

**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

<b>Test Number</b>			
<b>Test Stand</b>	<b>Number of Runs on Stand Since Last Calibration Test</b>		<b>Total Runs on Stand</b>
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.
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Submitted By:

\_\_\_\_\_ Testing Laboratory

\_\_\_\_\_ Signature

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

\_\_\_\_\_ 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 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:	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 <sup>A</sup>
Lab Engine				
Cam Lot Number		Head Lot		Rocker Arm Lot

### Average Camshaft Wear

Original Unit Result, $\mu\text{m}$		
Transformed Result		
Industry Correction Factor		
Corrected Transformed Result		
Severity Adjustment (non-reference oil tests only)		
Final Transformed Result		
Final Original Unit Result, $\mu\text{m}$		
<b>Additional Camshaft Lobe Wear Measurements</b>		
Intake Lobe	Maximum, $\mu\text{m}$	
	Average, $\mu\text{m}$	
Exhaust Lobe	Maximum, $\mu\text{m}$	
	Average, $\mu\text{m}$	
Nose	Maximum, $\mu\text{m}$	
	Average, $\mu\text{m}$	

### 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<sup>B</sup>

Test Number			
Oilcode			
Date		TMC Oil Code	
Final Average Camshaft Wear, $\mu\text{m}$			

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

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



## Sequence IVA Valve Train Wear

### Form 6

#### Operational Summary

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

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

<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:	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

### 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

<b>Camshaft End Play, mm</b>		End Play (Limit): 0.20mm
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<b>Camshaft Sprocket Run-out, mm</b>		Run-out (Limit): 0.12mm
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<b>Camshaft Run-out (bend), mm</b>		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

## Form 9

### Special Maintenance Record

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

Number of Downtime Occurrences			
Test Hours	Date	Down Time	Reasons
			<b>Total Downtime</b>

<b>Other Comments</b>	
<b>Number of Comment Lines</b>	

## 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
			<b>Total Downtime</b>

<b>Other Comments</b>	
<b>Number of Comment Lines</b>	

## 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
			<b>Total Downtime</b>

<b>Other Comments</b>	
<b>Number of Comment Lines</b>	

**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:	

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**Sequence IVA Valve Train Wear Evaluation**

**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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**Sequence IVA Valve Train Wear Evaluation**

**Form 13**

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

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

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**Sequence IVA Valve Train Wear Evaluation**

**Form 14**

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

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

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**Sequence IVA Valve Train Wear Evaluation**

**Form 15**

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

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

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**Sequence IVA Valve Train Wear Evaluation**

**Form 16**

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

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

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**Sequence IVA Valve Train Wear Evaluation**

**Form 17**

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

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

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# Sequence IVA Valve Train Wear Evaluation

## Form 18

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*)

### Check The Appropriate Conclusion

<input type="checkbox"/>	Operational review of this test indicates that the results should be included in the Multiple Test Acceptance Criteria calculations.
<input type="checkbox"/>	*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