

Sequence IX Aged Oil

Form 1

Version

Conducted For

	V = Valid
	I = Invalid
	N = Results cannot be interpreted as representative of oil performance (Non-reference oil) and shall not be Aged for multiple test acceptance

	NR = Non-reference oil
	RO = Reference oil

Test Number, Aging							
Stand		# of Runs since last Calibration		Total runs on stand			
Test Number, LSPI							
Stand		Stand Run		Engine		Engine Run	
Oil Code:				# of runs since last calibration LSPI			
Formulation Stand Code							
Alternate Codes							
Date Started, Aging				Time Started, Aging			
Date Started, LSPI				Time Started, LSPI			
Date Completed, Aging				Time Completed, Aging			
Date Completed, LSPI				Time Completed, LSPI			
Test Length, Aging				Total Downtime, Aging			
Test Length, LSPI				Total Downtime, LSPI			
Ref Oil Code ^A :							
SAE Viscosity							

^A Reference Tests Only

In my opinion this test _____ been conducted in a valid manner in accordance with test Method D8291 and appropriate amendments. The remarks included in the report describe the anomalies associated with this test.

Submitted By: _____

Testing Laboratory

Signature

Typed Name

Title

**Sequence IX Aged Oil
Form 2
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**Sequence IX Aged Oil
Form 3
Summary of Test Method**

The Sequence IX Aged Oil test is a fired engine dynamometer lubricant test which evaluates the ability of a test lubricant to reduce pre-ignition events on an aged oil. The test method consists of a cyclic test for aging and a steady state test for preignition.

The Pre-ignition test uses a Ford water cooled, 4 cycle, in-line cylinder, 2.0 liter EcoBoost engine as the test apparatus. The engine incorporates a dual overhead cam, four valves per cylinder (2 intake; 2 exhaust), and direct acting mechanical bucket lifter valve train design. The engine is monitored for pre-ignition events and total number of pre-ignition events. Results are tabulated at the end of test.

The test sequence for aging is summarized below and runs for 72 hours.

Parameter	Units	Quantity
Duration	H	72
Engine Speed	r/min	2500
Engine Torque	N·m	128
Oil Gallery Temperature	°C	100
Coolant Out Temperature	°C	85
Coolant Flow	L/min	70
Intake Air Temperature	°C	32
Intake Air Pressure	kPa	0.05
Intake Air Humidity	g/kg	11.4
Coolant Pressure	kPa	70
Air Charge Temperature	°C	30
Air-Fuel Ratio	λ	1.0
Exhaust Backpressure	kPa	107
Blowby Flowrate	L/min	65-75

The test sequence for LSPI is repeated for 4 test iterations. Each iteration is outlined in the table below:

Parameters	Units	Iteration			
		A	B	C	D
Duration	cycles	175000	175000	175000	175000
Engine Speed	r/min	1750	1750	1750	1750
Torque	Nm	269	269	269	269
Equivalence Ratio	λ	1.00	1.00	1.00	1.00
Coolant Out Temperature	°C	95	95	95	95
Coolant Flow	L/min	55	55	55	55
Oil Gallery Temperature	°C	95	95	95	95
Inlet Air Temperature	°C	30	30	30	30
Air Charge Temperature	°C	43	43	43	43
Fuel Temperature	°C	30	30	30	30
Inlet Air Pressure	kPa	0.05	0.05	0.05	0.05
Exhaust Back Pressure	kPaA	104	104	104	104

**Sequence IX Aged Oil
Form 4**

Test Result Summary, Aging

Lab		Oil Code	
Stand		Test No.	
Laboratory Oil Code			
Engine No.		Fuel Batch	
SAE Viscosity		Reference Oil	

Critical Oil Analysis Results

Analysis Parameter	New Oil	End of Test
Total Acid Number		
Total Base Number		
Kinematic Viscosity @ 40 °C		
Kinematic Viscosity @ 100 °C		
Soot Concentration		
Oxidation, FTIR by D7414		
Nitration, FTIR by D7624		
Fuel dilution, D3525		
Weight of Oil Drain @ End of Test		

Blowby	
Test Hours	Blowby, L/min
23.5 to 23.75	
47.5 to 47.75	
71.5 to 71.75	
Maximum	
Minimum	
Average	

**Sequence IX Aged Oil
Form 6
Operational Summary, Aging**

Lab		Oil Code	
Stand		Test No.	
Laboratory Oil Code			
Formulation Stand Code			

Controlled Parameters	Parameter	Units	QI	EOT	Target	Average	Number of	
			Threshold	OI			Samples	BQD
	Speed	r/min	0.000		2500			
	Torque	N·m	0.000		128			
	Oil Gallery Temperature	°C	0.000		100			
	Coolant Out Temperature	°C	0.000		85			
	Coolant System Pressure	kPa	0.000		70			
	Engine Coolant Flow	L/min	0.000		70			
	Intake Air Humidity	g/kg	0.000		11.4			
	Intake Air Pressure	kPa	0.000		0.05			
	Exhaust Back Pressure	kPa abs.	0.000		107			
	Intake Air Temperature	°C	0.000		32			
	Air Charge Temperature	°C	0.000		30			
	Lambda	λ	0.000		1			
	Blowby Flowrate	L/min			65-75			

Non Controlled	Parameter	Units	Average	Number of Samples	Number of BQD
		Ambient Cell	°C		
	Fuel Flow	kg/h			
	Ignition Voltage	V			
	Fuel Temperature	°C			
	Coolant In Temperature	°C			
	Oil Filter In Temperature	°C			
	Exhaust Temperature	°C			
	Manifold Absolute Pressure	kPa abs.			
	Boost Pressure	kPa abs.			
	Barometric Pressure	kPa abs.			
	Oil Gallery Pressure	kPa			
	Oil Head Pressure	kPa			
	Crankcase Pressure	kPa			
	Fuel Pressure	kPa			
	Pre-Intercooler Pressure	kPa abs.			

**Sequence IX Aged Oil
Form 7
Operational Summary – Iteration A**

Lab		Oil Code	
Stand		Test No.	
Laboratory Oil Code			
Formulation Stand Code			
Fuel Batch			

	Parameter	Units	QI Threshold	EOT QI	Target	Average	Standard Deviation	Number of	
								Samples	BQD
Controlled Parameters	Speed	r/min	0.000		1750				
	Torque	Nm	0.000		269				
	Coolant Out	°C	0.000		95				
	Oil Gallery	°C	0.000		95				
	Inlet Air	°C	0.000		30				
	Air Charge	°C	0.000		43				
	Fuel	°C	0.000		30				
	Inlet Air	kPaA	0.000		0.05				
	Exhaust Back	kPaA	0.000		104				
	Coolant	kPa	0.000		70				
	Humidity	g/kg	0.000		11.4				
	Coolant Flow	L/min	0.000		55				

	Parameter	Units	Average	Standard Deviation	Number of	
					Samples	BQD
Non-controlled Parameters	Coolant In	°C				
	Oil Sump (optional)	°C				
	Exhaust	°C				
	Boost Pressure	kPaA				
	Intake Manifold	kPaA				
	Barometric	kPaA				
	Crankcase	kPa				
	Fuel	kPa				
	Fuel Flow	kg/h				
	Power	kW				
	Equivalence Ratio	λ				

**Sequence IX Aged Oil
Form 8
Operational Summary – Iteration B**

Lab		Oil Code	
Stand		Test No.	
Laboratory Oil Code			
Formulation Stand Code			
Fuel Batch			

Controlled Parameters	Parameter	Units	QI Threshold	EOT QI	Target	Average	Standard Deviation	Number of	
								Samples	BQD
	Speed	r/min	0.000		1750				
	Torque	Nm	0.000		269				
	Coolant Out	°C	0.000		95				
	Oil Gallery	°C	0.000		95				
	Inlet Air	°C	0.000		30				
	Air Charge	°C	0.000		43				
	Fuel	°C	0.000		30				
	Inlet Air	kPaA	0.000		0.05				
	Exhaust Back	kPaA	0.000		104				
	Coolant	kPa	0.000		70				
	Humidity	g/kg	0.000		11.4				
	Coolant Flow	L/min	0.000		55				

Non-controlled Parameters	Parameter	Units	Average	Standard Deviation	Number of	
					Samples	BQD
	Coolant In	°C				
	Oil Sump (optional)	°C				
	Exhaust	°C				
	Boost Pressure	kPaA				
	Intake Manifold	kPaA				
	Barometric	kPaA				
	Crankcase	kPa				
	Fuel	kPa				
	Fuel Flow	kg/h				
	Power	kW				
	Equivalence Ratio	λ				

**Sequence IX Aged Oil
Form 9
Operational Summary – Iteration C**

Lab		Oil Code	
Stand		Test No.	
Laboratory Oil Code			
Formulation Stand Code			
Fuel Batch			

Controlled Parameters	Parameter	Units	QI Threshold	EOT QI	Target	Average	Standard Deviation	Number of	
								Samples	BQD
	Speed	r/min	0.000		1750				
	Torque	Nm	0.000		269				
	Coolant Out	°C	0.000		95				
	Oil Gallery	°C	0.000		95				
	Inlet Air	°C	0.000		30				
	Air Charge	°C	0.000		43				
	Fuel	°C	0.000		30				
	Inlet Air	kPaA	0.000		0.05				
	Exhaust Back	kPaA	0.000		104				
	Coolant	kPa	0.000		70				
	Humidity	g/kg	0.000		11.4				
	Coolant Flow	L/min	0.000		55				

Non-controlled Parameters	Parameter	Units	Average	Standard Deviation	Number of	
					Samples	BQD
	Coolant In	°C				
	Oil Sump (optional)	°C				
	Exhaust	°C				
	Boost Pressure	kPaA				
	Intake Manifold	kPaA				
	Barometric	kPaA				
	Crankcase	kPa				
	Fuel	kPa				
	Fuel Flow	kg/h				
	Power	kW				
	Equivalence Ratio	λ				

**Sequence IX Aged Oil
Form 10
Operational Summary – Iteration D**

Lab		Oil Code	
Stand		Test No.	
Laboratory Oil Code			
Formulation Stand Code			
Fuel Batch			

	Parameter	Units	QI Threshold	EOT QI	Target	Average	Standard Deviation	Number of	
								Samples	BQD
Controlled Parameters	Speed	r/min	0.000		1750				
	Torque	Nm	0.000		269				
	Coolant Out	°C	0.000		95				
	Oil Gallery	°C	0.000		95				
	Inlet Air	°C	0.000		30				
	Air Charge	°C	0.000		43				
	Fuel	°C	0.000		30				
	Inlet Air	kPaA	0.000		0.05				
	Exhaust Back	kPaA	0.000		104				
	Coolant	kPa	0.000		70				
	Humidity	g/kg	0.000		11.4				
	Coolant Flow	L/min	0.000		55				

	Parameter	Units	Average	Standard Deviation	Number of	
					Samples	BQD
Non-controlled Parameters	Coolant In	°C				
	Oil Sump (optional)	°C				
	Exhaust	°C				
	Boost Pressure	kPaA				
	Intake Manifold	kPaA				
	Barometric	kPaA				
	Crankcase	kPa				
	Fuel	kPa				
	Fuel Flow	kg/h				
	Power	kW				
	Equivalence Ratio	λ				

Sequence IX Aged Oil
Form 11
Operational Summary – CAN BUS, Iterations A and B

Lab		Oil Code	
Stand		Test No.	
Laboratory Oil Code			
Formulation Stand Code			

PCM CAN BUS Channels	Iteration A	Units	Average	Standard Deviation	Number of	
					Samples	BQD
	Ignition Timing Advance for #1 Cylinder	°				
	Absolute Throttle Position	%				
	Engine Coolant Temperature	°C				
	Intake Air Temperature	°C				
	Equivalence Ratio (Lambda)	λ				
	Absolute Load Value	%				
	Intake Manifold Absolute Pressure	kPaA				
	Fuel Rail Pressure	kPa				
	Boost Absolute Pressure - Raw Value	kPaA				
	Turbocharger/Supercharger Wastegate	%				
	Actual Intake (A) Camshaft Position	°				
	Actual Exhaust (B) Camshaft Position	°				
	Intake (A) Camshaft Position Actuator Duty	%				
	Exhaust (B) Camshaft Position Actuator Duty	%				
	Charge Air Cooler Temperature	°C				

PCM CAN BUS Channels	Iteration B	Units	Average	Standard Deviation	Number of	
					Samples	BQD
	Ignition Timing Advance for #1 Cylinder	°				
	Absolute Throttle Position	%				
	Engine Coolant Temperature	°C				
	Intake Air Temperature	°C				
	Equivalence Ratio (Lambda)	λ				
	Absolute Load Value	%				
	Intake Manifold Absolute Pressure	kPaA				
	Fuel Rail Pressure	kPa				
	Boost Absolute Pressure - Raw Value	kPaA				
	Turbocharger/Supercharger Wastegate	%				
	Actual Intake (A) Camshaft Position	°				
	Actual Exhaust (B) Camshaft Position	°				
	Intake (A) Camshaft Position Actuator Cycle	%				
	Exhaust (B) Camshaft Position Actuator Duty	%				
	Charge Air Cooler Temperature	°C				

**Sequence IX Aged Oil
Form 12
Operational Summary – CAN BUS, Iterations C and D**

Lab		Oil Code	
Stand		Test No.	
Laboratory Oil Code			
Formulation Stand Code			

PCM CAN BUS Channels	Iteration C	Units	Average	Standard Deviation	Number of	
					Samples	BQD
	Ignition Timing Advance for #1 Cylinder	°				
	Absolute Throttle Position	%				
	Engine Coolant Temperature	°C				
	Intake Air Temperature	°C				
	Equivalence Ratio (Lambda)	λ				
	Absolute Load Value	%				
	Intake Manifold Absolute Pressure	kPaA				
	Fuel Rail Pressure	kPa				
	Boost Absolute Pressure - Raw Value	kPaA				
	Turbocharger/Supercharger Wastegate	%				
	Actual Intake (A) Camshaft Position	°				
	Actual Exhaust (B) Camshaft Position	°				
	Intake (A) Camshaft Position Actuator Duty	%				
	Exhaust (B) Camshaft Position Actuator	%				
	Charge Air Cooler Temperature	°C				

PCM CAN BUS Channels	Iteration D	Units	Average	Standard Deviation	Number of	
					Samples	BQD
	Ignition Timing Advance for #1 Cylinder	°				
	Absolute Throttle Position	%				
	Engine Coolant Temperature	°C				
	Intake Air Temperature	°C				
	Equivalence Ratio (Lambda)	λ				
	Absolute Load Value	%				
	Intake Manifold Absolute Pressure	kPaA				
	Fuel Rail Pressure	kPa				
	Boost Absolute Pressure - Raw Value	kPaA				
	Turbocharger/Supercharger Wastegate	%				
	Actual Intake (A) Camshaft Position	°				
	Actual Exhaust (B) Camshaft Position	°				
	Intake (A) Camshaft Position Actuator Cycle	%				
	Exhaust (B) Camshaft Position Actuator	%				
	Charge Air Cooler Temperature	°C				

**Sequence IX Aged Oil
Form 13
Cycle Count and Type Summary**

Lab		Oil Code	
Stand		Test No.	
Laboratory Oil Code			
Formulation Stand Code			

Cylinder	Iteration A			Iteration B			Iteration C			Iteration D		
	PP Only	MFB2 Only	PP and MFB2	PP Only	MFB2 Only	PP and MFB2	PP Only	MFB2 Only	PP and MFB2	PP Only	MFB2 Only	PP and MFB2
1												
2												
3												
4												
All												

Evaluation Criteria

Parameter	Iteration A				Iteration B				Iteration C				Iteration D			
	Cyl 1	Cyl 2	Cyl 3	Cyl 4	Cyl 1	Cyl 2	Cyl 3	Cyl 4	Cyl 1	Cyl 2	Cyl 3	Cyl 4	Cyl 1	Cyl 2	Cyl 3	Cyl 4
PP Mean																
PP Std Dev																
PP F Value																
PP Thresh																
MFB2 Mean																
MFB2 Std Dev																
MFB2 F Value																
MFB2 Thresh																

Legend:

- PP** **Peak Pressure Only**
- MFB2** **Mass Fraction Burn 2% Only**
- PP& MFB2** **Both Peak Pressure and Mass Fraction Burn 2%**

**Sequence IX Aged Oil
Form 19
Chemical Analyses**

Lab		Oil Code						
Stand, Aging		Test No. Aging						
Stand LSPI		Test No. LSPI						
Laboratory Oil Code								
Formulation Stand Code								
Analytical Measurement	New Oil	Aged Oil	New LSPI	Iteration A	Iteration B	Iteration C	Iteration D	
Aluminum (Al) by D5185								
Boron (B) by D5185								
Calcium (Ca) by D5185								
Chromium (Cr) by D5185								
Copper (Cu) by D5185								
Iron (Fe) by D5185								
Lead (Pb) by D5185								
Magnesium (Mg) by D5185								
Manganese (Mn) by D5185								
Molybdenum (Mo) by D5185								
Potassium (K) by D5185								
Phosphorus (P) by D5185								
Silicone (Si) by D5185								
Sodium (Na) by D5185								
Tin (Sn) by D5185								
Titanium (Ti) by D5185								
Zinc (Zn) by D5185								
Total Acid Number								
Total Base Number								
Kinematic Viscosity @ 40 °C								
Kinematic Viscosity @ 100 °C								
Soot Concentration								
Oxidation, FTIR by D7414								
Nitration, FTIR by D7624								
Fuel Dilution by GC D3525								

**Sequence IX Aged Oil
Form 22
American Chemistry Council Code of Practice
Test Laboratory Conformance Statement**

Test Laboratory					
Test Sponsor					
Formulation / Stand Code					
Test Number, Aging					
Test Number, LSPI					
Start Date		Start Time		Time Zone	

Declarations

No. 1 All requirements of the ACC Code of Practice for which the test laboratory is responsible were met in the conduct of this test. Yes _____ No _____*

No. 2 The laboratory ran this test for the full duration following all procedural requirements; and all operational validity requirements of the latest version of the applicable test procedure (ASTM or other), including all updates issued by the organization responsible for the test, were met.
Yes _____ No _____*

If the response to this Declaration is “No”, does the test engineer consider the deviations from operational validity requirements that occurred to be beyond the control of the laboratory? Yes _____* No _____

No 3. A deviation occurred for one of the test parameters identified by the organization responsible for the test as being a special case. Yes _____* No _____ (This currently applies only to specific deviations identified in the ASTM Information Letter System)

	Operational review of this test indicates that the results should be included in the Multiple Test Acceptance Criteria calculations.
	*Operational review of this test indicates that the results should not be included in the Multiple Test Acceptance Criteria calculations.

Note: Supporting comments are required for all responses identified with an asterisk.

Comments

Signature

Date

Typed Name
