air Humidity	g/kg	0.000	<i>QAIRHUM</i>	11.4	11.4	11.4	<i>AAIRHUM1</i>	<i>AAIRHUM2</i>	<i>AAIRHUM3</i>	<i>NAHUM</i>	<i>BAHUM</i>	<i>OAHUM</i>
	Exhaust Backpressure	kPa	0.000	<i>QEXBKPR</i>	104	107	Record	<i>AEXBKPR1</i>	<i>AEXBKPR2</i>	<i>AEXBKPR3</i>	<i>NEXBP</i>	<i>BEXBP</i>	<i>OEXBP</i>
Non-controlled Parameters	Parameter	Units		Specifications									
	Fuel Flow	kg/h		Record	Record	Record	<i>AFUELRT1</i>	<i>AFUELRT2</i>	<i>AFUELRT3</i>				
	Blowby	L/min		Record	60-70			<i>ACBLWRT2</i>					
	Power	kW		Record	Record	1.3 ± 0.2	<i>APOWER1</i>	<i>APOWER2</i>	<i>APOWER3</i>				
	Exhaust Gas												
	Left Manifold O ₂	% Vol		1.0 Max	1.0 Max	3.0 Max	<i>ALEXGO1</i>	<i>ALEXGO2</i>	<i>ALEXGO3</i>				
	Right Manifold O ₂	% Vol		1.0 Max	1.0 Max	3.0 Max	<i>AREXGO1</i>	<i>AREXGO2</i>	<i>AREXGO3</i>				
	Left Manifold CO	% Vol		1.0 Max	2.0 Max	8.5±1.5	<i>ALEXGCO1</i>	<i>ALEXGCO2</i>	<i>ALEXGCO3</i>				
	Right Manifold CO	% Vol		1.0 Max	2.0 Max	8.5±1.5	<i>AREXGCO1</i>	<i>AREXGCO2</i>	<i>AREXGCO3</i>				
	Left Manifold CO ₂	% Vol		13.5-15.5	13.5-15.5	Record	<i>ALEXCO21</i>	<i>ALEXCO22</i>	<i>ALEXCO23</i>				
Right Manifold CO ₂	% Vol		13.5-15.5	13.5-15.5	Record	<i>AREXCO21</i>	<i>AREXCO22</i>	<i>AREXCO23</i>					
Lambda	AFR		1.0	1.0	0.75	<i>ALAMBDA1</i>	<i>ALAMBDA2</i>	<i>ALAMBDA3</i>					

FIG A7.6 Operational Summary

**SEQUENCE VG
FORM 7
OIL ADDITION RECORD & BLOWBY RATES
NON-REFERENCE & REFERENCE OIL TESTS**

Laboratory: <i>LAB</i>	Stand: <i>STAND</i>	Stand Runs: <i>STRUN</i>	Oil Code: <i>OILCODE</i>
Date Started: <i>DTSTRT</i>	Time Started: <i>STRTIME</i>	Date Completed: <i>DTCOMP</i>	Time Completed: <i>EOTTIME</i>
Formulation/Stand Code: <i>FORM</i>			

Cycle	Test Hour	Oil Added, g	Oil Consumed, g
6	23 h, 25 min	<i>OILAR006</i>	<i>OILCR006</i>
12	47 h, 25 min	<i>OILAR012</i>	<i>OILCR012</i>
18	71 h, 25 min	<i>OILAR018</i>	<i>OILCR018</i>
24	95 h, 25 min	<i>OILAR024</i>	<i>OILCR024</i>
30	119 h, 25 min	<i>OILAR030</i>	<i>OILCR030</i>
36	143 h, 25 min	<i>OILAR036</i>	<i>OILCR036</i>
42	167 h, 25 min	<i>OILAR042</i>	<i>OILCR042</i>
48	191 h, 25 min	<i>OILAR048</i>	<i>OILCR048</i>
54	215 h, 25 min		<i>OILCR054</i>
Total, g		<i>TOILADD</i>	<i>TOILCONS</i>

Stage II	
Test Hours	Blowby, L/min
Break-in	<i>BLBYH001</i>
23	<i>BLBYH023</i>
47	<i>BLBYH047</i>
71	<i>BLBYH071</i>
95	<i>BLBYH095</i>
119	<i>BLBYH119</i>
143	<i>BLBYH143</i>
167	<i>BLBYH167</i>
191	<i>BLBYH191</i>
215	<i>BLBYH215</i>
Maximum	<i>XCBLWRT2</i>
Minimum	<i>MCBLWRT2</i>
Average Blowby, Hours 23 - 119	<i>ABLW2120</i>
Average	<i>ACBLWRT2</i>

FIG A7.7 Blowby and Oil Additions

**SEQUENCE VG
FORM 8
ANALYSIS OF OIL**

Laboratory: <i>LAB</i>	Stand: <i>STAND</i>	Stand Runs: <i>STRUN</i>	Oil Code: <i>OILCODE</i>
Date Started: <i>DTSTRT</i>	Time Started: <i>STRTIME</i>	Date Completed: <i>DTCOMP</i>	Time Completed: <i>EOTIME</i>
Formulation/Stand Code: <i>FORM</i>			

Test Hours	Ag, ppm	Al, ppm	Cr, ppm	Cu, ppm	Fe, ppm	Pb, ppm	Si, ppm	Sn, ppm	Fuel Dilution by GC, Wt. % D3525	Pentane Insolubles, Wt. % D893B ^A	TBN D4739 ^A	Vis. @ 40°C, cSt D445	Vis. @ 100°C, cSt D445 ^A
<i>TST_HNEW</i>	<i>AGWMHNEW</i>	<i>ALWMHNEW</i>	<i>CRWMHNEW</i>	<i>CUWMHNEW</i>	<i>FEWMHNEW</i>	<i>PBWMHNEW</i>	<i>SIWMHNEW</i>	<i>SNWMHNEW</i>			<i>TBN_HNEW</i>	<i>V40_HNEW</i>	<i>V100HNEW</i>
<i>TST_H024</i>	<i>AGWMH024</i>	<i>ALWMH024</i>	<i>CRWMH024</i>	<i>CUWMH024</i>	<i>FEWMH024</i>	<i>PBWMH024</i>	<i>SIWMH024</i>	<i>SNWMH024</i>	<i>FUELH024</i>		<i>TBN_H024</i>	<i>V40_H024</i>	<i>V100H024</i>
<i>TST_H048</i>	<i>AGWMH048</i>	<i>ALWMH048</i>	<i>CRWMH048</i>	<i>CUWMH048</i>	<i>FEWMH048</i>	<i>PBWMH048</i>	<i>SIWMH048</i>	<i>SNWMH048</i>	<i>FUELH048</i>	<i>PEN_H048</i>	<i>TBN_H048</i>	<i>V40_H048</i>	<i>V100H048</i>
<i>TST_H072</i>	<i>AGWMH072</i>	<i>ALWMH072</i>	<i>CRWMH072</i>	<i>CUWMH072</i>	<i>FEWMH072</i>	<i>PBWMH072</i>	<i>SIWMH072</i>	<i>SNWMH072</i>	<i>FUELH072</i>		<i>TBN_H072</i>	<i>V40_H072</i>	<i>V100H072</i>
<i>TST_H096</i>	<i>AGWMH096</i>	<i>ALWMH096</i>	<i>CRWMH096</i>	<i>CUWMH096</i>	<i>FEWMH096</i>	<i>PBWMH096</i>	<i>SIWMH096</i>	<i>SNWMH096</i>	<i>FUELH096</i>	<i>PEN_H096</i>	<i>TBN_H096</i>	<i>V40_H096</i>	<i>V100H096</i>
<i>TST_H120</i>	<i>AGWMH120</i>	<i>ALWMH120</i>	<i>CRWMH120</i>	<i>CUWMH120</i>	<i>FEWMH120</i>	<i>PBWMH120</i>	<i>SIWMH120</i>	<i>SNWMH120</i>	<i>FUELH120</i>		<i>TBN_H120</i>	<i>V40_H120</i>	<i>V100H120</i>
<i>TST_H144</i>	<i>AGWMH144</i>	<i>ALWMH144</i>	<i>CRWMH144</i>	<i>CUWMH144</i>	<i>FEWMH144</i>	<i>PBWMH144</i>	<i>SIWMH144</i>	<i>SNWMH144</i>	<i>FUELH144</i>	<i>PEN_H144</i>	<i>TBN_H144</i>	<i>V40_H144</i>	<i>V100H144</i>
<i>TST_H168</i>	<i>AGWMH168</i>	<i>ALWMH168</i>	<i>CRWMH168</i>	<i>CUWMH168</i>	<i>FEWMH168</i>	<i>PBWMH168</i>	<i>SIWMH168</i>	<i>SNWMH168</i>	<i>FUELH168</i>		<i>TBN_H168</i>	<i>V40_H168</i>	<i>V100H168</i>
<i>TST_H192</i>	<i>AGWMH192</i>	<i>ALWMH192</i>	<i>CRWMH192</i>	<i>CUWMH192</i>	<i>FEWMH192</i>	<i>PBWMH192</i>	<i>SIWMH192</i>	<i>SNWMH192</i>	<i>FUELH192</i>	<i>PEN_H192</i>	<i>TBN_H192</i>	<i>V40_H192</i>	<i>V100H192</i>
<i>TST_H216</i>	<i>AGWMH216</i>	<i>ALWMH216</i>	<i>CRWMH216</i>	<i>CUWMH216</i>	<i>FEWMH216</i>	<i>PBWMH216</i>	<i>SIWMH216</i>	<i>SNWMH216</i>	<i>FUELH216</i>	<i>PEN_H216</i>	<i>TBN_H216</i>	<i>V40_H216</i>	<i>V100H216</i>

^A Analyses not required by Test Method

