Sequence IVA Valve Train Wear Evaluation
Final Report Cover Sheet

Form 1

Version:

Conducted For

	V = Valid
	I = Invalid

	NR = Non-reference oil
	RO = Reference oil

Test Number			
Test Stand	**Number of Runs on Since Last Calibration Test**		**Total Runs on Test Stand**
Lab Engine Number		Total Runs on Cylinder Head	
Lab Head Number		Lab Cam Number	
Date Completed		Completion Time	
Oil Code		Fuel Batch	
Formulation/Stand Code			
Alternate Codes:			

In my opinion this test been conducted in a valid manner in accordance with the ASTM Test Method D 6891 and the appropriate amendments through the Information Letter System. The remarks included in this report describe anomalies associated with this test.

Submitted By:

_____
Testing Laboratory

_____
Signature

_____
Typed Name

_____
Title

Sequence IVA Valve Train Wear Test

Form 2

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Sequence IVA Valve Train Wear Test

Form 3

Summary of Test Method

The Sequence IVA engine valve train wear test is a fired engine-dynamometer lubricant test which evaluates the ability of a test lubricant to reduce camshaft lobe wear. The test method is a low temperature cyclic test, with a total running duration of 100 hours.

A 1994 Nissan model KA24E water-cooled, 4 cycle, in-line cylinder, 2.4L engine is used as the test apparatus. The engine incorporates a single overhead cam (SOHC), three valves per cylinder (2 intake; 1 exhaust), and sliding follower valve train design. An engine short block is utilized for 16 tests; a cylinder head assembly for 8 tests; and the critical test parts (camshaft, rocker arms, rocker shafts) are replaced every test. A 95-minute break-in schedule is conducted whenever the long block or cylinder head is replaced.

The Sequence IVA test is a flush and run type of lubricant test. Each individual test consists of two 20-minute flushes, followed by the 100-hour cyclic test. The cyclic test is comprised of 100 hourly cycles. Each cycle consists of two stages. The idle speed Stage 1 duration is 50 minutes; the 1500 r/min stage 2 operates for 10 minutes. The stages of the test cycle are set at the following conditions:

Parameter	**Units**	**Stage 1**	**Stage 2**
Duration	Min	50	10
Engine Speed	r/min	800	1500
Engine Torque	N•m	25	
Coolant Out Temperature	°C	50	55
Oil Cylinder Head Temperature	°C	49	59
Intake Air Temperature	°C	32	
Intake Air Pressure	KPa	0.050	
Intake Air Humidity	G/kg	11.5	
Exhaust Pressure	kPa absolute	103.5	
Coolant Flow	L/min	30	
Fresh Air Flow	SL/min	10	

Upon test completion, the camshaft is removed from the engine and measured for individual lobe wear at seven prescribed locations (nose; 14 degrees before and after the nose; 10 degrees before and after the nose; 4 degrees before and after the nose). For each lobe, the seven locations are summed to determine the lobe wear. Then the twelve lobes are averaged to compute the final test result.

Sequence IVA Valve Train Wear Test

Form 4

Results Summary

Laboratory:	Test Number: - -
Oil Code:	
Formulation/Stand Code:	

Laboratory Oil					
Fuel Batch				SAE Grade	
Date Started		Date Completed		Test Length	
Time Started		Time Completed		TMC Oil Code[A]	
Lab Engine					
Cam Lot Number		Head Lot		Rocker Arm Lot	

Average Camshaft Wear

Original Unit Result, µm	
Transformed Result	
Industry Correction Factor	
Corrected Transformed Result	
Severity Adjustment (non-reference oil tests only)	
Final Transformed Result	
Final Original Unit Result, µm	

Additional Camshaft Lobe Wear Measurements

Intake Lobe	Maximum, µm	
	Average, µm	
Exhaust Lobe	Maximum, µm	
	Average, µm	
Nose	Maximum, µm	
	Average, µm	

Additional Information

Total Oil Consumption @ EOT, g	
Fuel Dilution @ EOT, %	
Fuel Consumption @ EOT, kg	
Fe by ICP @ EOT, ppm	
Corrected Blowby, L/min @ hour 5	
Corrected Blowby, L/min @ hour 100	

Most Recent Reference Oil Test History[B]

Test Number	- -		
Oilcode			
Date		TMC Oil Code	
Final Average Camshaft Wear, µm			

[A] Reference Oil Tests Only

[B] Non-reference Oil Tests Only

Sequence IVA Valve Train Wear Evaluation

Form 5

Camshaft Lobe Wear

Laboratory:	Test Number: - -
Oil Code:	
Formulation/Stand Code:	

7-point Measurement Method

Position	Cylinder	Lobe Number	14° BTC Wear, µm	10° BTC Wear, µm	4° BTC Wear, µm	0° (Nose) Wear, µm	4° ATC Wear, µm	10° ATC Wear, µm	14° ATC Wear, µm	Lobe Wear, µm
Intake	1	1								
		3								
	2	4								
		6								
	3	7								
		9								
	4	10								
		12								
	Maximum									
	Average									
Exhaust	1	2								
	2	5								
	3	8								
	4	11								
	Maximum									
	Average									
Overall Maximum										
Overall Average										

Sequence IVA Valve Train Wear Test

Form 6

Operational Summary

Laboratory:	Test Number: - -
Oil Code:	
Formulation/Stand Code:	

	Parameter	Units	QI Limit	EOT QI	Target		Average		Samples[A]	BQD[B]	Over/Under Range[C]
Controlled Parameters	Speed	r/min	**0.000**		**800**	**1500**					
	Torque	N·m	**0.000**		**25.0**						
	Coolant Out Temperature	°C	**0.000**		**50.0**	**55.0**					
	Humidity	g/kg	**0.000**		**11.5**						
	Intake Air Temperature	°C	**0.000**		**32**						
	Intake Air Pressure	kPa	**0.000**		**0.05**						
	Exhaust Pressure, absolute	kPa	**0.000**		**103.5**						
	Engine Coolant Flow	L/min	**0.000**		**30**						
	Oil Cylinder Head Temperature	°C	**0.000**		**49.0**	**59.0**					
	Rocker Cover Fresh Air Flow	SL/min	**0.000**		**10.0**						

	Parameter	Units	Typical Values		Average	
Non-controlled Parameters	Oil Sump Temperature	°C	49 – 54	**57 – 65**		
	Oil Gallery Temperature	°C	46.5 – 50.5	**58.5 – 61.5**		
	Coolant In Temperature	°C	44 – 46	**49 – 50**		
	Exhaust Gas Temperature	°C	306 – 332	**414 – 434**		
	Fuel Rail Temperature	°C	15 – 30	**15 – 30**		
	Oil Gallery Pressure	°C	99.5 – 145.5	**210.5 – 280.5**		
	Oil Cylinder Head Pressure	kPa	30 – 60	**50 – 90**		
	Fuel Pressure	kPa	230 – 380	**230 – 380**		
	Manifold Vacuum	kPa	57.7 – 59.9	**63.8 – 65.8**		
	Air-to-Fuel Ratio	-	14.1 – 14.7	**14.1 – 14.7**		
	Crankcase Pressure	kPa	-0.1 – -0.4	**-0.1 – -0.4**		
	Fuel Flow	kg/h	1.2 – 1.4	**2.0 – 2.2**		
	Ignition Timing	°BTDC	9 – 11	**22 – 26**		
	Ambient Temperature	°C	20 – 45	**20 – 45**		
	Rocker Cover Gas Temperature	°C	47 – 49	**52 – 55**		
	Rocker Cover Coolant Flow	L/min	3.0 – 4.5	**3.0 – 4.5**		

[A] Total number of data points taken as determined from test length and sampling rate

[B] Number of Bad Quality Data points not used in the calculation of statistical measures

[C] Number of points clipped by over or under range limits of the statistical measures

Sequence IVA Valve Train Wear Evaluation

Form 7

Used Oil Analysis

Laboratory:	Test Number: - -
Oil Code:	
Formulation/Stand Code:	

Chemical Analysis of 0, 25, 50, 75, & 100-hour Used Engine Oil Samples

ASTM Method	Analysis Description	Units					
D445	Kinematic Viscosity @ 40°C	cSt					
D3525-M	Fuel Dilution, Gasoline	%					
D5185 (ICP)	Iron by ICP	ppm					
D5185 (ICP)	Copper by ICP	ppm					

Sequence IVA Valve Train Wear Test

Form 8
Camshaft Bore/Journal Measurements

Laboratory:	Test Number: - -
Oil Code:	
Formulation/Stand Code:	

Camshaft Bearing Bore Diameter (mm)

Bore Gauge Set: 33.000mm

Diameter (Standard): 33.000 – 33.025mm

Bore Number	X		V		Y		Maximum Run-out	
	F	R	F	R	F	R	F	R
1								
2								
3								
4								
5								

Camshaft Bearing Journal Diameter (mm)

Diameter (Standard): 32.935 – 32.955mm

Clearance (Limit): 0.120mm

Bore Number	V		H		Run-out		Clearance @ V	
	F	R	F	R	F	R	F	R
1								
2								
3								
4								
5								

Note: Calculate camshaft bearing clearance @ vertical bore diameter

Camshaft End Play, mm	

End Play (Limit): 0.20mm

Camshaft Sprocket Run-out, mm	

Run-out (Limit): 0.12mm

Camshaft Run-out (bend), mm	

Run-out (Limit): 0.02mm

Cylinder Compression, kPa

Cylinder Number	1	2	3	4
Before Test				

Sequence IVA Valve Train Wear Test

Form 9

Special Maintenance Record

Laboratory:	Test Number: - -
Oil Code:	
Formulation/Stand Code:	

Number of Downtime Occurrences			
Test Hours	**Date**	**Down Time**	**Reasons**
			Total Downtime

Other Comments	
Number of Comment Lines	

Sequence IVA Valve Train Wear Evaluation

Form 10

Cycle 5 Stage 2 to 1 Transition: Oil Cylinder Head Temperature

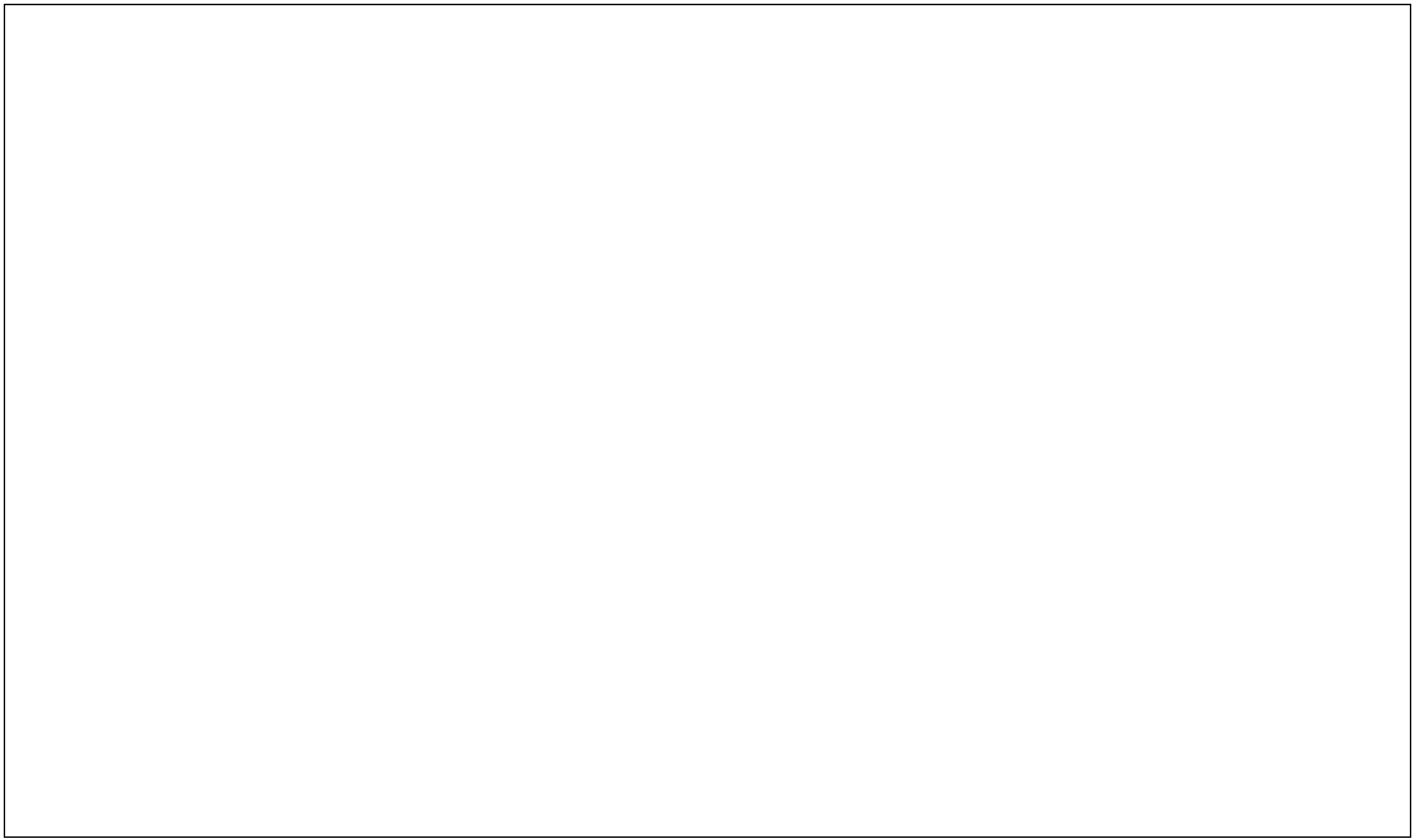
Laboratory:	Test Number: - -
Oil Code:	
Formulation/Stand Code:	

Sequence IVA Valve Train Wear Test

Form 11

Cycle 5 Stage 1 to 2 Transition: Oil Cylinder Head Temperature

Laboratory:	Test Number: - -
Oil Code:	
Formulation/Stand Code:	



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Form 12

Cycle 5 Stage 2 to 1 Transition: Coolant Out Temperature

Laboratory:	Test Number: - -
Oil Code:	
Formulation/Stand Code:	

Sequence IVA Valve Train Wear Test

Form 13

Cycle 5 Stage 1 to 2 Transition: Coolant Out Temperature

Laboratory:	Test Number: - -
Oil Code:	
Formulation/Stand Code:	

Sequence IVA Valve Train Wear Test

Form 14

Cycle 5 Stage 2 to 1 Transition: Engine Torque

Laboratory:	Test Number: - -
Oil Code:	
Formulation/Stand Code:	

Sequence IVA Valve Train Wear Test

Form 15

Cycle 5 Stage 1 to 2 Transition: Engine Torque

Laboratory:	Test Number: - -
Oil Code:	
Formulation/Stand Code:	

Sequence IVA Valve Train Wear Test

Form 16

Cycle 5 Stage 2 to 1 Transition: Engine Speed

Laboratory:	Test Number: - -
Oil Code:	
Formulation/Stand Code:	

Sequence IVA Valve Train Wear Test

Form 17

Cycle 5 Stage 1 to 2 Transition: Engine Speed

Laboratory:	Test Number: - -
Oil Code:	
Formulation/Stand Code:	