

**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		Laboratory Run Number
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:			

<p>In my opinion this test been conducted in a valid manner in accordance with the ASTM Research Report RR-D2-XXXX and the appropriate amendments through the Information Letter System. The remarks included in this report describe anomalies associated with this test.</p>

SUBMITTED BY:

Testing Laboratory

Signature

Typed Name

Title

Sequence IVA Valve Train Wear Evaluation

Form 2

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Sequence IVA Valve Train Wear Evaluation

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 12 tests; a cylinder head assembly for 6 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 (before tests 1 and 7).

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 Evaluation

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								
			5								
3		8									
		11									
			Maximum								
			Average								
		Overall Maximum									
		Overall Average									

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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
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					
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 Evaluation

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
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Camshaft Sprocket Run-out, mm		Run-out (Limit): 0.12mm
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Camshaft Run-out (bend), mm		Run-out (Limit): 0.02mm
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Cylinder Compression, kPa

Cylinder Number	1	2	3	4
Before Test				

Sequence IVA Valve Train Wear Evaluation

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 9A

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 9B

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:				

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

Sequence IVA Valve Train Wear Evaluation

Form 11

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

Empty rectangular area for test results.

Cycle 5 Stage 2 to 1 Transition: Coolant Out Temperature

Sequence IVA Valve Train Wear Evaluation

Form 12

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

Large empty rectangular area for data entry.

Cycle 5 Stage 1 to 2 Transition: Coolant Out Temperature

Sequence IVA Valve Train Wear Evaluation

Form 13

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

Large empty rectangular area for data entry.

Cycle 5 Stage 2 to 1 Transition: Engine Torque

Sequence IVA Valve Train Wear Evaluation

Form 14

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

Empty rectangular area for test results.

Cycle 5 Stage 1 to 2 Transition: Engine Torque

Sequence IVA Valve Train Wear Evaluation

Form 15

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

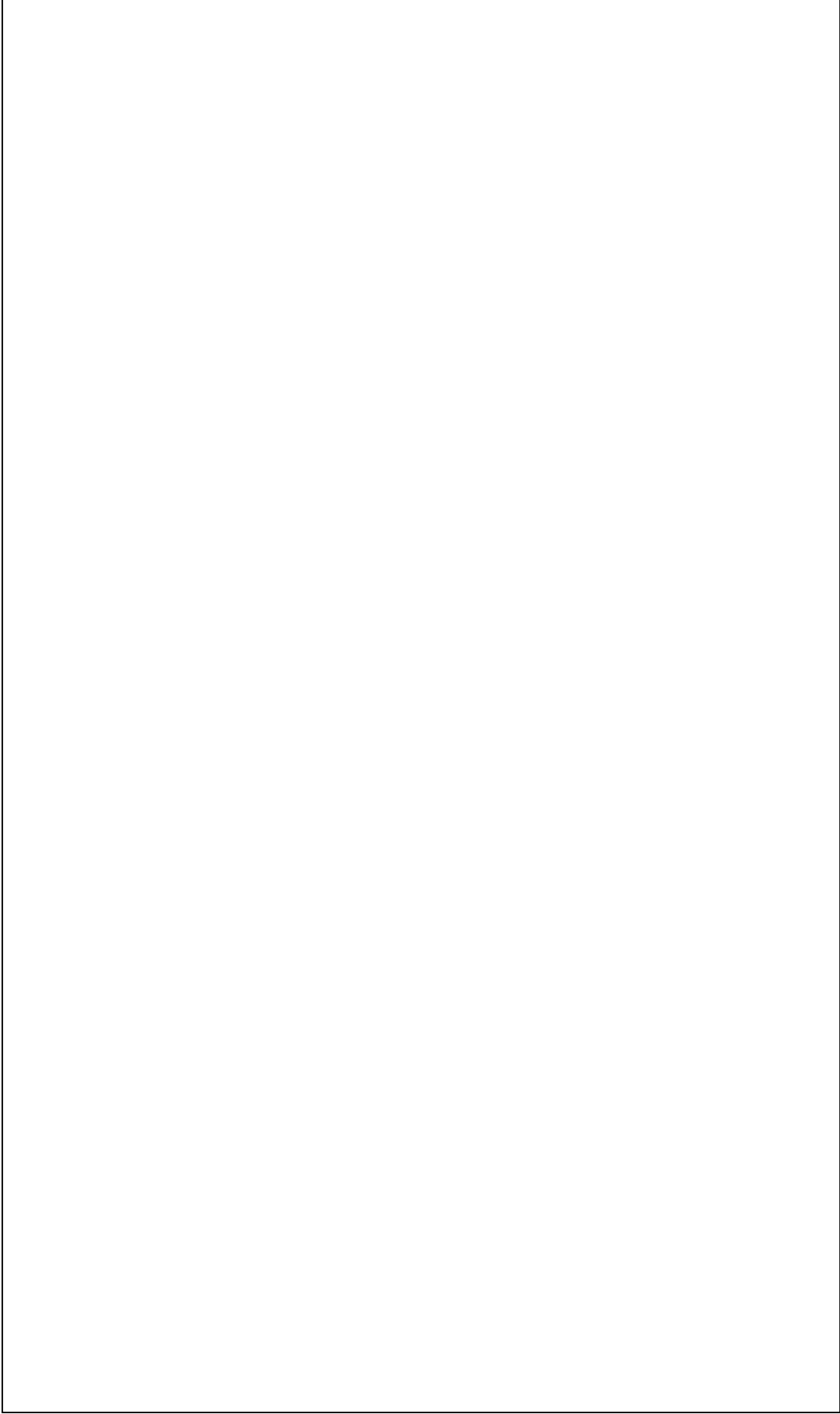
Empty rectangular area for data entry.

Cycle 5 Stage 2 to 1 Transition: Engine Speed

Sequence IVA Valve Train Wear Evaluation

Form 16

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



Cycle 5 Stage 1 to 2 Transition: Engine Speed

Sequence IVA Valve Train Wear Evaluation

Form 17

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

Large empty rectangular area for data entry.