

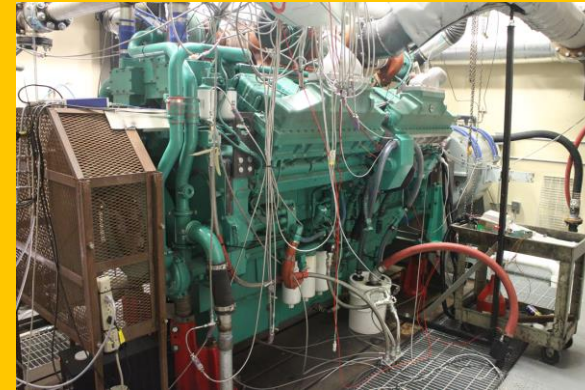
INTERTEK AUTOMOTIVE RESEARCH SAN ANTONIO, TEXAS

Juan Vega, Director



SAN ANTONIO - AUTOMOTIVE RESEARCH OVERVIEW

- 70 years of independent testing
- Fuels and Lubricants Industry
- Engine/Vehicle OEM and Tiered Suppliers
- 4 stand alone laboratories in San Antonio, Texas
- 30+ Engineers, ~300 employees
- 24/7/365 operation
- **Over 120 Engine Dynamometer Test Cells**
- Vehicle level Development and Durability Testing
- Fuel System Testing
- Evaporative Emission (SHED) Testing
- Automatic Transmission Fluid Testing
- Axle efficiency Testing
- Analytical Testing
- Quality: ISO 17025



WIDE RANGE OF FLUID TESTING CAPABILITIES



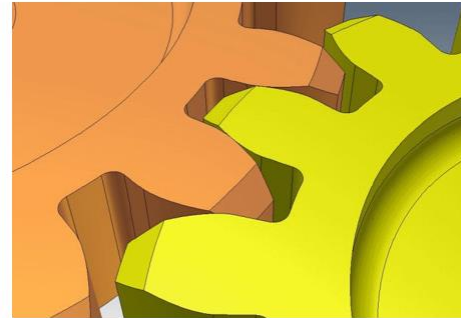
Crankcase Lubes

- ASTM/API
- Diesel
 - PC-11 Standard
- Gasoline
 - GF-6 Standard
- Research/Special Projects



Fuels

- Diesel
- Gasoline
 - IVD
 - LSPI
 - Combustion Chamber Deposits (CCD)
- Vehicle Work



Driveline

- Gear
- Efficiency
- ASTM
 - L37, L42,
- OEM



Transmission

- 21 Test Types
- GM, Ford, Chrysler
- FZG
- JASO

OIL TESTING DETAILS



Light Duty/PCMO

ILSAC/GF-6

IIIH A/B/60/70
IVB
VH
VIE/F
VIII
IX
IX

GM dexos™

GMOD
GMTC
GMSPi, GMPSi3
GMAER

Fuels

FORD IVD
GMIVD
GMGDI



Heavy Duty

API

1K
1N
1P
C13
T-8 A/E
T-11
T-12
T-13
ISM
ISB
COAT

PC12 Adds

DD13
FORD 6.7L

OEM

CUMMINS COP (CNG TEST)

BUSINESS LINES - POINT OF CONTACTS



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Manager	Micheal Portell	micheal.portell@intertek.com	210-647-9483	Driveline Laboratory Manager

PASSENGER CAR MOTOR OIL TESTS





SEQUENCE IIH, ASTM 8111

Objective – The test method was developed to evaluate an automotive engine oil's ability to protect against oil thickening and piston deposits during moderate high speed, high temperature conditions.

Specifications

- API Category – SJ, SL, SM, SN, SN+, SP
- ILSAC – GF-6

Engine - 2014 Chrysler Pentastar 3.6 Liter, V-6 engine.

Operating Conditions– . The Sequence IIH Test consists 90 hours of engine operation at moderately high speed, load, and temperature conditions. The 90-hour segment is broken down into four 20-hour test segments and one 10-hour segment. Oil samples are taken after each segment and analyzed for viscosity, FTIR, wear metals (ICP), TAN and TBN.



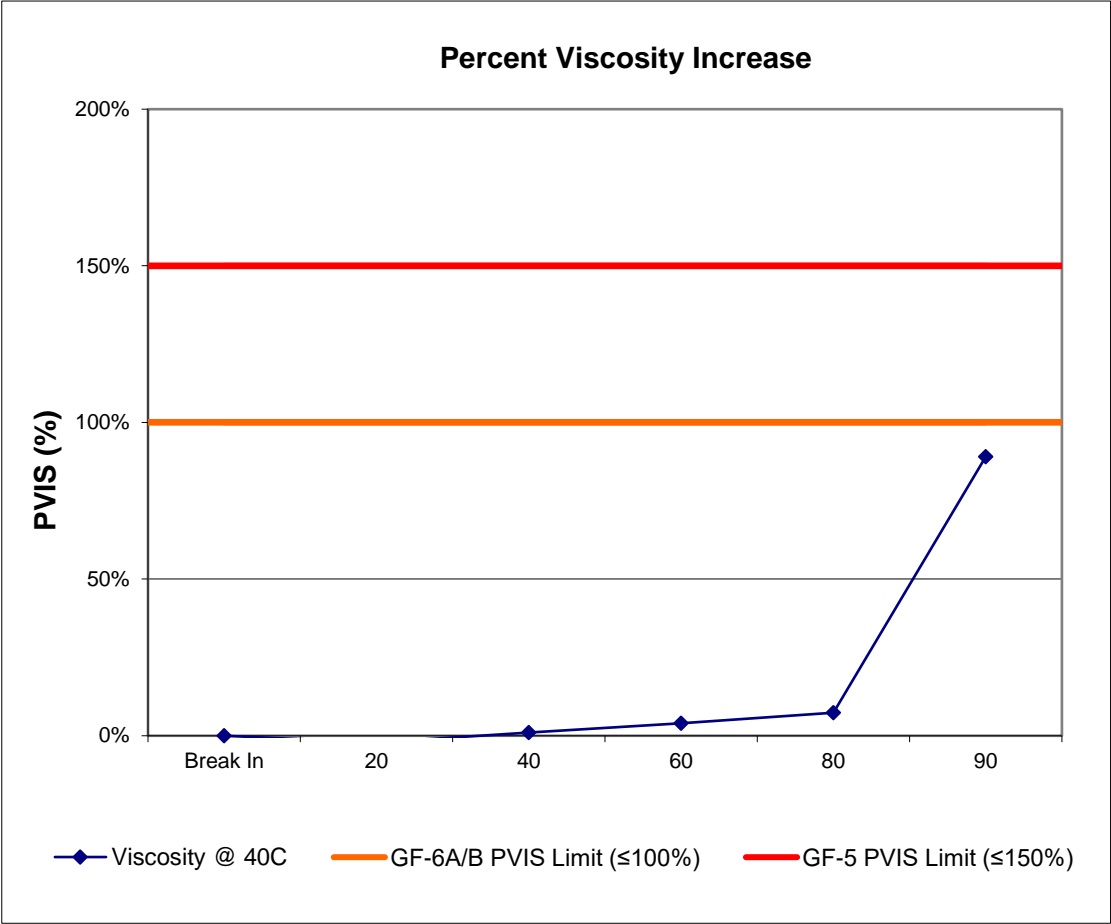
Test Conditions		
	Units	Target
Test Duration	hours	90
Speed	rpm	3900
Load	Nm	250
Oil Block Temperature	°C	151
Coolant Out Temperature	°C	115
Intake Air Temperatures	°C	35
Fuel Temperature	°C	30
Dew Point	°C	16.1
Intake Air Pressure	kPa gauge	0.05
Right Exhaust Pressure	kPa gauge	4.5
Left Exhaust Pressure	kPa gauge	4.5
Coolant Flow Rate	LPM	170

SEQUENCE IIH PASS / FAIL CRITERIA



ASTM TEST	SEQUENCE TEST	PARAMETER	API SP 2020 and newer vehicles		API SN Plus 2020 and older engines		SM 2010 and older engines	SL 2004 and older engines	SJ 2001 and older engines
			API SP LIMITS	Resource Conserving / ILSAC GF-6	API SN LIMITS	Resource Conserving	API SM LIMITS	API SL LIMITS	API SJ LIMITS
D8111	IIH	PVIS @40C, %	≤ 100	≤ 100	≤ 150	≤ 150	≤ 150	--	--
		Ave Weighted Piston Deposits, Merits	≥ 4.2	≥ 4.2	≥ 3.7	≥ 3.7	≥ 3.2	--	--
		Hot Stuck Rings	None	None	None	None	None	--	--
D8111	IIHA or ROBO	MRV, cP	60,000	60,000	60,000	60,000	60,000	--	--
		Yield Stress	<35	<35	<35	<35	<35	--	--
D8111	IIHB	Phos Retention	--	≥ 81	--	≥ 81	--	--	--
D8111	IIH 60	60h Kinematic Vis Increase, %	--	--	--	--	--	--	≤ 307
		60h Ave Weighted Piston Deposits, Merits	--	--	--	--	--	--	--
		60h Avg Piston Skirt Varnish, Merits	--	--	--	--	--	--	--
D8111	IIH 70	70h Kinematic Vis Increase, %	--	--	--	--	--	≤ 181	--
		70h Ave Weighted Piston Deposits, Merits	--	--	--	--	--	≥ 3.3	≥ 2.5
		70h Avg Piston Skirt Varnish, Merits	--	--	--	--	--	≥ 7.9	≥ 7.5

SEQUENCE IIH, TEST EVALUATION (PVIS AND WPD)



Pass



Fail





SEQUENCE IVA, ASTM D6891

Objective – The test method was developed to measure an oil’s ability to protect against camshaft lobe wear for overhead camshafts with sliding camshaft followers at low temperature operating conditions.

Specifications

- API Category – SJ, SL, SM, SN

Engine - 1994 Nissan KA24E 2.4 L

Operating Conditions– . The Sequence IVA Test consists 100 hours of continuous engine running, cycling from 800 rpm to a short 1500 rpm stage, 100 times. Oil samples are taken at 25 h, 50 hr, 75 hr and 100 hr and analyzed for viscosity, wear metals (ICP) and fuel dilution,



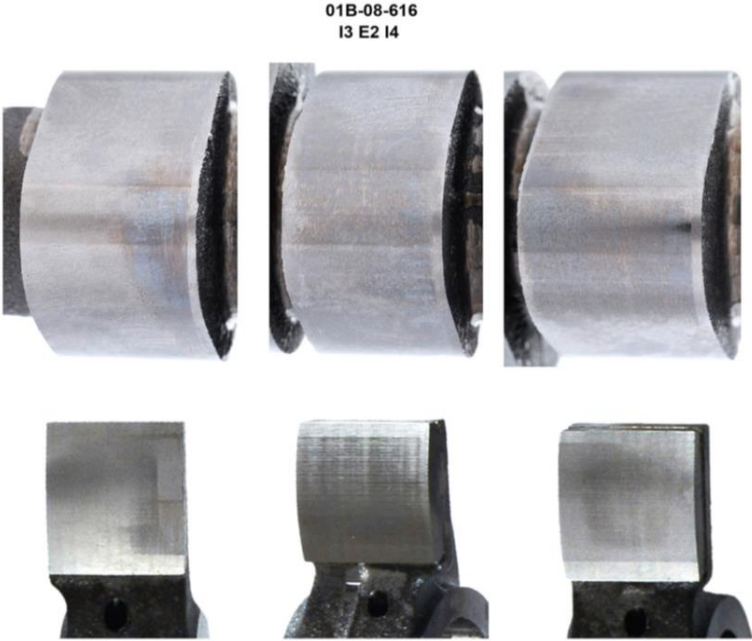
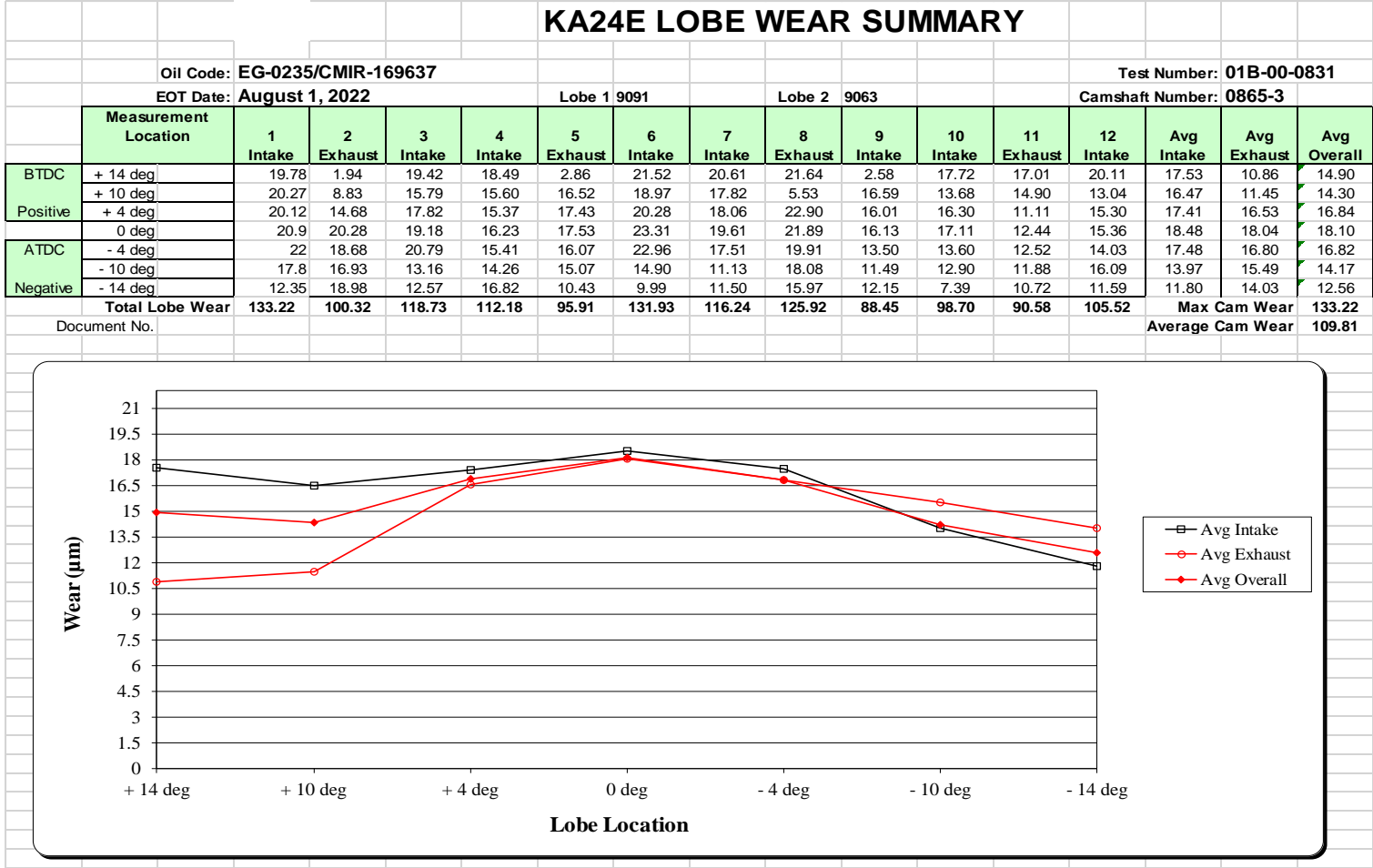
Test Conditions			
	Units	Stage 1	Stage 2
Duration	Min	50	10
Speed	RPM	800	1500
Engine Torque	Nm	25	25
Coolant Out Temperature	°C	50	55
Oil Cylinder Head Temperature	°C	49	59
Intake Air Temperature	kPa	32	32
Intake Air Pressure	kPa	0.05	0.05
Intake Air Humidity	g/kg	11.5	11.5
Exhaust Pressure, absolute	kPa	103.5	103.5
Engine Coolant Flow	LPM	30	30
Rocker Cover Fresh Air Flow	SLPM	10	10
Ignition Timing	°BTDC	10	N/A

SEQUENCE IVA PASS / FAIL CRITERIA



ASTM TEST	SEQUENCE TEST	PARAMETER	API SP 2020 and newer vehicles		API SN Plus 2020 and older engines		SM 2010 and older engines	SL 2004 and older engines	SJ 2001 and older engines
			API SP LIMITS	Resource Conserving / ILSAC GF-6	API SN LIMITS	Resource Conserving	API SM LIMITS	API SL LIMITS	API SJ LIMITS
D6891	IVA	Avg Cam Wear, μm	--	--	≤ 90	≤ 90	≤ 90	≤ 120	≤ 120

IVA CAM WEAR SUMMARY





SEQUENCE IVB, ASTM D8350

Objective – The test method was developed to measure an oil’s ability to control valve-train wear and overall engine wear, at low temperature operating conditions.

Specifications

- API Category – SP
- ILSAC – GF-6A/B
- JASO GLV-1
- ACEA A7/B7, A3/B4, A5/B5, C2, C3, C4, C5, and C6

Engine – 2011 Toyota 2NR-FE, 1.5 L, Dual overhead cams

Operating Conditions– . The Sequence IVB Test consists 200 hours of cyclic operation with a minimum of 24,000 cycles. Oil samples are taken every 25 hrs and analyzed for viscosity, wear metals (ICP), oxidation (FTIR), Karl Fischer water content, fuel dilution, TAN and TBN.



Operating Conditions						
	Units	Ramp to Stage 1	Stage 1	Ramp to Stage 2	Stage 2	
Test Duration	Seconds	8	7	8	7	
Engine Speed	RPM	4300 to 800	800	800 to 4300	4300	
Engine Torque	N-m	25	25	25	25	
Coolant Out Temperature	°C	52	52	52	52	
Oil Gallery Temperature	°C	54	54	54	54	
RAC Coolant Out Temperature	°C	20	20	20	20	
Fuel Rail Temperature	°C	24	24	24	24	
Load Cell Temperature	°C	45	45	45	45	
Intake Air Temperature	°C	32	32	32	32	
Blow-by Gas Temperature	°C	29	29	29	29	
Intake Air Pressure	kPa	0.25	0.25	0.25	0.25	
Exhaust Pressure (Absolute)	kPa	-	-	-	104.5	

SEQUENCE IVB PASS / FAIL CRITERIA

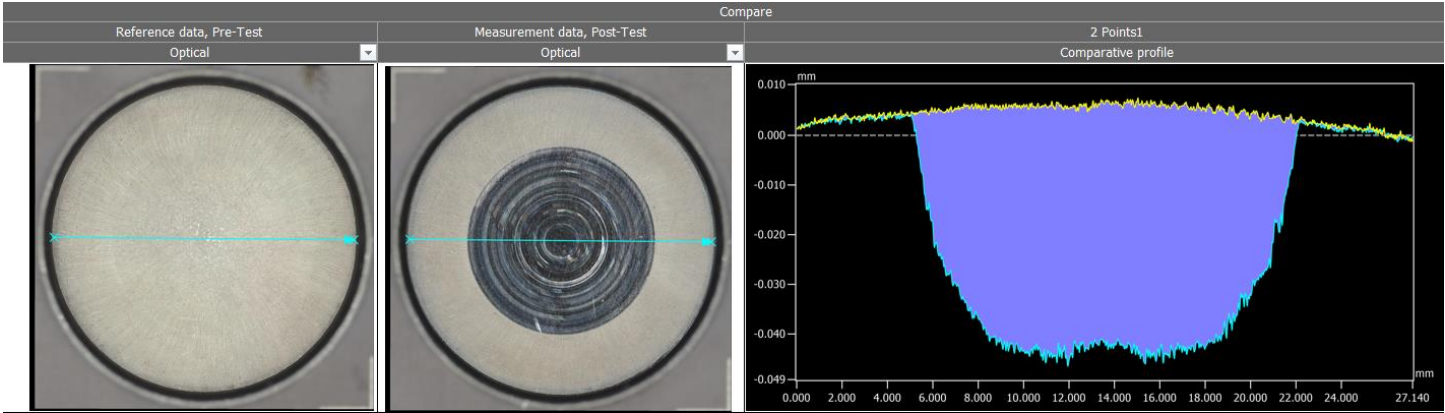
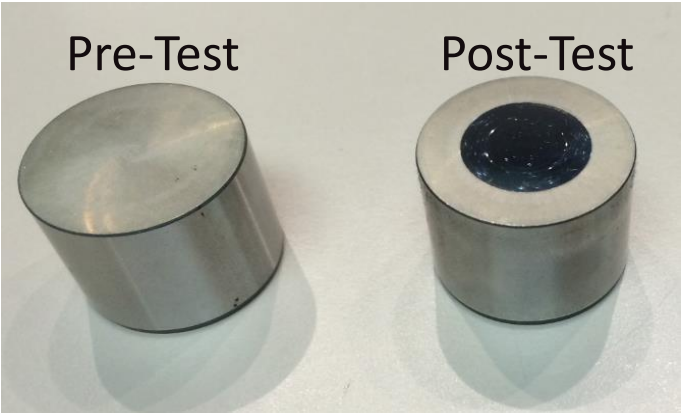
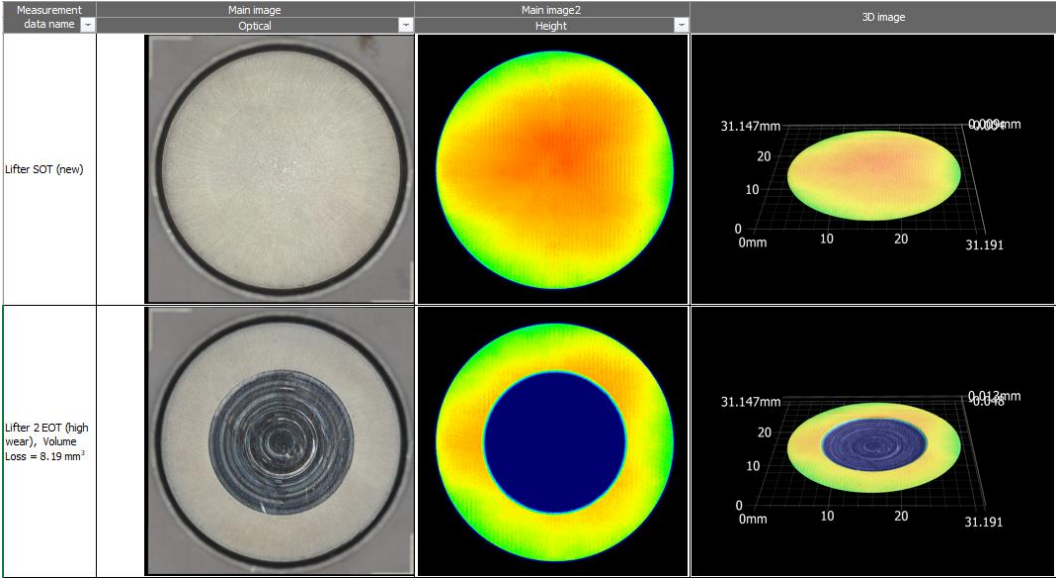


ASTM TEST	SEQUENCE TEST	PARAMETER	API SP LIMITS	Resource Conserving / ILSAC GF-6	ILSAC GF-6 A/B	JASO GLV-1	ACEA A7/B7 and C6	ACEA A3/B4, A5/B5, C2, C3, C4 and C5
D8350	IVB	Avg Intake Lifter Volume Loss,	≤ 2.7	≤ 2.7	≤ 2.7	≤ 2.7	≤ 2.7	≤ 3.3
		End of Test Iron	≤ 400	≤ 400	≤ 400	≤ 400	≤ 400	≤ 400

SEQUENCE IVB CAM TAPPET WEAR SUMMARY



Measureable Paramaters	Units	Value
Intake Lifter Average Volume		
Loss by Keyence,	mm ³	2.15
End of Test Iron	ppm	222
Exhaust Lifter Average Volume		
Volume Loss by Keyence	mm ³	1.74
Intake Lifter Average Mass		
Loss,	mg	18
Exhaust Lifter Average Mass		
Loss	mg	16.6
Camshaft Lobe Failure	(Y or N)	N
Intake Camshaft Average Heel to Toe Wear	µm	0.5
Exhaust Camshaft Average Heel to Toe Wear	µm	1.9
Oil Consumption	g	152



SEQUENCE VH, ASTM D8256



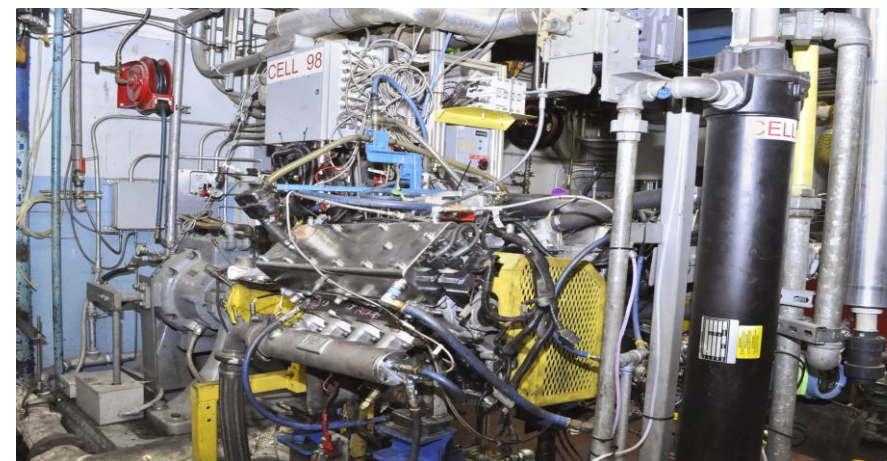
Objective –The test method is used to evaluate an engine's oil ability to control engine deposits under operating condition selected to accelerated deposit formation. Deposit formation includes but not limited to engine varnish and oil sludge.

Specifications

- API Category – SJ, SL, SM, SN, SN+, SP
- ILSAC- GF-6
- dexos™ I Gen III

Engine – 2013 Ford 4.6L V8, Port Fuel Injected

Operating Conditions– . The Sequence VH Test consists of 216 hours total run time, consisting of 54 cycles, 4 hours each. Each cycle consists of three stages. Oil samples are taken every 24 hrs and analyzed for kinematic viscosity, wear metals (ICP), fuel dilution, TAN and TBN.



Operating Conditions				
	Units	Stage 1	Stage 2	Stage 3
Test Duration	Minutes	120	75	45
Speed	RPM	1200	2900	700
Manifold Abs Press, kPa (abs)	kPa	69	66	Record
Engine Oil In	°C	68	100	45
Engine Coolant Out	°C	57	85	45
Engine Coolant Flow	LPM	48	Record	Record
Engine Coolant Pressure	kPa gauge	70	70	70
RAC Coolant In	°C	29	85	29
Rocker Cover Flow	LPM	15	15	15
Intake Air Temp	°C	30	30	30
Intake Air, Press	kPa gauge	0.05	0.05	0.05
Intake Air Humidity	g/ Kg	11.4	11.4	11.4

SEQUENCE VH PASS / FAIL CRITERIA

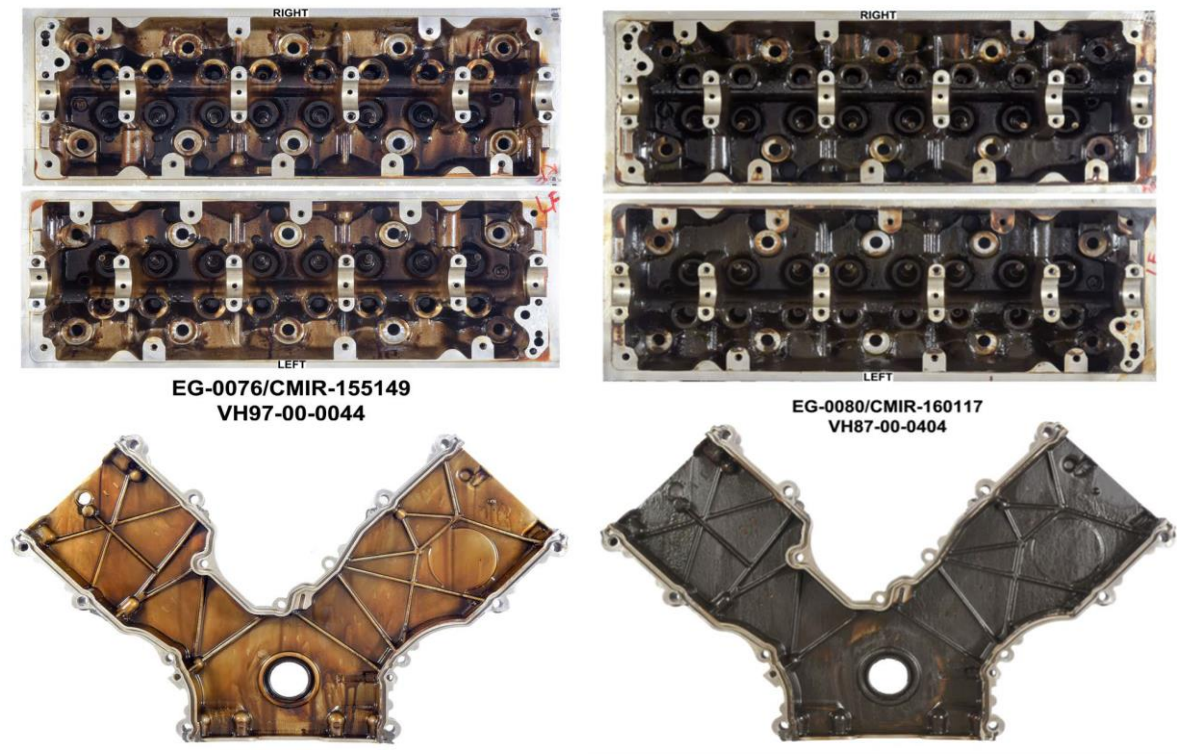


ASTM TEST	SEQUENCE TEST	PARAMETER	API SP 2020 and newer vehicles		API SN Plus 2020 and older engines		SM 2010 and older engines	SL 2004 and older engines	SJ 2001 and older engines
			API SP LIMITS	Resource Conserving / ILSAC GF-6	API SN LIMITS	Resource Conserving	API SM LIMITS	API SL LIMITS	API SJ LIMITS
D8256	VH	Avg Engine Sludge, Merits	≥ 7.6	≥ 7.6	≥ 7.6	≥ 7.6	≥ 7.4	≥ 7.8	≥ 7.8
		Rocker Cover Sludge, Merits	≥ 7.7	≥ 7.7	≥ 7.7	≥ 7.7	≥ 7.4	≥ 8	≥ 8
		Avg Engine Varnish, Merits	≥ 8.6	≥ 8.6	≥ 8.6	≥ 8.6	≥ 8.6	≥ 8.9	≥ 8.9
		Avg Piston Varnish, Merits	≥ 7.6	≥ 7.6	≥ 7.6	≥ 7.6	≥ 7.6	≥ 7.5	≥ 7.5
		Oil Screen Sludge, %	Report	Report	Report	Report	--	--	--
		Hot Stuck Compression Rings	None	None	None	None	None	None	None
		Cold Stuck Ring	Report	Report	--	--	--	Report	Report
		Oil Ring Clogging, %	Report	Report	--	--	--	Report	Report
		Oil Screen Clogging, %	--	--	Report	Report	Report	≤ 20	≤ 20

SEQUENCE VH HARDWARE EVALUATION



Cylinder head and Timing Cover



Pistons and Rear Engine Cover



SEQUENCE VH HARDWARE EVALUATION CONT'D

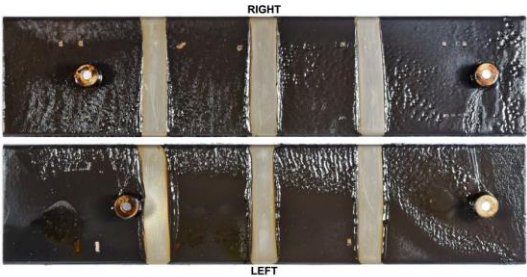
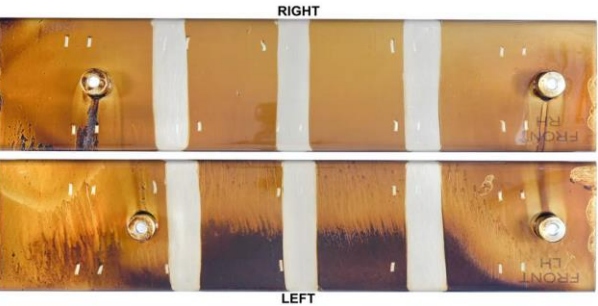


Rocker Cover and Rocker Cover baffles

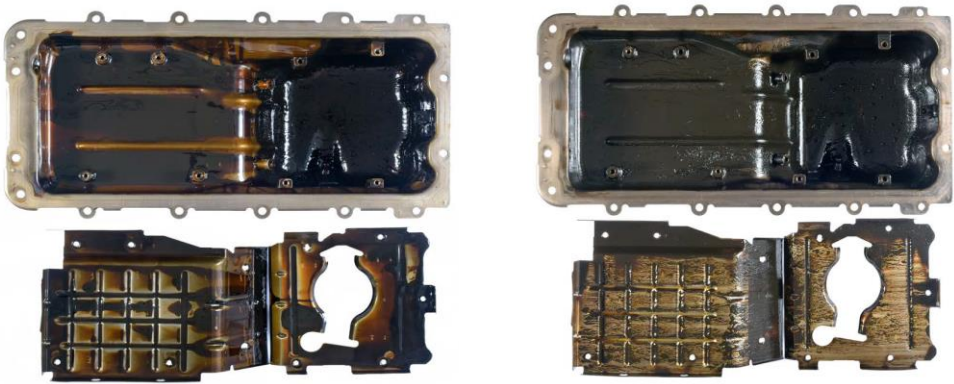


EG-0076/CMIR-155149
VH97-00-0044

EG-0080/CMIR-160117
VH87-00-0404



Oil Pan, Baffle and Screen



EG-0076/CMIR-155149
VH97-00-0044

EG-0080/CMIR-160117
VH87-00-0404





SEQUENCE VIE, ASTM D8114

Objective – The test method was developed to measure an oil’s comparative fuel economy index (FEI) of the fuel-saving capabilities of automotive engine oils under repeatable laboratory conditions.

Specifications

- API Category – SN+, SP
- ILSAC – GF-6A

Engine – 2012 General Motors V6 DOHC with a displacement of 3.6L

Operating Conditions– . The Sequence VIE test method is used to measure the laboratory engine break specific fuel consumption (BSFC) at six constant speed/torque/temperature conditions for the baseline calibration oil, test oil, and repeated of the baseline calibration oil. New and used oil samples are analyzed for viscosity.



Operating Conditions							
	Units	Stage 1	Stage 2	Stage 3	Stage 4	Stage 5	Stage 6
Duration	Min	90	90	90	90	90	90
Speed	RPM	2000	2000	1500	695	695	695
Torque	Nm	105	105	105	20	20	40
Oil Gallery Temp	°C	115	65	115	115	35	115
Coolant Inlet Temp	°C	109	65	109	109	35	109
Intake Air Temperature	°C	29	29	29	29	29	29
Fuel to Fuel Rail Temp	°C	22	22	22	22	22	22
Fuel to Flowmeter Temp	°C	26	26	26	26	26	26
Intake Air Pressure	kPa	0.05	0.05	0.05	0.05	0.05	0.05
Exhaust back Pressure, abs	kPa abs	105	105	105	104	104	104

SEQUENCE VIE PASS / FAIL CRITERIA



ASTM TEST	SEQUENCE TEST	PARAMETER	API SP 2020 and newer vehicles		API SN Plus 2020 and older engines		SM 2010 and older engines	SL 2004 and older engines	SJ 2001 and older engines
			API SP LIMITS	Resource Conserving / ILSAC GF-6	API SN LIMITS	Resource Conserving	API SM LIMITS	API SL LIMITS	API SJ LIMITS
D8114	VIE	XW-20 FEI SUM, %	--	≥ 3.8	--	≥ 3.2	--	--	--
		XW-20 FEI 2, %	--	≥ 1.8	--	≥ 1.5	--	--	--
		XW-30 FEI SUM, %	--	≥ 3.1	--	≥ 2.5	--	--	--
		XW-30 FEI 2, %	--	≥ 1.5	--	≥ 1.2	--	--	--
		10W-30 FEI SUM, %	--	≥ 2.8	--	≥ 2.2	--	--	--
		10W-30 FEI 2, %	--	≥ 1.3	--	≥ 1.0	--	--	--



SEQUENCE VIF, ASTM 8226

Objective – The test method was developed to measure an oil’s comparative fuel economy index (FEI) of the fuel-saving capabilities of automotive engine oils under repeatable laboratory conditions for viscosity 0W-16 or lower.

Specifications

- API Category – SN+, SP
- ILSAC – GF-6B

Engine – 2012 General Motors V6 DOHC with a displacement of 3.6L

Operating Conditions– . The Sequence VIF test method is used to measure the laboratory engine break specific fuel consumption (BSFC) at six constant speed/torque/temperature conditions for the baseline calibration oil, test oil, and repeated of the baseline calibration oil. New and used oil samples are analyzed for viscosity.



Operating Conditions							
	Units	Stage 1	Stage 2	Stage 3	Stage 4	Stage 5	Stage 6
Duration	Min	90	90	90	90	90	90
Speed	RPM	2000	2000	1500	695	695	695
Torque	Nm	105	105	105	20	20	40
Oil Gallery Temp	°C	100	65	100	100	35	100
Coolant Inlet Temp	°C	94	65	94	94	35	94
Intake Air Temperature	°C	29	29	29	29	29	29
Fuel to Fuel Rail Temp	°C	22	22	22	22	22	22
Fuel to Flowmeter Temp	°C	26	26	26	26	26	26
Intake Air Pressure	kPa	0.05	0.05	0.05	0.05	0.05	0.05
Exhaust back Pressure, abs	kPa abs	105	105	105	104	104	104

SEQUENCE VIF PASS / FAIL CRITERIA



ASTM TEST	SEQUENCE TEST	PARAMETER	API SP 2020 and newer vehicles		API SN Plus 2020 and older engines		SM 2010 and older engines	SL 2004 and older engines	SJ 2001 and older engines
			API SP LIMITS	Resource Conserving / ILSAC GF-6	API SN LIMITS	Resource Conserving	API SM LIMITS	API SL LIMITS	API SJ LIMITS
D8226	VIF	0W-16 FEI SUM, %	--	≥ 4.1	--	≥ 3.7	--	--	--
		0W-16 FEI 2, %	--	≥ 1.9	--	≥ 1.8	--	--	--



SEQUENCE VIII, ASTM D6709

Objective – The test method was developed to evaluate automotive engine oil for protection of engines against bearing weight loss.

Specifications

- API Category – SJ, SL, SM, SN, SN+, SP
- ILSAC – GF-6

Engine – Various designation such as the L-38 engine, the CLR engine or the Seq VIII engine.

Operating Conditions– . The Sequence VIII Test consists 40 hours of operation at a constant speed and fuel flow. New and used oil samples are analyzed for viscosity.



Operating Conditions		
	Units	Settings
Duration	hrs	40
Speed	RPM	3150
Air-to-Fuel Ratio	Lamda	13.43
Fuel Flow	kg/h	2.25
Gallery Oil Temperature	°C	135 or 143.5*
Coolant Out Temperature	°C	93.5
Coolant Delta Temperature	°C	5.6
Oil Pressure	kPa	276
Exhaust back pressure	kPa	0 - 3.4
Crankcase Vacuum	Pa	500
Crankcase Off Gas	SLH	850
Spark Advance	°BTDC	35

SEQUENCE VIII



ASTM TEST	SEQUENCE TEST	PARAMETER	API SP 2020 and newer vehicles		API SN Plus 2020 and older engines		SM 2010 and older engines	SL 2004 and older engines	SJ 2001 and older engines
			API SP LIMITS	Resource Conserving / ILSAC GF-6	API SN LIMITS	Resource Conserving	API SM LIMITS	API SL LIMITS	API SJ LIMITS
D6709	VIII	Bearing Weight Loss, mg	≤ 26	≤ 26	≤ 26	≤ 26	≤ 26	≤ 26.4	≤ 26.4

SEQUENCE VIII HARDWARE EVALUATION



Rod Bearing, Pass



Rod Bearing, Fail





SEQUENCE IX, ASTM D8291

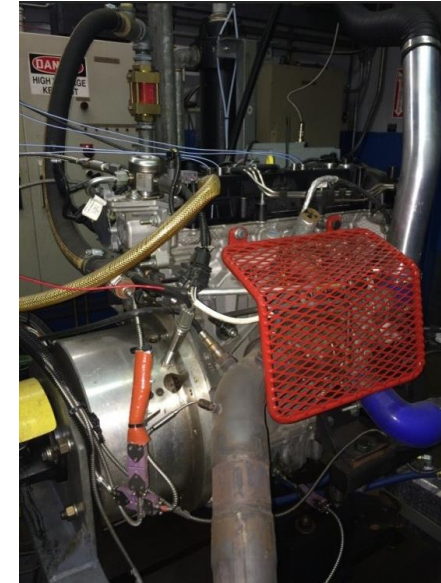
Objective – The test method was developed to evaluate an engine oil’s ability to mitigate preignition in the combustion chambers in a turbocharged, direct injection, gasoline engines under low speed and high-load operating conditions.

Specifications

- API Category –SN+, SP
- ILSAC – GF-6

Engine – 2012 Ford Ecoboost 2.0L inline four-cylinder.

Operating Conditions– . The Sequence IX test procedure is conducted in four iterations. Each iterations is approximately 4 hours and 19 minutes in length. New oil samples are analyzed for viscosity, fuel dilution and wear metals (ICP).



Operating Conditions							
	Units	Stage 1	Stage 2	Stage 3	Stage 4	Stage 5	Stage 6
Time per Stage	h:mm	0:02	0:15	0:25	~3:20	0:15	0:02
Engine Speed	r/min	Idle	2000	1750	1750	2000	Idle
Engine Torque	N·m	0	100	269	269	50	0
Coolant Temp	°C	95	95	95	95	45	45
Oil Gallery Temp	°C	95	95	95	95	45	45
Intake Air Temperature	°C	43	43	43	43	30	30

SEQUENCE IX PASS / FAIL CRITERIA

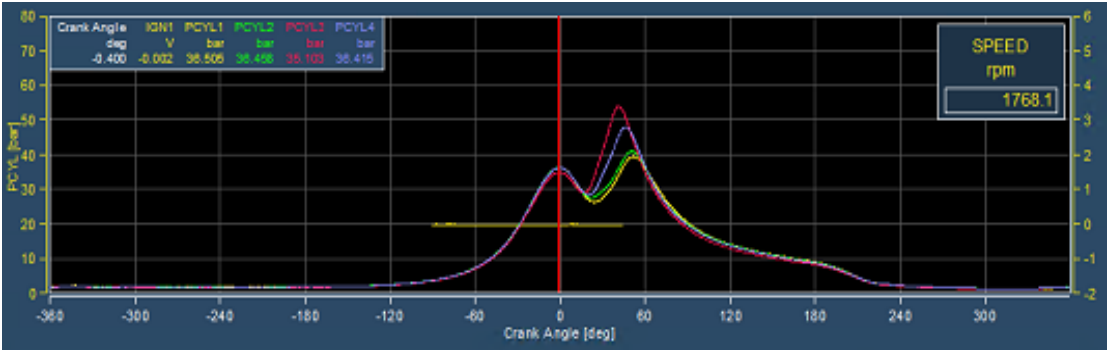


ASTM TEST	SEQUENCE TEST	PARAMETER	API SP 2020 and newer vehicles		API SN Plus 2020 and older engines		SM 2010 and older engines	SL 2004 and older engines	SJ 2001 and older engines
			API SP LIMITS	Resource Conserving / ILSAC GF-6	API SN LIMITS	Resource Conserving	API SM LIMITS	API SL LIMITS	API SJ LIMITS
D8291	IX	Avg Number of Events	≤ 5	≤ 5	≤ 5	≤ 5	--	--	--
		Number of Events per Iteration	≤ 8	≤ 8	--	--	--	--	--

SEQUENCE IX, EVALUATION OF CYCLES USING AVL SOFTWARE



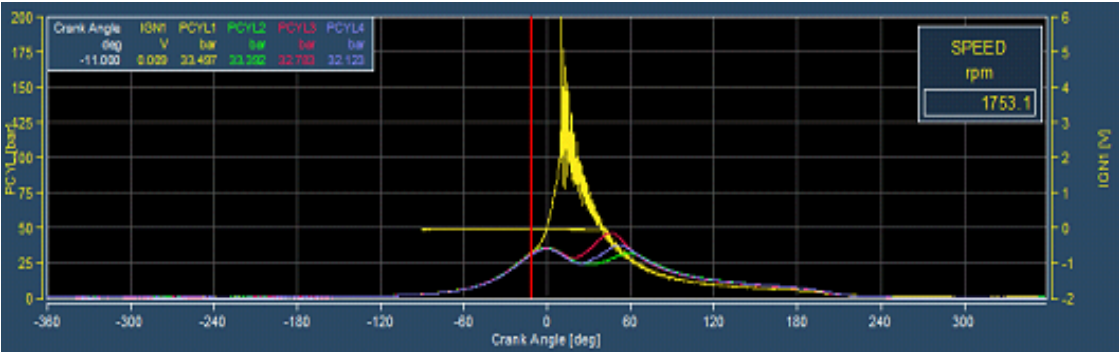
Normal combustion pressure graph



Piston damage due to preignition events



Preignition event in cylinder 1





SEQUENCE X, ASTM D8279

Objective – The test method was developed to evaluate an engine oil’s ability to protect against timing chain lengthening under operation conditions selected to accelerate timing chain wear.

Specifications

- API Category – SP
- ILSAC – GF-6

Engine – 2012 Ford Ecoboost 2.0L inline four-cylinder.

Operating Conditions– . The Sequence X test procedure is composed of two stages. Together the two stages and two ramps comprise of one cycle repeated 54 times for a total of 216 hours. New oil samples are analyzed for viscosity, fuel dilution, TGA soot and wear metals (ICP).



Operating Conditions				
	Units	Stage 1	Stage 2	
Test Duration	Minutes	120	60	
Engine Speed	RPM	1550	2500	
Torque	Nm	50	128	
Oil Gallery Temperature	°C	50	100	
Coolant Out Temperature	°C	45	85	
Coolant Flow	LPM	40	70	
Inlet Air Pressure	kPa	0.05	0.05	
Coolant Pressure	kPa	70	70	
Inlet Air Temperature	°C	32	32	
Exhaust Back Pressure	kPaA	104	107	
Air Charge Temperature	°C	30	30	
Air Fuel Ratio (AFR)	Lamda	0.78	1	
Blowby-outlet Temperature	kPa Abs	23	78	
Blowby	LPM	Not Measured	65 - 75	

SEQUENCE IX PASS / FAIL CRITERIA

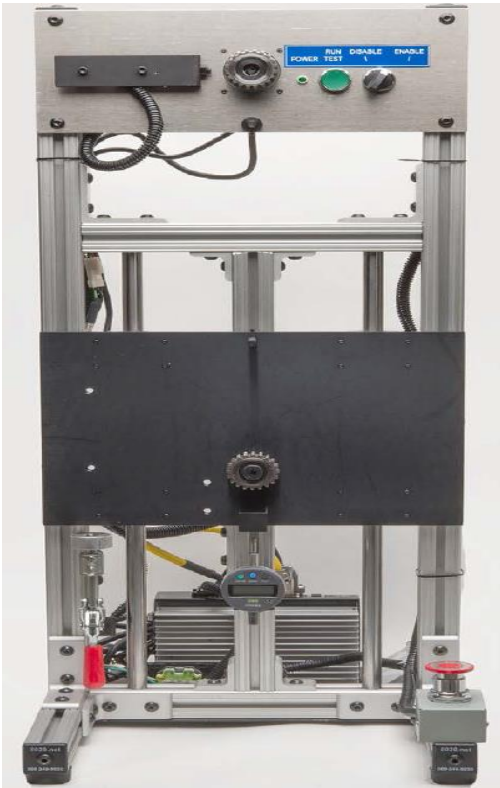


ASTM TEST	SEQUENCE TEST	PARAMETER	API SP 2020 and newer vehicles		API SN Plus 2020 and older engines		SM 2010 and older engines	SL 2004 and older engines	SJ 2001 and older engines
			API SP LIMITS	Resource Conserving / ILSAC GF-6	API SN LIMITS	Resource Conserving	API SM LIMITS	API SL LIMITS	API SJ LIMITS
D8279	X	Chain Stretch, %	≤ 0.085	≤ 0.085	--	--	--	--	--

SEQUENCE X EVALUATION OF HARDWARE



Chain Measurement Rig



Timing Chain on Engine



Chain wear measurements

Reference		0 Hour	216hr
	1	0.0000	0.0000
	2	0.0001	0.0001
	3	0.0001	0.0001
	Average	0.0001	0.0001
Test Chain	1	0.0024	0.0226
	2	0.0025	0.0226
	3	0.0025	0.0226
	Average	0.0025	0.0226
	% Change		0.0934
		Current Severity Adjustment	
		Final % Change	0.0934

JASO M366

Objective – The **JASO M366** is a fired engine fuel economy test developed for use with ultra-low viscosity engine oils

Specifications

- JASO GLV-1 / GLV-2
- ACEA C6

Engine –Toyota **2ZR-FXE** 1.8L inline four-cylinder engine

Operating Conditions– . Test conditions are based on actual Prius data obtained from the **WLTC** (Worldwide Harmonized Light Vehicles Test Cycle). A single test consists of one flush sequence, 10-hour aging and 6 fuel economy stages New Oil samples are analyzed for viscosity.



JASO GLV-1 SPECIFICATION – TEST REQUIREMENTS



Test	Test Method	JASO GLV-1 Specification Requirements
Fuel Economy	JASO M365 (Motoring FE)	0W-8: 2.0% min, 0W-12: 1.7 min
	JASO M366 (Firing FE) OR	1.1% min
Oil Thickening	Sequence IIIH	ILSAC GF-5 level
Valve Train Wear	Sequence IVA	ILSAC GF-5 level
	Sequence IVB OR	ILSAC GF-6 level
Sludge and Varnish	Sequence VH	ILSAC GF-6 level
Chain Wear	Sequence X	ILSAC GF-6 level
Bench Tests: <ul style="list-style-type: none"> • SAE J300, Shear Stability, Aged Oil Low Temp Viscosity • Catalyst Compatibility, Wear, Homogeneity and Miscibility • Volatility, Filterability, Foaming, Emulsion Retention • Elastomer Compatibility, Gelation Index 		ILSAC GF-6B level

GENERAL MOTORS DEXOS™ TESTS, GMAER



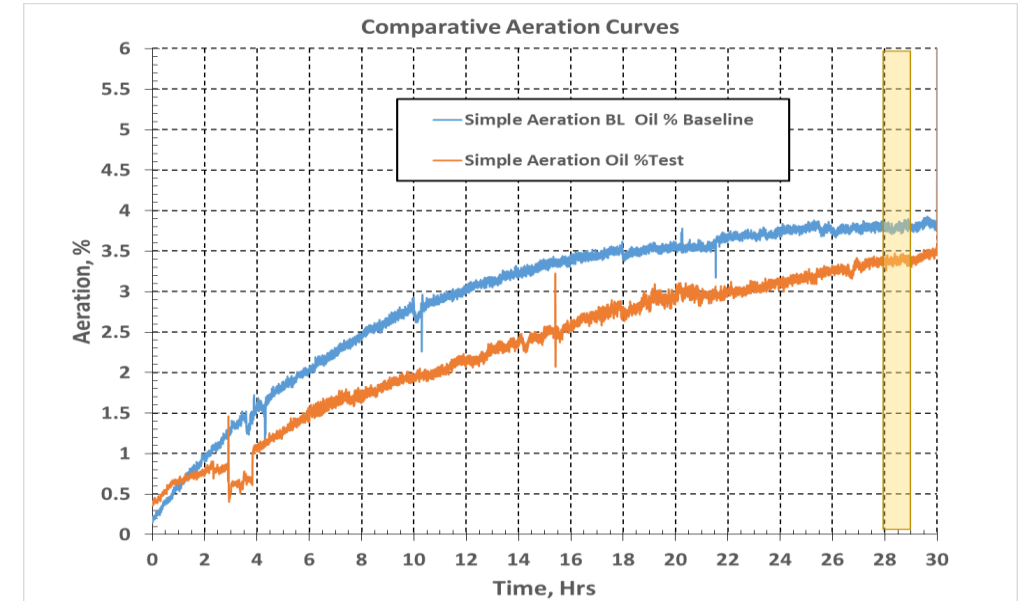
Objective— This test was developed to measure an oil's tendency to entrain free air during engine operation.

Specifications

- GM's dexos™ 1 Gen III

Engine – GM 5.3L V8 LS

Operating Conditions— . The test runs for a total of 60 hours and compares the aeration of a baseline to a candidate oil. New oil samples are analyzed for viscosity, fuel dilution and wear metals (ICP).



* 5 Gallons required for each Run

*2nd Run must be performed within 72 hours of 1st Run to compare.

*Typically 4 days to run full Paired Test

*We request 10 gallons in the event of a shutdown to prevent the loss of a paired run

GENERAL MOTORS DEXOS™ TESTS, GMTC



Objective– This test was developed to determine the level of turbocharger oil coking which is achieved with an engine oil formulation.

Specifications

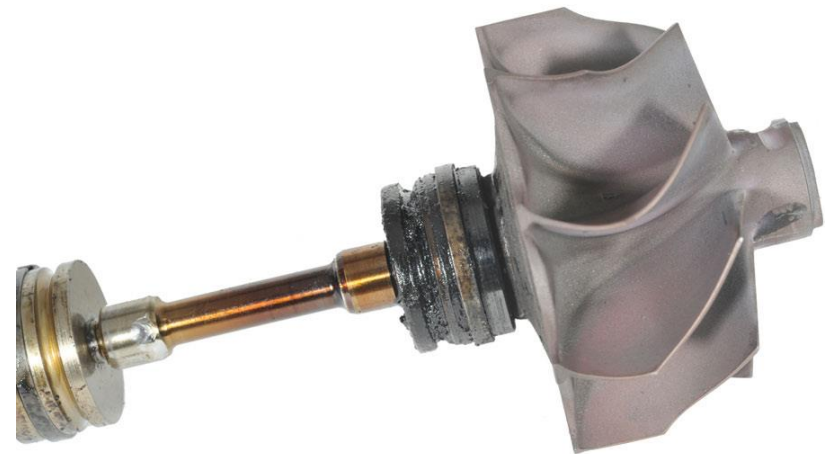
- GM's dexos™ 1 and dexos™ 2

Engine – GM 1.4L Turbo I4 Ecotec LUV Engine

Operating Conditions– . The GMTC test runs for 2000 cycles, approximately 540 hours. New oil samples are analyzed for viscosity, fuel dilution and wear metals (ICP).



2011 1.4L I4 VVT Turbo (LUV)



GENERAL MOTORS DEXOS™ TESTS, GMSPI AND GMPSI3



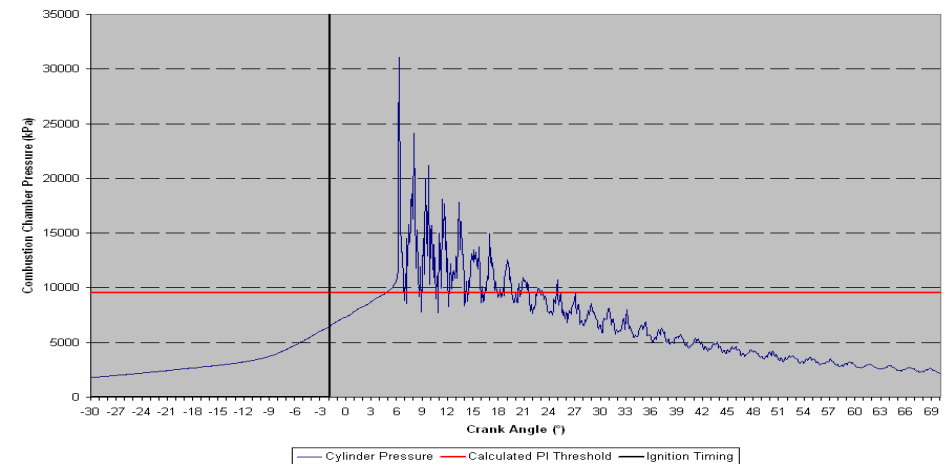
Objective— This test was developed to evaluate the stochastic pre-ignition (SPI) tendency of engine oils seeking dexos™ licensing approval.

Specifications

- GM's dexos™ 1 Gen III

Engine – 2013 GM 2.0L Turbo I4 Ecotec LHU Engine

Operating Conditions— A full SPI evaluation requires five SPI consecutive tests. Each test is comprised of various speeds and loads.



GENERAL MOTORS DEXOS™ TESTS, GMOD



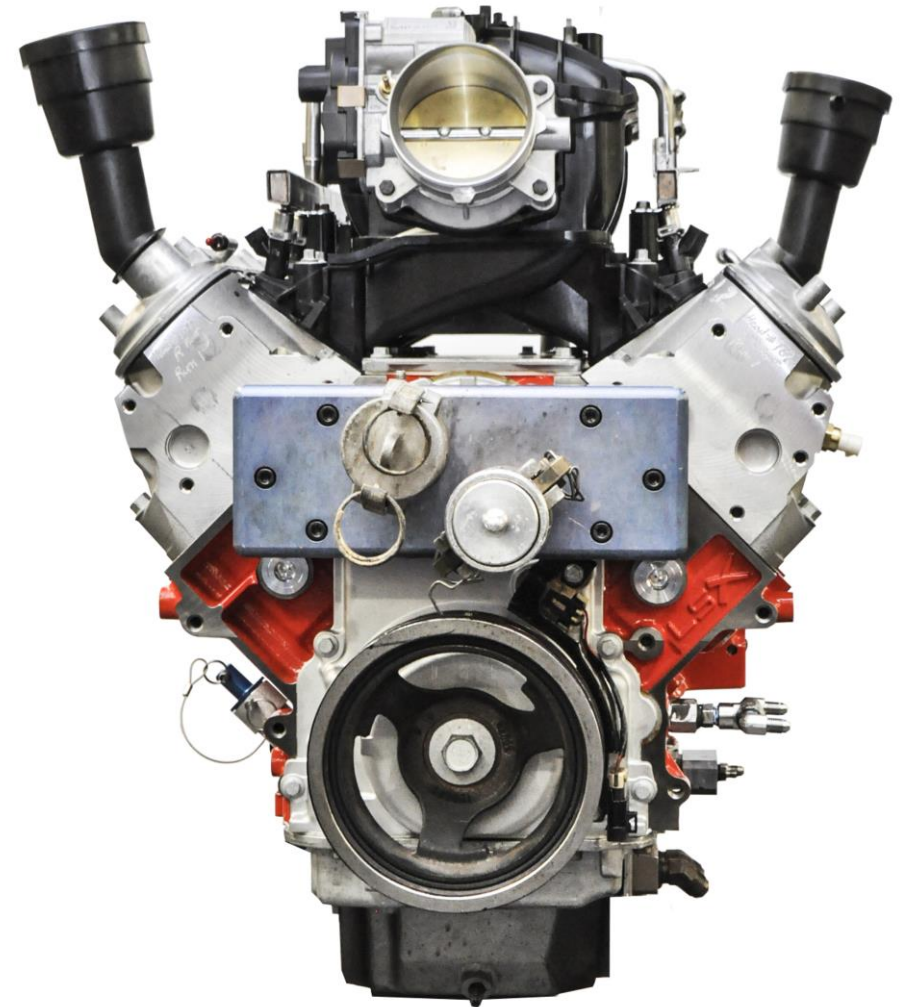
Objective— This test was developed to evaluate an oil's resistance to oxidation during high temperature operation. GMOD is a part of GM's dexos™ engine oil specification.

Specifications

- GM's dexos™ 1 Gen III

Engine – GM 5.7L LSX, V8 Engine

Operating Conditions— The test runs for a total of 100 hours at a constant speed and load with elevated temperatures to accelerate oil oxidation.



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