

Report On
Sequence IVB Evaluation

Version

Conducted For

	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

	NR = Non-reference oil test
	RO = Reference oil test

Test Number			
Test Stand	Number of Tests Since Last Stand Calibration Test	Total Runs on Test Stand	
Lab Engine Number		Total Runs on Engine	
Lab Head Number		Total Runs on Cyl Head	
Intake Cam Number		Test Fuel	
Exhaust Cam Number		Fuel Batch	
EOT Date		EOT Time	
Oil Code			
Formulation/Stand			
Alternate Codes			

<p>In my opinion this test been conducted in a valid manner in accordance with the Test Method, D 8350, and appropriate amendments. The remarks included in the report describe the anomalies associated with this test.</p>

Submitted By:

Testing Laboratory

Signature

Typed Name

Title

Sequence IVB
Form 2
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**Sequence IVB
Form 3
Summary of Test Method**

The Sequence IVB engine valve train wear test is a fired engine dynamometer lubricant test which evaluates the ability of a test lubricant to reduce valve train and overall engine wear. The test method is a low temperature cyclic test, with a total running duration of 200 hours.

The Sequence IVB uses a Toyota 2NR-FE water cooled, 4 cycle, in-line cylinder, 1.5 liter 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 critical test parts (camshafts, direct acting mechanical bucket lifters) are replaced each test. A 95 minute run-in schedule, followed by a 50 hour aging schedule, for Silicon (Si) pacification, is conducted whenever the long block or cylinder head are replaced with new components, or whenever a long block is cleaned after a lobe failure. An additional 50 hour break in is conducted after the 50 hour aging, whenever a new long block is brought into service.

The Sequence IVB valve train wear test is a flush and run type of lubricant test with one 6 minute engine oil system flush and three 38 minute engine oil system flushes conducted prior to the actual test start. The test sequence is repeated for 24,000 test cycles. Each cycle consists of four stages as outlined in the table below:

Parameter	Units	Stage 2 → 1	Stage 1	Stage 1 → 2	Stage 2
Duration	Sec.	8	7	8	7
Engine Speed	r/min	4300 to 800	800 ± 25	800 to 4300	4300 ± 25
Engine Torque	N-m	25 ± 1.5	25 ± 1.5	25 ± 1.5	25 ± 1.5
Coolant Out Temperature	°C		52 ± 1.0		52 ± 1.0
Coolant Flow (Engine)	L/min	80 ± 0.4	80 ± 0.4	80 ± 0.4	80 ± 0.4
Coolant Flow (RAC)	L/min	120 ± 0.75	120 ± 0.75	120 ± 0.75	120 ± 0.75
Oil Gallery Temperature	°C	54 ± 4	54 ± 4	54 ± 4	54 ± 4
RAC Coolant Out Temperature	°C	20 ± 0.75	20 ± 0.75	20 ± 0.75	20 ± 0.75
Fuel Rail Temperature	°C	24 ± 0.5	24 ± 0.5	24 ± 0.5	24 ± 0.5
Load Cell Temperature	°C	45 ± 4	45 ± 4	45 ± 4	45 ± 4
Intake Air Temperature	°C	32 ± 0.75	32 ± 0.75	32 ± 0.75	32 ± 0.75
Blowby Gas Temperature	°C	29 ± 0.5	29 ± 0.5	29 ± 0.5	29 ± 0.5
Intake Air Pressure	kPa(g)	0.25 ± 0.25	0.25 ± 0.25	0.25 ± 0.25	0.25 ± 0.25
Intake Air Humidity	g/kg	11.5 ± 0.5	11.5 ± 0.5	11.5 ± 0.5	11.5 ± 0.5
Exhaust Pressure	kPa(a)				104.5 ± 3
Engine Coolant Pressure	kPa	70 ± 10	70 ± 10	70 ± 10	70 ± 10
Fuel Rail Pressure	kPa	335 ± 10	335 ± 10	335 ± 10	335 ± 10
Air-to-Fuel Ratio (Not Controlled)	:1	Record	14.5 ± 0.5	Record	14.5 ± 0.5

**Sequence IVB
Form 4
Test Results Summary**

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

Date Started		Engine No.	
Time Started		Fuel Batch	
Date Completed		SAE Viscosity	
Time Completed		Reference Oil	
Hours on Engine		Hours on Head	
Test Length			

Critical Parameters			
	Intake Lifter Average Volume Loss by Keyence, mm ³	End of Test Iron, mg/kg	SA *Capped
Original Unit Result			
Transformed Result			
Industry Correction Factor			
Corrected Transformed Result			
Severity Adjustment			
Final Transformed Result			
Final Original Unit Result			

*Severity Adjustments are capped at ±100 ppm

Additional Information	
Exhaust Lifter Average Volume Loss by Keyence, mm ³	
Intake Lifter Average Mass Loss, mg	
Exhaust Lifter Average Mass Loss, mg	
Camshaft Lobe Failure (Y or N)	
Intake Camshaft Average Heel to Toe Wear, μm	
Exhaust Camshaft Average Heel to Toe Wear, μm	
Oil Consumption, g	
Fuel Consumption, l	
Fuel Dilution @ EOT, %	
40°C Viscosity @ EOT, cSt	
Total Acid Number @ EOT, g KOH/g	
Total Base Number @ EOT, g KOH/g	
Oxidation by FTIR 5.8 Peak Area @EOT, ABS/cm ²	
Nitration by FTIR 6.1 Peak Area @EOT, ABS/cm ²	
Used Oil Water @ EOT, mg/Kg	
TAN/TBN Crossover hours	
Average Fuel Dilution, %	
Calcium or detergent metal ratio adjusted Iron @ EOT, mg/kg	

**Sequence IVB
Form 5
Operational Summary**

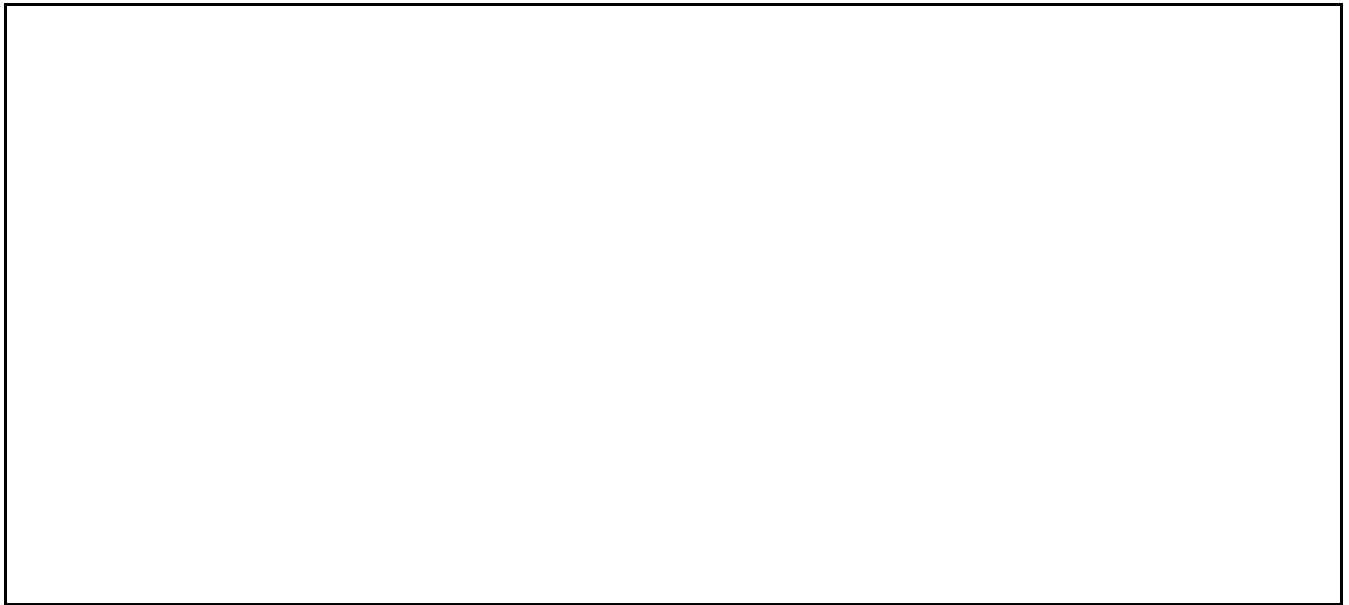
Lab		Oil Code	
Stand		Test No.	
Laboratory Oil Code			
Formulation Stand Code			

Controlled Parameters	Parameter	Units	QI Threshold	EOT QI	Target		Average		Samples	BQD
					Stage 1	Stage 2	Stage 1	Stage 2		
					Speed	r/min	0.000			
Torque	n·m	0.000		25	25					
Engine Oil Gallery	°C	0.000		54	54					
Engine Coolant Out	°C	0.000		52	52					
Engine Coolant Flow	L/min	0.000		80	80					
Engine Coolant Pressure	kPa	0.000		70	70					
RAC Coolant Out	°C	0.000		20	20					
Load Cell	°C	0.000		45	45					
RAC Flow	L/min	0.000		120	120					
Intake Air	°C	0.000		32	32					
Intake Air Pressure	kPa	0.000		0.25	0.25					
Intake Air Humidity	g/kg	0.000		11.5	11.5					
Fuel Rail Temperature	°C	0.000		24	24					
Blowby Gas	°C	0.000		29	29					
Fuel Rail Pressure	kPa	0.000		335	335					
Exhaust Backpressure	kPaA	0.000			104.5					
Non-controlled Parameters	Parameter	Units								
	Fuel Flow	kg/h			Record	Record				
	Blowby	L/min			Record	Record				
	Power	kW			Record	Record				
	Air Fuel Ratio	AFR			Record	Record				
	Engine Coolant In	°C			Record	Record				
	Engine Coolant Delta	°C			Record	Record				
	RAC Coolant In	°C			Record	Record				
	Oil Sump Temp	°C			Record	Record				
	Exhaust Gas	°C			Record	Record				
	Cell Ambient	°C			Record	Record				
	Oil Gallery	kPa			Record	Record				
	Crankcase Pressure	kPa			Record	Record				
	Intake Manifold Pressure	kPaA			Record	Record				

**Sequence IVB
Form 7
Oil Analysis Trend Plots**

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

Fuel Dilution and Kinematic Viscosity @ 40°C Plot



TAN, TBN, and Fe Plot



**Sequence IVB
Form 9
Camshaft and Lifter Wear Measurements**

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

Lifter Measurements				
Lifter	Intake		Exhaust	
	Keyence Volume Loss mm ³	Mass Loss mg	Keyence Volume Loss mm ³	Mass Loss mg
1				
2				
3				
4				
5				
6				
7				
8				
Average				
Minimum				
Maximum				
Std. Dev.				

Camshaft Lobe Measurements								
Lobe	Intake Camshaft				Exhaust Camshaft			
	Heel to Toe, mm		Wear μm	Lobe Fail Y or N	Heel to Toe, mm		Wear, μm	Lobe Fail Y or N
	SOT	EOT			SOT	EOT		
1								
2								
3								
4								
5								
6								
7								
8								
	Average				Average			
	Minimum				Minimum			
	Maximum				Maximum			
	Std. Dev.				Std. Dev.			

**Sequence IVB
Form 10
Valve Clearance, Compression and Leakdown Measurements**

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

Valve Clearance Measurements								
Intake								
Position	1	2	3	4	5	6	7	8
Clearance, SOT								
Clearance, EOT								
Change								
Exhaust								
Clearance, SOT								
Clearance, EOT								
Change								

Compression and Cylinder Leak Down					
Cylinder	Compression, kPa			Cylinder Leak Down, %	
	Pre-test	Post test	Delta, %	Pre-test	Post test
1					
2					
3					
4					

**Sequence IVB
Form 11
Hardware Information**

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

Hardware Information			
		Intake	Exhaust
Camshaft			
Bucket Lifter Position	1		
	2		
	3		
	4		
	5		
	6		
	7		
	8		

Engine	
Cylinder Head	
Oil Filter	
Spark Plug	
Number of Runs on Cylinder Head	
Number of Runs on Engine	

Serial Numbers	
Engine	
Cylinder Head	
Intake Camshaft	
Exhaust Camshaft	

**Sequence IVB
Form 12
Downtime Summary**

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

Number of Downtime Occurrences			
Test Hours	Date	Downtime	Reasons
			Total Downtime (hours)

**Sequence IVB
Form 14
American Chemistry Council Code of Practice
Test Laboratory Conformance Statement**

Test Laboratory					
Test Sponsor					
Formulation / Stand Code					
Test Number					
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

Title