

**Sequence IVA Valve Train Wear Evaluation  
Final Report Cover Sheet**

**Form 1**

Version: IVA VERSION 20041124 BETA

Conducted For  
TSTSPON1  
TSTSPON2

LABVALID	V = Valid
	I = Invalid

TSTOIL	NR = Non-reference oil
	RO = Reference oil

Test Number			
Test Stand	Number of Runs on Stand Since Last Calibration Test		Total Runs on Stand
STAND	STRUN		TOTSTRUN
Lab Engine Number	ENGINE	Total Runs on Engine	TOTENRUN
Lab Head Number	HEADSN	Total Runs on Cylinder Head	TOTHDRUN
Lab Cam Number	CAMNO		
Date Completed	DTCOMP	Completion Time	EOTTIME
Oil Code	OILCODE	Fuel Batch	FUELBTID
Formulation/Stand Code	FORM		
Alternate Codes:	ALTCODE1	ALTCODE2	ALTCODE3

<p>In my opinion this test OPVALID 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.</p>
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Submitted By:

SUBLAB

Testing Laboratory

SUBSIGIM

Signature

SUBNAME

Typed Name

SUBTITLE

Title

# 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 20 tests; a cylinder head assembly for 10 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: LAB	Test Number: TESTNUM
Oil Code: OILCODE	
Formulation/Stand Code: FORM	

Laboratory Oil	LABOCODE				
Fuel Batch	FUELBTID			SAE Grade	SAEVISC
Date Started	DTSTRT	Date Completed	DTCOMP	Test Length	TESTLEN
Time Started	STRTTIME	Time Completed	EOTTIME	TMC Oil Code <sup>A</sup>	IND
Lab Engine	ENGINE				
Cam Lot Number	CAMLOT	Head Lot	HEADLOT	Rocker Arm Lot	RARMLOT

### Average Camshaft Wear

Original Unit Result, $\mu\text{m}$	ACW
Transformed Result	TACW
Industry Correction Factor	ACWCF
Corrected Transformed Result	ACWCOR
Severity Adjustment (non-reference oil tests only)	ACWSA
Final Transformed Result	TACWFNL
Final Original Unit Result, $\mu\text{m}$	ACWFNL

### Additional Camshaft Lobe Wear Measurements

Intake Lobe	Maximum, $\mu\text{m}$	MCWI
	Average, $\mu\text{m}$	ACWI
Exhaust Lobe	Maximum, $\mu\text{m}$	MCWE
	Average, $\mu\text{m}$	ACWE
Nose	Maximum, $\mu\text{m}$	MNW
	Average, $\mu\text{m}$	ANW

### Additional Information

Total Oil Consumption @ EOT, g	OILCON
Fuel Dilution @ EOT, %	FUELH100
Fuel Consumption @ EOT, kg	FUELCON
Fe by ICP @ EOT, ppm	FEWMH100
Corrected Blowby, L/min @ hour 5	BLWBH005
Corrected Blowby, L/min @ hour 100	BLWBH100

### Most Recent Reference Oil Test History<sup>B</sup>

Test Number	RTESTNUM			
Oilcode	ROILCODE			
Date	RDTCOMP	TMC Oil Code	RIND	
Final Average Camshaft Wear, $\mu\text{m}$	RACWFNL			

<sup>A</sup> Reference Oil Tests Only

<sup>B</sup> Non-reference Oil Tests Only

**Sequence IVA Valve Train Wear Evaluation**

**Form 5**

**Camshaft Lobe Wear**

Laboratory: LAB	Test Number: TESTNUM
Oil Code: OILCODE	
Formulation/Stand Code: FORM	

**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	
<b>Intake</b>	1	1	W14B01	W10B01	W04B01	WN01	W04A01	W10A01	W14A01	CAMW01	
		3	W14B03	W10B03	W04B03	WN03	W04A03	W10A03	W14A03	CAMW03	
	2	4	W14B04	W10B04	W04B04	WN04	W04A04	W10A04	W14A04	CAMW04	
		6	W14B06	W10B06	W04B06	WN06	W04A06	W10A06	W14A06	CAMW06	
	3	7	W14B07	W10B07	W04B07	WN07	W04A07	W10A07	W14A07	CAMW07	
		9	W14B09	W10B09	W04B09	WN09	W04A09	W10A09	W14A09	CAMW09	
	4	10	W14B10	W10B10	W04B10	WN10	W04A10	W10A10	W14A10	CAMW10	
		12	W14B12	W10B12	W04B12	WN12	W04A12	W10A12	W14A12	CAMW12	
		Maximum	MW14BI	MW10BI	MW04BI	MWNI	MW04AI	MW10AI	MW14AI	MCWI	
		Average	AW14BI	AW10BI	AW04BI	AWN1	AW04AI	AW10AI	AW14AI	ACWI	
	<b>Exhaust</b>	1	2	W14B02	W10B02	W04B02	WN02	W04A02	W10A02	W14A02	CAMW02
			5	W14B05	W10B05	W04B05	WN05	W04A05	W10A05	W14A05	CAMW05
3		8	W14B08	W10B08	W04B08	WN08	W04A08	W10A08	W14A08	CAMW08	
		11	W14B11	W10B11	W04B11	WN11	W04A11	W10A11	W14A11	CAMW11	
		Maximum	MW14BE	MW10BE	MW04BE	MWNE	MW04AE	MW10AE	MW14AE	MCWE	
		Average	AW14BE	AW10BE	AW04BE	AWNE	AW04AE	AW10AE	AW14AE	ACWE	
<b>Overall Maximum</b>			MW14B	MW10B	MW04B	MNW	MW04A	MW10A	MW14A	MCW	
<b>Overall Average</b>			AW14B	AW10B	AW04B	ANW	AW04A	AW10A	AW14A	ACW	

# Sequence IVA Valve Train Wear

## Form 6

### Operational Summary

Laboratory: LAB	Test Number: TESTNUM
Oil Code: OILCODE	
Formulation/Stand Code: FORM	

Parameter	Units	QI Limit	EOT QI	Target		Average		Samples <sup>A</sup>	BQD <sup>B</sup>	Over/Under Range <sup>C</sup>
				800	1500	ARPM1	ARPM2			
Speed	r/min	0.000	QRPM			ARPM1	ARPM2	NRPM	BRPM	ORPM
Torque	N-m	0.000	QTORQUE		25.0	ATORQUE1	ATORQUE2	NTORQUE	BTORQUE	OTORQUE
Coolant Out Temperature	°C	0.000	QCOLOUT		50.0	ACOLOUT1	ACOLOUT2	NCOLOUT	BCOLOUT	OCOLOUT
Humidity	g/kg	0.000	QHUMID		11.5	AHUMID		NHUMID	BHUMID	OHUMID
Intake Air Temperature	°C	0.000	QINAIPT		32	AINAIPT		NINAIPT	BINAIPT	OINAIPT
Intake Air Pressure	kPa	0.000	QINAIPT		0.05	AINAIPT		NINAIPT	BINAIPT	OINAIPT
Exhaust Pressure, absolute	kPa	0.000	QEXHBKP		103.5	AEXHBKP		NEXHBKP	BEXHBKP	OEXHBKP
Engine Coolant Flow	L/min	0.000	QCOLFRT		30	ACOLFRT		NCOLFRT	BCOLFRT	OCOLFRT
Oil Cylinder Head Temperature	°C	0.000	QCYLOT		49.0	ACYLOT1	ACYLOT2	NCYLOT	BCYLOT	OCYLOT
Rocker Cover Fresh Air Flow	SL/min	0.000	QFAF		10.0	AFAF		NFAF	BFAF	OFAF
<b>Parameter</b>	<b>Units</b>	<b>Typical Values</b>		<b>Typical Values</b>		<b>Average</b>				
Oil Sump Temperature	°C	49 – 54		57 – 65		ASUMPT1	ASUMPT2			
Oil Gallery Temperature	°C	46.5 – 50.5		58.5 – 61.5		AOILT1	AOILT2			
Coolant In Temperature	°C	44 – 46		49 – 50		ACOLIN1	ACOLIN2			
Exhaust Gas Temperature	°C	306 – 332		414 – 434		AEXHT1	AEXHT2			
Fuel Rail Temperature	°C	15 – 30		15 – 30		AFUEL1	AFUEL2			
Oil Gallery Pressure	°C	99.5 – 145.5		210.5 – 280.5		AOILPRS1	AOILPRS2			
Oil Cylinder Head Pressure	kPa	30 – 60		50 – 90		ACYLOPR1	ACYLOPR2			
Fuel Pressure	kPa	230 – 380		230 – 380		AFUELPR1	AFUELPR2			
Manifold Vacuum	kPa	57.7 – 59.9		63.8 – 65.8		AIMNVAC1	AIMNVAC2			
Air-to-Fuel Ratio	-	14.1 – 14.7		14.1 – 14.7		AAFR1	AAFR2			
Crankcase Pressure	kPa	-0.1 – -0.4		-0.1 – -0.4		ACCASEP1	ACCASEP2			
Fuel Flow	kg/h	1.2 – 1.4		2.0 – 2.2		AFUELRT1	AFUELRT2			
Ignition Timing	°BTDC	9 – 11		22 – 26		ASPKTIM1	ASPKTIM2			
Ambient Temperature	°C	20 – 45		20 – 45		AAMBAT1	AAMBAT2			
Rocker Cover Gas Temperature	°C	47 – 49		52 – 55		ARACGT1	ARACGT2			
Rocker Cover Coolant Flow	L/min	3.0 – 4.5		3.0 – 4.5		ARACFLO1	ARACFLO2			

<sup>A</sup> Total number of data points taken as determined from test length and sampling rate

<sup>B</sup> Number of Bad Quality Data points not used in the calculation of statistical measures

<sup>C</sup> 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: LAB	Test Number: TESTNUM
Oil Code: OILCODE	
Formulation/Stand Code: FORM	

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

ASTM Method	Analysis Description	Units	TST_HNEW	TST_H025	TST_H050	TST_H075	TST_H100
D445	Kinematic Viscosity @ 40°C	cSt	V040HNEW				V040H100
D3525-M	Fuel Dilution, Gasoline	%					FUELH100
D5185 (ICP)	Iron by ICP	ppm		FEWMH025	FEWMH050	FEWMH075	FEWMH100
D5185 (ICP)	Copper by ICP	ppm		CUWMH025	CUWMH050	CUWMH075	CUWMH100

## Sequence IVA Valve Train Wear

### Form 8 Camshaft Measurements

Laboratory: LAB	Test Number: TESTNUM
Oil Code: OILCODE	
Formulation/Stand Code: FORM	

#### 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	CJFV001	CJRV001	CJFH001	CJRH001	XCJF001	XCJR001	CCF001	CCR001
2	CJFV002	CJRV002	CJFH002	CJRH002	XCJF002	XCJR002	CCF002	CCR002
3	CJFV003	CJRV003	CJFH003	CJRH003	XCJF003	XCJR003	CCF003	CCR003
4	CJFV004	CJRV004	CJFH004	CJRH004	XCJF004	XCJR004	CCF004	CCR004
5	CJFV005	CJRV005	CJFH005	CJRH005	XCJF005	XCJR005	CCF005	CCR005

Note: Calculate camshaft bearing clearance @ vertical bore diameter

<b>Camshaft End Play, mm</b>	CAMENDP	End Play (Limit): 0.20mm
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<b>Camshaft Sprocket Run-out, mm</b>	CAMSROUT	Run-out (Limit): 0.12mm
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<b>Camshaft Run-out (bend), mm</b>	CAMBEND	Run-out (Limit): 0.02mm
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#### Cylinder Compression, kPa

Cylinder Number	1	2	3	4
Before Test	COMP1	COMP2	COMP3	COMP4



## Sequence IVA Valve Train Wear

### Form 9

## Special Maintenance Record

Laboratory: LAB	Test Number: TESTNUM
Oil Code: OILCODE	
Formulation/Stand Code: FORM	

Number of Downtime Occurrences			DWNOCR
Test Hours	Date	Down Time	Reasons
DOWNR001	DDATR001	DTIMR001	DREAR001
DOWNR002	DDATR002	DTIMR002	DREAR002
DOWNR003	DDATR003	DTIMR003	DREAR003
DOWNR004	DDATR004	DTIMR004	DREAR004
DOWNR005	DDATR005	DTIMR005	DREAR005
DOWNR006	DDATR006	DTIMR006	DREAR006
DOWNR007	DDATR007	DTIMR007	DREAR007
DOWNR008	DDATR008	DTIMR008	DREAR008
DOWNR009	DDATR009	DTIMR009	DREAR009
DOWNR010	DDATR010	DTIMR010	DREAR010
DOWNR011	DDATR011	DTIMR011	DREAR011
DOWNR012	DDATR012	DTIMR012	DREAR012
DOWNR013	DDATR013	DTIMR013	DREAR013
DOWNR014	DDATR014	DTIMR014	DREAR014
DOWNR015	DDATR015	DTIMR015	DREAR015
		TOTLDOWN	<b>Total Downtime</b>

Other Comments	
Number of Comment Lines	TOTCOM
OCOMR001	
OCOMR002	
OCOMR003	
OCOMR004	
OCOMR005	
OCOMR006	
OCOMR007	
OCOMR008	
OCOMR009	
OCOMR010	
OCOMR011	
OCOMR012	
OCOMR013	
OCOMR014	
OCOMR015	

## Sequence IVA Valve Train Wear Evaluation

### Form 9A

### Special Maintenance Record

Laboratory: LAB	Test Number: TESTNUM
Oil Code: OILCODE	
Formulation/Stand Code: FORM	

Number of Downtime Occurrences			DWNOCR
Test Hours	Date	Down Time	Reasons
DOWNR016	DDATR016	DTIMR016	DREAR016
DOWNR017	DDATR017	DTIMR017	DREAR017
DOWNR018	DDATR018	DTIMR018	DREAR018
DOWNR019	DDATR019	DTIMR019	DREAR019
DOWNR020	DDATR020	DTIMR020	DREAR020
DOWNR021	DDATR021	DTIMR021	DREAR021
DOWNR022	DDATR022	DTIMR022	DREAR022
DOWNR023	DDATR023	DTIMR023	DREAR023
DOWNR024	DDATR024	DTIMR024	DREAR024
DOWNR025	DDATR025	DTIMR025	DREAR025
DOWNR026	DDATR026	DTIMR026	DREAR026
DOWNR027	DDATR027	DTIMR027	DREAR027
DOWNR028	DDATR028	DTIMR028	DREAR028
DOWNR029	DDATR029	DTIMR029	DREAR029
DOWNR030	DDATR030	DTIMR030	DREAR030
		<b>TOTLDOWN</b>	<b>Total Downtime</b>

Other Comments	Number of Comment Lines	TOTCOM
OCOMR016		
OCOMR017		
OCOMR018		
OCOMR019		
OCOMR020		
OCOMR021		
OCOMR022		
OCOMR023		
OCOMR024		
OCOMR025		
OCOMR026		
OCOMR027		
OCOMR028		
OCOMR029		
OCOMR030		

## Sequence IVA Valve Train Wear Evaluation

### Form 9B

### Special Maintenance Record

Laboratory: LAF	Test Number: TESTNUM
Oil Code: OILCODE	
Formulation/Stand Code: FORM	

Number of Downtime Occurrences			DWNOCR
Test Hours	Date	Down Time	Reasons
DOWNR031	DDATR031	DTIMR031	DREAR031
DOWNR032	DDATR032	DTIMR032	DREAR032
DOWNR033	DDATR033	DTIMR033	DREAR033
DOWNR034	DDATR034	DTIMR034	DREAR034
DOWNR035	DDATR035	DTIMR035	DREAR035
DOWNR036	DDATR036	DTIMR036	DREAR036
DOWNR037	DDATR037	DTIMR037	DREAR037
DOWNR038	DDATR038	DTIMR038	DREAR038
DOWNR039	DDATR039	DTIMR039	DREAR039
DOWNR040	DDATR040	DTIMR040	DREAR040
DOWNR041	DDATR041	DTIMR041	DREAR041
DOWNR042	DDATR042	DTIMR042	DREAR042
DOWNR043	DDATR043	DTIMR043	DREAR043
DOWNR044	DDATR044	DTIMR044	DREAR044
DOWNR045	DDATR045	DTIMR045	DREAR045
		TOTLDOWN	<b>Total Downtime</b>

Other Comments	
Number of Comment Lines	TOTCOM
OCOMR031	
OCOMR032	
OCOMR033	
OCOMR034	
OCOMR035	
OCOMR036	
OCOMR037	
OCOMR038	
OCOMR039	
OCOMR040	
OCOMR041	
OCOMR042	
OCOMR043	
OCOMR044	
OCOMR045	

Sequence IVA Valve Train Wear Evaluation

Form 10

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

Laboratory: LAB	Test Number: TESTNUM
Oil Code: OILCODE	
Formulation/Stand Code: FORM	

OC2TO1IM

Sequence IVA Valve Train Wear Evaluation

Form 11

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

Laboratory: LAB	Test Number: TESTNUM
Oil Code: OILCODE	
Formulation/Stand Code: FORM	

OC1TO2IM

**Sequence IVA Valve Train Wear Evaluation**

**Form 12**

**Cycle 5 Stage 2 to 1 Transition: Coolant Out Temperature**

Laboratory: LAB	Test Number: TESTNUM
Oil Code: OILCODE	
Formulation/Stand Code: FORM	

CO2TO11M

Sequence IVA Valve Train Wear Evaluation

Form 13

Cycle 5 Stage 1 to 2 Transition: Coolant Out Temperature

Laboratory: LAB	Test Number: TESTNUM
Oil Code: OILCODE	
Formulation/Stand Code: FORM	

CO1TO2IM

**Sequence IVA Valve Train Wear Evaluation**

**Form 14**

**Cycle 5 Stage 2 to 1 Transition: Engine Torque**

Laboratory: LAB	Test Number: TESTNUM
Oil Code: OILCODE	
Formulation/Stand Code: FORM	

ET2TO1IM



**Sequence IVA Valve Train Wear Evaluation**

**Form 15**

**Cycle 5 Stage 1 to 2 Transition: Engine Torque**

Laboratory: LAB	Test Number: TESTNUM
Oil Code: OILCODE	
Formulation/Stand Code: FORM	

ETIT02IM

**Sequence IVA Valve Train Wear Evaluation**

**Form 16**

**Cycle 5 Stage 2 to 1 Transition: Engine Speed**

Laboratory: LAB	Test Number: TESTNUM
Oil Code: OILCODE	
Formulation/Stand Code: FORM	

ES2TO1IM

**Sequence IVA Valve Train Wear Evaluation**

**Form 17**

**Cycle 5 Stage 1 to 2 Transition: Engine Speed**

Laboratory: LAB	Test Number: TESTNUM
Oil Code: OILCODE	
Formulation/Stand Code: FORM	

ES1TO2IM

## Sequence IVA Valve Train Wear Evaluation

### Form 18

American Chemistry Council Code of Practice  
Test Laboratory Conformance Statement

Test Laboratory		SUBLAB			
Test Sponsor		TSTSPON1			
Formulation / Stand Code		FORM			
Test Number		TESTNUM			
Start Date	DTSTRT	Start Time	STRTIME	Time Zone	TZONE

### 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 ESRQME No ORQME\*
- 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 YESFULL No NOFULL \*
- 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 YESNODEC\* No NONODEC
- 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 YESDEV\* No NODEV (*This currently applies only to specific deviations identified in the ASTM Information Letter System*)

### Check The Appropriate Conclusion

INCLUDE	Operational review of this test indicates that the results should be included in the Multiple Test Acceptance Criteria calculations.
DONOTINC	*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
ACCCOMM1
ACCCOMM2
ACCCOMM3
ACCCOMM4

SUBSIGIM \_\_\_\_\_  
Signature

SUBDATE \_\_\_\_\_  
Date

SUBNAME \_\_\_\_\_  
Typed Name

SUBTITLE \_\_\_\_\_  
Title