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			

In my opinion this test been conducted in a valid manner in accordance with the Test Method, D XXXX, 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 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 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 100 hour aging schedule, for Silicon (Si) pacification, is conducted whenever the long block or cylinder head are replaced with new components.

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	Stage1	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 ± 2	25 ± 2	25 ± 2	25 ± 2
Coolant In Temperature	°C	49 ± 3	49 ± 3	49 ± 3	49 ± 3
Coolant Flow (Engine)	L/min	80 ± 2	80 ± 2	80 ± 2	80 ± 2
Coolant Flow (RAC)	L/min	120 ± 2	120 ± 2	120 ± 2	120 ± 2
Oil Gallery Temperature	°C	55 to 53	53 ± 3	53 to 55	55 ± 3
RAC Coolant Out Temperature	°C	20 ± 2	20 ± 2	20 ± 2	20 ± 2
Fuel Rail Temperature	°C	24 ± 3	24 ± 3	24 ± 3	24 ± 3
Load Cell Temperature	°C	45 ± 3	45 ± 3	45 ± 3	45 ± 3
Intake Air Temperature	°C	32 ± 3	32 ± 3	32 ± 3	32 ± 3
Blowby Gas Temperature	°C	28 ± 2	28 ± 2	28 ± 2	28 ± 2
Intake Air Pressure	kPa(g)	0.07 ± 0.07	0.07 ± 0.07	0.07 ± 0.07	0.07 ± 0.07
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 to 103.5	103.5 ± 1	103.5 to 104.5	104.5 ± 1
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 Result 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			

PARAMETER	RESULT
Intake Camshaft Average Heel to Toe Wear, µm	
Intake Camshaft Summation Heel to Toe Wear, µm	
Exhaust Camshaft Average Heel to Toe Wear, µm	
Exhaust Camshaft Summation Heel to Toe Wear, µm	
Intake Bucket Lifters Average z diff, µm	
Intake Bucket Lifters Summation z diff, µm	
Intake Bucket Lifters Average Area Loss, μm^2	
Intake Bucket Lifters Average Volume Loss by Keyence, mm^3	
Intake Bucket Lifters Summation Volume Loss by Keyence, mm^3	
Intake Bucket Lifters Summation Area Loss, μm^2	
Intake Bucket Lifters Average Mass Loss, mg	
Intake Bucket Lifters Summation Mass Loss, mg	
Exhaust Bucket Lifters Average z diff, µm	
Exhaust Bucket Lifters Summation z diff, µm	
Exhaust Bucket Lifters Average Area Loss, μm^2	
Exhaust Bucket Lifters Summation Area Loss, μm^2	
Exhaust Bucket Lifters Average Volume Loss by Keyence, mm^3	
Exhaust Bucket Lifters Summation Volume Loss by Keyence, mm^3	
Exhaust Bucket Lifters Average Mass Loss, mg	
Exhaust Bucket Lifters Summation Mass Loss, mg	
Camshaft Lobe Failure (Y or N)	
Oil Consumption, g	
Fuel Consumption, l	
Fuel Dilution @ EOT, %	
40ºC 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 Iron @EOT, mg/Kg	

Sequence IVB
Form 5
Operational Summary

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

	Parameter	Units	QI Threshold	EOT QI	Target		Average		Samples	BQD
					Stage 1	Stage 2	Stage 1	Stage 2		
Controlled Parameters	Speed	r/min	**0.000**		**800**	**4300**				
	Torque	n·m	**0.000**		**25**	**25**				
	Engine Oil Gallery	°C	**0.000**		**53**	**55**				
	Engine Coolant In	°C	**0.000**		**49**	**49**				
	Engine Coolant Flow	L/min	**0.000**		**80**	**80**				
	RAC Coolant Out	°C	**0.000**		**20**	**20**				
	RAC Flow	L/min	**0.000**		**120**	**120**				
	Intake Air	°C	**0.000**		**32**	**32**				
	Intake Air Pressure	kPa	**0.000**		**0.07**	**0.07**				
	Intake Air Humidity	g/kg	**0.000**		**11.5**	**11.5**				
	Fuel Rail Temperature	°C	**0.000**		**24**	**24**				
	Blowby Gas	°C	**0.000**		**28**	**28**				
	Exhaust Backpressure	kPaA	**0.000**		**103.5**	**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 Pressure	kPa			70±10	70±10				
	Engine Coolant Out	°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				
	Fuel Rail Pressure	kPa			335±10	335±10				
	Crankcase Pressure	kPa			Record	Record				
	Intake Manifold Pressure	kPaA			Record	Record				

Sequence IVB
Form 6
Used Oil Analysis Results

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

Test Hour	D3525 Fuel Dilution %	Viscosity 40ºC, mm^2/s	D4739 Total Base Number g KOH/g	D664 Total Acid Number, g KOH/g	FTIR 5.8 Peak Area, ABS/cm^2	FTIR 6.1 Peak Area, ABS/cm^2	Water by Karl Fisher, mg/kg

Sequence IVB
Form 7
ICP Analysis

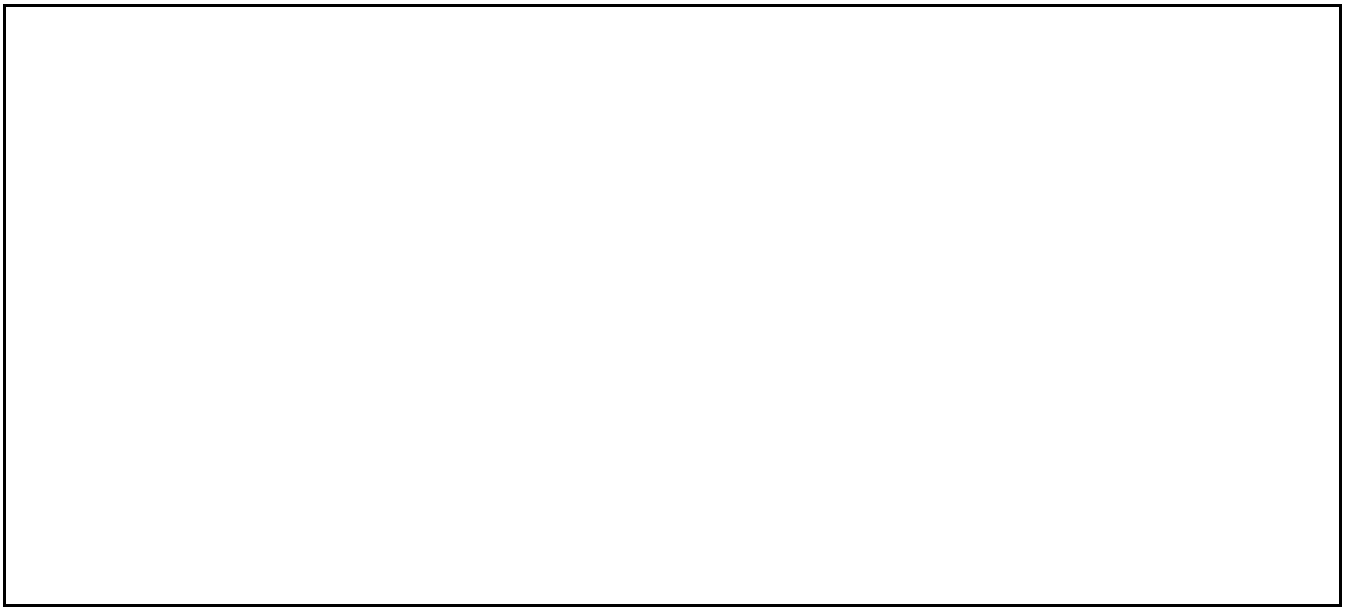
Lab		Oil Code	
Stand		Test No.	
Laboratory Oil Code			
Formulation Stand Code			

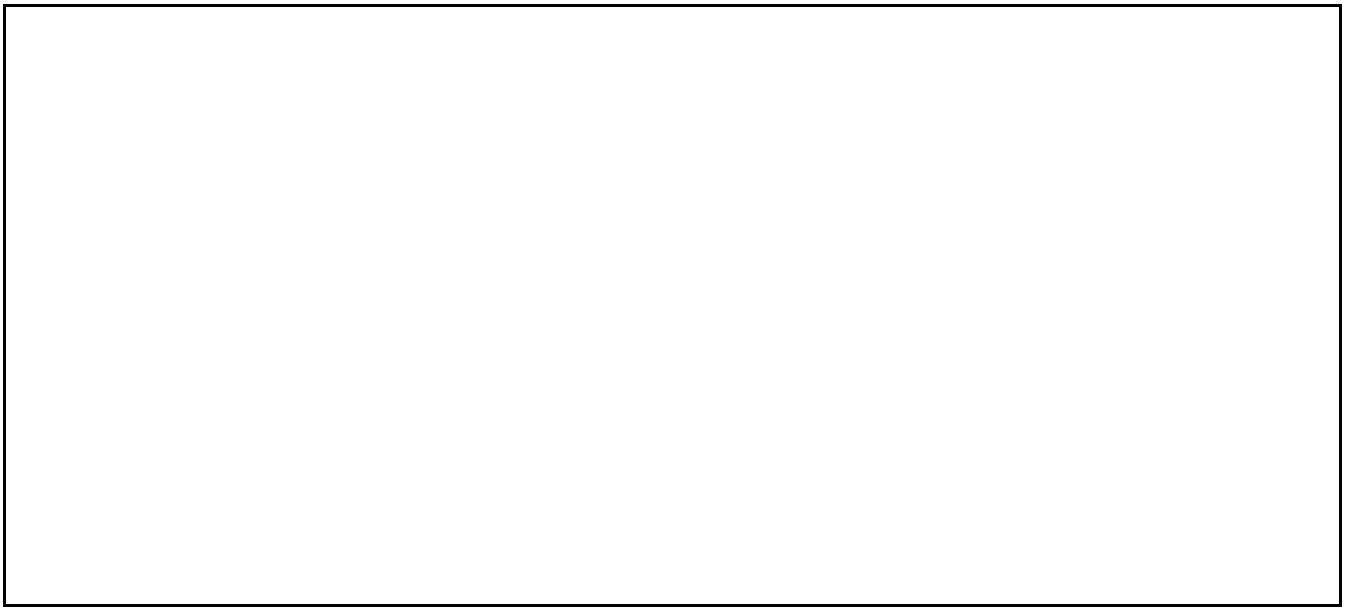
Hours	ICP Metals									
	Al	Cr	Cu	Fe	K	Ni	Na	Pb	Si	Sn
Flush 1										
Flush 2										
Flush 3										
Flush 4										

Sequence IVB
Form 8

Oil Analyses Trend Plots

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





Sequence IVB
Form 9
Engine Build Measurements

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

Bucket Lifter Size and Identification						
Cylinder	Intake			Exhaust		
	Location	Size	ID	Location	Size	ID
1	Intake 1			Exhaust 1		
	Intake 2			Exhaust 2		
2	Intake 3			Exhaust 3		
	Intake 4			Exhaust 4		
3	Intake 5			Exhaust 5		
	Intake 6			Exhaust 6		
4	Intake 7			Exhaust 7		
	Intake 8			Exhaust 8		

Camshaft Journal Measurements				
Intake			Exhaust	
Journal Number	Oil Feed Hole Dia., mm	Journal Dia., mm	Oil Feed Hole Dia., mm	Journal Dia., mm
Main Feed				
1				
2				
3				
4				
Run Out, mm			Run Out, mm	

Camshaft Lobe Measurements						
Intake				Exhaust		
Lobe	Heel to Toe, mm	Wt, µm	Ra, µm	Heel to Toe, mm	Wt, µm	Ra, µm
1						
2						
3						
4						
5						
6						
7						
8						

Sequence IVB
Form 10
Bucket Lifter Wear Measurements

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

Lifter	Position	Intake				Exhaust			
		PDI Max z diff., µm	PDI Area Loss, µm ^{2}	Keyence Volume Loss, mm^3	Mass Loss, mg	PDI Max z diff., µm	PDI Area Loss, µm ^{2}	Keyence Volume Loss, mm^3	Mass Loss, mg
1	X								
	Y								
2	X								
	Y								
3	X								
	Y								
4	X								
	Y								
5	X								
	Y								
6	X								
	Y								
7	X								
	Y								
8	X								
	Y								
Sum.									
Avg.									
Min.									
Max.									
Std. Dev.									
Avg Wear Rate per Hour of Test Time		z diff., µm	Area Loss, µm ^{2}	Keyence Volume Loss, mm^3	Mass Loss, mg	z diff., µm	Area Loss, µm 2	Keyence Volume Loss, mm^3	Mass Loss, mg

Sequence IVB
Form 11
Camshaft Lobe Wear Measurements

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

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								
		Sum				Sum		
		Average				Average		
		Minimum				Minimum		
		Maximum				Maximum		
		Std. Dev.				Std. Dev.		

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

Sequence IVB
Form 12
Miscellaneous 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	

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 13
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
Test Comments

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

Number of Comment Lines		

Sequence IVB
Form 15
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