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
Table of Contents

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	Ramp to Stage 1	Stage 1	Ramp to Stage 2	Stage 2
Duration	sec	8	7	8	7
Engine Speed	r/min	4300 to 800	800	800 to 4300	4300
Engine Torque	N·m	25	25	25	25
Oil Gallery Temperature	°C	55 to 53	53	53 to 55	55
Coolant In Temperature	°C	49	49	49	49
Intake Air Temperature	°C	32	32	32	32
Intake Air Pressure	kPa	0.07	0.07	0.07	0.07
Intake Air Humidity	g/kg	11.5	11.5	11.5	11.5
Exhaust Back Pressure	kPa-abs	104.5 to 103.5	103.5	103.5 to 104.5	104.5
Differential Coolant Temperature	°C	5 to 2	2	2 to 5	5
Rocker Cover Coolant Outlet Temperature	°C	20	20	20	20

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 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 Mass Loss, mg	
Exhaust Bucket Lifters Summation Mass Loss, mg	
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, ppm	

Sequence IVB
Form 5
Operational Summary – Phase 1

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

Parameter	Units	Target	Minimum	Maximum	Average	Std. Dev.	CV, %
Engine Speed	r/min	800 ± 25					
Engine Torque	N-m	25 ± 2					
Engine Power	kW						
Brake Mean Effective Power	bar						
Air Fuel Ratio	afr	14.5 ± .2					
Fuel Flow Rate	kg/h						
Coolant Temperature Into Engine	°C	49 ± 3					
Coolant Temperature Out of Engine	°C						
Coolant Delta	°C	2 ± 1					
Engine Oil Sump	°C						
Engine Oil Gallery	°C	53 ± 3					
Intake Air Temperature	°C	32 ± 3					
Exhaust Gas Temperature	°C						
Fuel Rail Temperature	°C	24 ± 3					
Test Cell Air Temperature	°C						
Rocker Cover Coolant In Temperature	°C						
Rocker Cover Coolant Out Temperature	°C	20 ± 2					
Oil Gallery Pressure	kPa G						
Exhaust Pressure	kPa Abs	103.5 ± 1					
Intake Air Pressure	kPa G	0.07 ± 0.02					
Fuel Rail Pressure	kPa G	335 ± 5					
Crankcase Gas Pressure	kPa G						
Barometric Pressure	kPa Abs						
Intake Manifold Pressure	kPa Abs						
Intake Air Humidity	g/kg	11.5 ± 0.5					
Blowby Flow Rate	sl/min						

Sequence IVB
Form 6
Operational Summary – Phase 2

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

Parameter	Units	Target	Minimum	Maximum	Average	Std. Dev.	CV, %
Engine Speed	r/min	4300 ± 25					
Engine Torque	N-m	25 ± 2					
Engine Power	kW						
Brake Mean Effective Power	bar						
Air Fuel Ratio	afr	14.5 ± .2					
Fuel Flow Rate	kg/h						
Coolant Temperature Into Engine	°C	49 ± 3					
Coolant Temperature Out of Engine	°C						
Coolant Delta	°C	5 ± 1					
Engine Oil Sump	°C						
Engine Oil Gallery	°C	55 ± 3					
Intake Air Temperature	°C	32 ± 3					
Exhaust Gas Temperature	°C						
Fuel Rail Temperature	°C	24 ± 3					
Test Cell Air Temperature	°C						
Rocker Cover Coolant In Temperature	°C						
Rocker Cover Coolant Out Temperature	°C	20 ± 2					
Oil Gallery Pressure	kPa G						
Exhaust Pressure	kPa Abs	104.5 ± 1					
Intake Air Pressure	kPa G	0.07 ± 0.02					
Fuel Rail Pressure	kPa G	335 ± 5					
Crankcase Gas Pressure	kPa G						
Barometric Pressure	kPa Abs						
Intake Manifold Pressure	kPa Abs						
Intake Air Humidity	g/kg	11.5 ± 0.5					
Blowby Flow Rate	sl/min						

Sequence IVB
Form 7
Used Oil Analysis Results

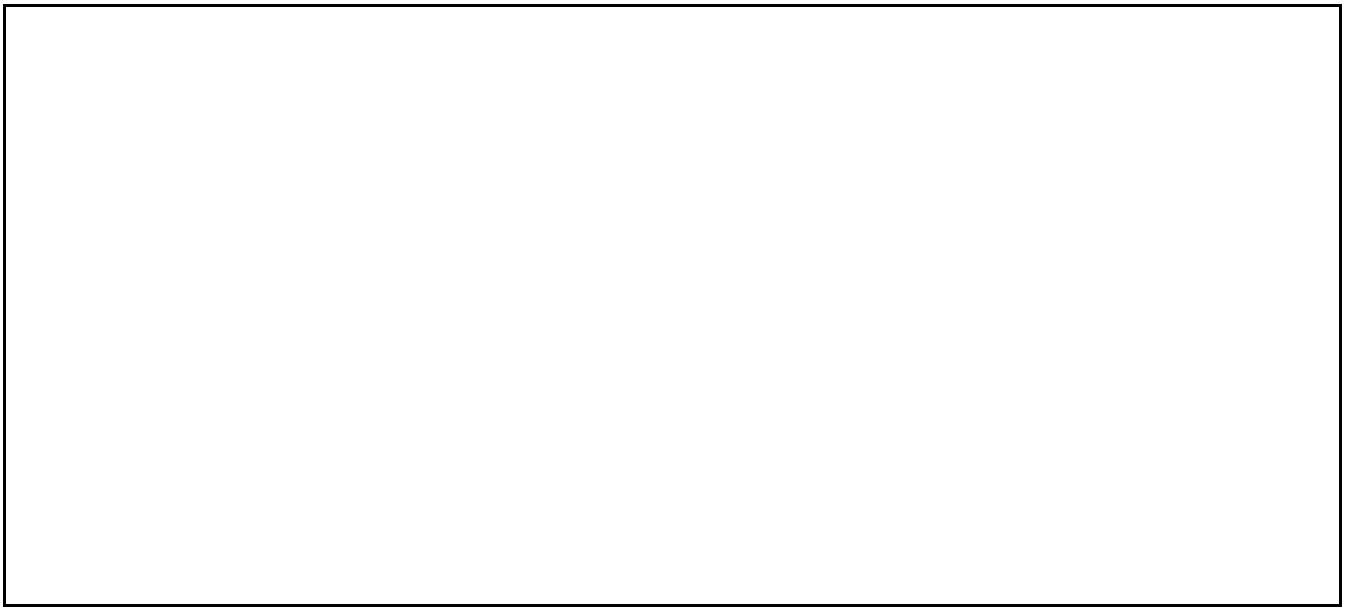
Lab		Oil Code	
Stand		Test No.	
Laboratory Oil Code			
Formulation Stand Code			

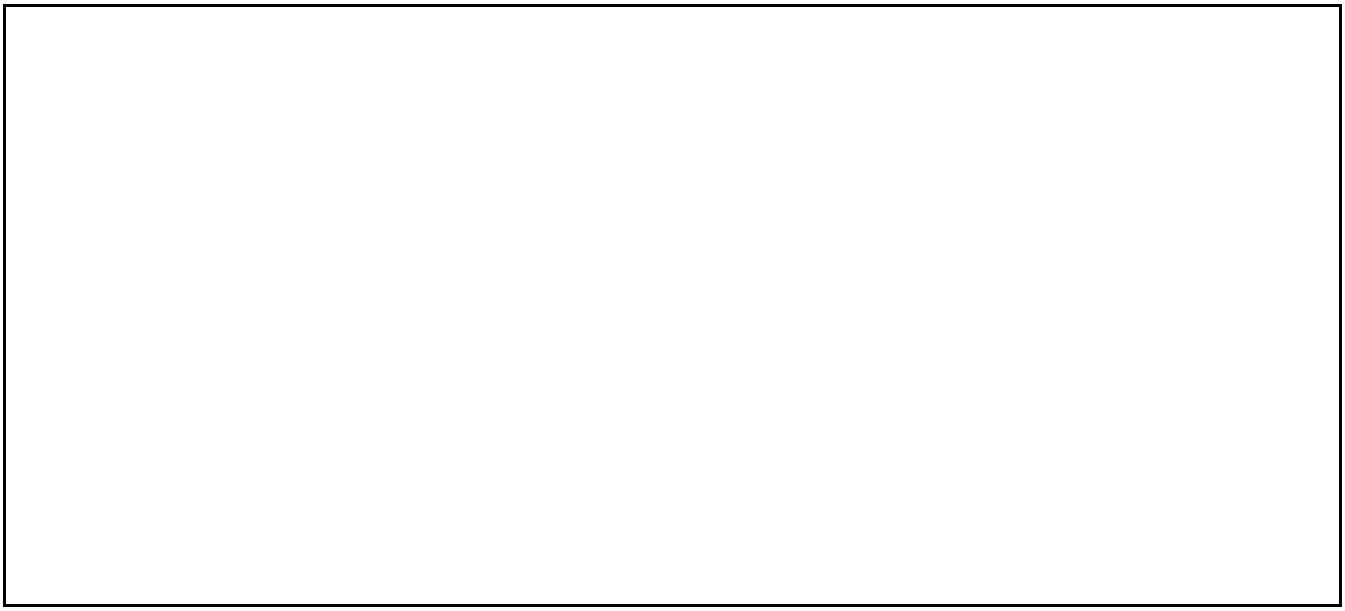
Test Hour	**Flush1**	**Flush2**	**Flush3**	**Flush4**									
D5185 Metals, ppm													
Aluminum (Al)													
Chromium (Cr)													
Copper (Cu)													
Iron (Fe)													
Potassium (K)													
Nickel (Ni)													
Sodium (Na)													
Lead (Pb)													
Silicon (Si)													
Tin (Sn)													
D3525 Fuel Dilution %													
Viscosity 40ºC, cSt													
D664 Total Acid Number, gkOH/g													
D4739 Total Base Number, gkOH/g													
FTIR 5.8 Peak Area, ABS/cm^2													
FTIR 6.1 Peak Area, ABS/cm^2													

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		
	Start of Test Heel to Toe, mm	End of Test Heel to Toe, mm	Wear, µm	Start of Test Heel to Toe, mm	End of Test Heel to Toe, mm	Wear, µm
1						
2						
3						
4						
5						
6						
7						
8						
		Sum of Wear			Sum of Wear	
		Average			Average	
		Minimum			Minimum	
		Maximum			Maximum	
		Std. Dev.			Std. Dev.	

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