

Sequence IVA Valve Train Wear

Form 2

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Sequence IVA Valve Train Wear

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

Form 4

Results Summary

Laboratory: CC	Test Number: CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCC
Oil Code: CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCC	
Formulation/Stand Code: CC-CCCCCCCCC-C-C-CCCCC-CC-CC-CCCC	

Laboratory Oil	CCCCCCCCCCCCCCCCCCCC				
Fuel Batch	CCCCCCCC	SAE Grade		CCCCCCC	
Date Started	YYYYMMDD	Date Completed	YYYYMMDD	Test Length	S1234
Time Started	HH:MM	Time Completed	HH:MM	TMC Oil Code ^A	CCCCCC
Lab Engine	CCCCCCCCCCCCCCCCCCCC				
Cam Lot Number	CCCCCC	Head Lot	CCCCCC	Rocker Arm Lot	CCCCCC

Average Camshaft Wear

Original Unit Result, μm	S1234.12
Transformed Result	S1234.12
Industry Correction Factor	S12.123
Corrected Transformed Result	S12.123
Severity Adjustment (non-reference oil tests only)	S12.123
Final Transformed Result	S1234.12
Final Original Unit Result, μm	S123.12

Additional Camshaft Lobe Wear Measurements

Intake Lobe	Maximum, μm	S123.12
	Average, μm	S123.12
Exhaust Lobe	Maximum, μm	S123.12
	Average, μm	S123.12
Nose	Maximum, μm	S123.12
	Average, μm	S123.12

Additional Information

Total Oil Consumption @ EOT, g	S123456
Fuel Dilution @ EOT, %	S123.12
Fuel Consumption @ EOT, kg	S123.12
Fe by ICP @ EOT, ppm	AAAAAA
Corrected Blowby, L/min @ hour 5	S1234.12
Corrected Blowby, L/min @ hour 100	S1234.12

Most Recent Reference Oil Test History^B

Test Number	CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCC				
Oilcode	CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCC				
Date	YYYYMMDD	TMC Oil Code		CCCCCC	
Final Average Camshaft Wear, μm	S123.12				

^A Reference Oil Tests Only

^B Non-reference Oil Tests Only

Sequence IVA Valve Train Wear

Form 6

Operational Summary

Laboratory: CC	Test Number: CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCC
Oil Code: CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCC	
Formulation/Stand Code: CC-CCCCCCCCC-C-C-CCCCC-CC-CC-CCCC	

Parameter	Units	QI Limit	EOT QI	Target		Average		Samples ^A	BQD ^B	Over/Under Range ^C
Speed	r/min	0.000	S123.12	800	1500	S1234.12	S1234.12	S1234567	S1234567	S1234567
Torque	N-m	0.000	S123.12	25.0		S1234.12	S1234.12	S1234567	S1234567	S1234567
Coolant Out Temperature	°C	0.000	S123.12	50.0	55.0	S1234.12	S1234.12	S1234567	S1234567	S1234567
Humidity	g/kg	0.000	S123.12	11.5		S1234.12	S1234.12	S1234567	S1234567	S1234567
Intake Air Temperature	°C	0.000	S123.12	32		S1234.12	S1234.12	S1234567	S1234567	S1234567
Intake Air Pressure	kPa	0.000	S123.12	0.05		S123.123	S1234.12	S1234567	S1234567	S1234567
Exhaust Pressure, absolute	kPa	0.000	S123.12	103.5		S1234.12	S1234.12	S1234567	S1234567	S1234567
Engine Coolant Flow	L/min	0.000	S123.12	30		S1234.12	S1234.12	S1234567	S1234567	S1234567
Oil Cylinder Head Temperature	°C	0.000	S123.12	49.0	59.0	S1234.12	S1234.12	S1234567	S1234567	S1234567
Rocker Cover Fresh Air Flow	SL/min	0.000	S123.12	10.0		S1234.12	S1234.12	S1234567	S1234567	S1234567
Parameter		Typical Values		Average		Average				
Oil Sump Temperature	°C	49 – 54		57 – 65		S1234.12	S1234.12			
Oil Gallery Temperature	°C	46.5 – 50.5		58.5 – 61.5		S1234.12	S1234.12			
Coolant In Temperature	°C	44 – 46		49 – 50		S1234.12	S1234.12			
Exhaust Gas Temperature	°C	306 – 332		414 – 434		S1234.12	S1234.12			
Fuel Rail Temperature	°C	15 – 30		15 – 30		S1234.12	S1234.12			
Oil Gallery Pressure	°C	99.5 – 145.5		210.5 – 280.5		S1234.12	S1234.12			
Oil Cylinder Head Pressure	kPa	30 – 60		50 – 90		S1234.12	S1234.12			
Fuel Pressure	kPa	230 – 380		230 – 380		S1234.12	S1234.12			
Manifold Vacuum	kPa	57.7 – 59.9		63.8 – 65.8		S1234.12	S1234.12			
Air-to-Fuel Ratio	-	14.1 – 14.7		14.1 – 14.7		S123.12	S123.12			
Crankcase Pressure	kPa	-0.1 – -0.4		-0.1 – -0.4		S1234.12	S1234.12			
Fuel Flow	kg/h	1.2 – 1.4		2.0 – 2.2		S1234.12	S1234.12			
Ignition Timing	°BTDC	9 – 11		22 – 26		S1234.12	S1234.12			
Ambient Temperature	°C	20 – 45		20 – 45		S1234.12	S1234.12			
Rocker Cover Gas Temperature	°C	47 – 49		52 – 55		S1234.12	S1234.12			
Rocker Cover Coolant Flow	L/min	3.0 – 4.5		3.0 – 4.5		S1.12	S1.12			

Non-controlled Parameters

^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: CC	Test Number: CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCC
Oil Code: CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCC	
Formulation/Stand Code: CC-CCCCCCCCC-C-C-CCCCC-CC-CC-CCCC	

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

ASTM Method	Analysis Description	Units	CCC	CCC	CCC	CCC	CCC
D445	Kinematic Viscosity @ 40°C	cSt	S123.12				S123.12
D3525-M	Fuel Dilution, Gasoline	%					S123.12
D5185 (ICP)	Iron by ICP	ppm		AAAAAA	AAAAAA	AAAAAA	AAAAAA
D5185 (ICP)	Copper by ICP	ppm		AAAAAA	AAAAAA	AAAAAA	AAAAAA

Sequence IVA Valve Train Wear

Form 8

Camshaft Bore/Journal Measurements

Laboratory: CC	Test Number: CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCC
Oil Code: CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCC	
Formulation/Stand Code: CC-CCCCCCCC-C-C-CCCC-CC-CC-CCCC	

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	S123.123	S123.123	S123.123	S123.123	S123.123	S123.123	S123.123	S123.123
2	S123.123	S123.123	S123.123	S123.123	S123.123	S123.123	S123.123	S123.123
3	S123.123	S123.123	S123.123	S123.123	S123.123	S123.123	S123.123	S123.123
4	S123.123	S123.123	S123.123	S123.123	S123.123	S123.123	S123.123	S123.123
5	S123.123	S123.123	S123.123	S123.123	S123.123	S123.123	S123.123	S123.123

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	S123.123	S123.123	S123.123	S123.123	S123.123	S123.123	S123.123	S123.123
2	S123.123	S123.123	S123.123	S123.123	S123.123	S123.123	S123.123	S123.123
3	S123.123	S123.123	S123.123	S123.123	S123.123	S123.123	S123.123	S123.123
4	S123.123	S123.123	S123.123	S123.123	S123.123	S123.123	S123.123	S123.123
5	S123.123	S123.123	S123.123	S123.123	S123.123	S123.123	S123.123	S123.123

Note: Calculate camshaft bearing clearance @ vertical bore diameter

Camshaft End Play, mm	S123.123	End Play (Limit): 0.20mm
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Camshaft Sprocket Run-out, mm	S123.123	Run-out (Limit): 0.12mm
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Camshaft Run-out (bend), mm	S123.123	Run-out (Limit): 0.02mm
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Cylinder Compression, kPa

Cylinder Number	1	2	3	4
Before Test	S12345	S12345	S12345	S12345

Sequence IVA Valve Train Wear Evaluation

Form 10

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

Laboratory: CC	Test Number: CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCC
Oil Code: CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCC	
Formulation/Stand Code: CC-CCCCCCCCCCC-C-C-CCCCCCC-CC-CC-CCCC	

CC

Sequence IVA Valve Train Wear Evaluation

Form 11

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

Laboratory: CC	Test Number: CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCC
Oil Code: CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCC	
Formulation/Stand Code: CC-CCCCCCCCCCC-C-C-CCCCCC-CC-CC-CCCC	

CC

Sequence IVA Valve Train Wear Evaluation

Form 12

Cycle 5 Stage 2 to 1 Transition: Coolant Out Temperature

Laboratory: CC	Test Number: CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCC
Oil Code: CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCC	
Formulation/Stand Code: CC-CCCCCCCCCC-C-C-CCCCCC-CC-CC-CCCC	

CC

Sequence IVA Valve Train Wear Evaluation

Form 13

Cycle 5 Stage 1 to 2 Transition: Coolant Out Temperature

Laboratory: CC	Test Number: CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCC
Oil Code: CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCC	
Formulation/Stand Code: CC-CCCCCCCCCCC-C-CCCCCCC-CC-CC-CCCCC	

CC

Sequence IVA Valve Train Wear Evaluation

Form 14

Cycle 5 Stage 2 to 1 Transition: Engine Torque

Laboratory: CC	Test Number: CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCC
Oil Code: CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCC	
Formulation/Stand Code: CC-CCCCCCCCC-C-C-CCCCCC-CC-CC-CCCC	

CC

Sequence IVA Valve Train Wear Evaluation

Form 15

Cycle 5 Stage 1 to 2 Transition: Engine Torque

Laboratory: CC	Test Number: CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCC
Oil Code: CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCC	
Formulation/Stand Code: CC-CCCCCCCCC-C-C-CCCCC-CC-CC-CCCC	

CC

Sequence IVA Valve Train Wear Evaluation

Form 16

Cycle 5 Stage 2 to 1 Transition: Engine Speed

Laboratory: CC	Test Number: CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCC
Oil Code: CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCC	
Formulation/Stand Code: CC-CCCCCCCCCC-C-C-CCCCCC-CC-CC-CCCC	

CC

Sequence IVA Valve Train Wear Evaluation

Form 17

Cycle 5 Stage 1 to 2 Transition: Engine Speed

Laboratory: CC	Test Number: CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCC
Oil Code: CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCC	
Formulation/Stand Code: CC-CCCCCCCCCCC-C-CCCCCCC-CC-CC-CCCCC	

CC

