

# SEQUENCE IVA VALVE TRAIN WEAR EVALUATION FINAL REPORT COVER SHEET

VERSION 20010418

CONDUCTED FOR

TSTSPON1

TSTSPON2

LABVALID	V =VALID I =INVALID
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TSTOIL	NR = Non-reference Oil Test RO = Reference Oil Test
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Test Number					
Test Stand: STAND	No. Tests Since Last Stand Calibration Test: STRUN	Laboratory Run Number: LABRUN			
Lab Engine No.	ENGINE	Total Runs on Cylinder Head		TOTHDRUN	
Lab Head Number	HEADSN	Lab Cam Number	CAMNO		
Date Completed	DTCOMP	End of Test	EOTTIME		
Oil Code	OILCODE	Fuel Batch	FUELBTID		
Formulation/Stand Code	FORM				
Alternate Codes	ALTCODE1	ALTCODE2	ALTCODE3		

<p>In my opinion this test <del>OPVALID</del> <sup>OPVALID</sup> 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 the report describe the anomalies associated with this test.</p>
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SUBMITTED BY:

SUBLAB

Testing Laboratory

SUBSIGIM

Signature

SUBNAME

Typed Name

SUBTITLE

Title

## Form 2

### Sequence IVA Valve Train Wear Test

#### Table of Contents

1.	Title / Validity Declaration Page	Form 1
2.	Table of Contents	Form 2
3.	Summary of Test Method	Form 3
4.	Results Summary	Form 4
5.	Camshaft Lobe Wear Table	Form 5
6.	Operational Data Summary	Form 6
7.	Used Oil Analysis	Form 7
8.	Engine Build Measurements	Form 8
9.	Special Maintenance Record	Form 9
10.	Cycle 5 Stage 2 to 1 Transition: Oil Gallery Temperature	Form 10
11.	Cycle 5 Stage 1 to 2 Transition: Oil Gallery Temperature	Form 11
12.	Cycle 5 Stage 2 to 1 Transition: Coolant Out Temperature	Form 12
13.	Cycle 5 Stage 1 to 2 Transition: Coolant Out Temperature	Form 13
14.	Cycle 5 Stage 2 to 1 Transition: Engine Torque	Form 14
15.	Cycle 5 Stage 1 to 2 Transition: Engine Torque	Form 15
16.	Cycle 5 Stage 2 to 1 Transition: Engine Speed	Form 16
17.	Cycle 5 Stage 1 to 2 Transition: Engine Speed	Form 17

## 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, 2.389 (2.4) liter 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 shortblock 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	25
Coolant Out Temperature	°C	50	55
Oil Cylinder Head	°C	49	59
Intake Air Temperature	°C	32	32
Intake Air Pressure	kPa	0.050	0.050
Intake Air Humidity	g/kg	11.5	11.5
Exhaust Pressure	kPa-abs	103.5	103.5
Coolant Flow	L/min	30	30
Fresh Airflow	SL/min	10	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: LAB	Test Number: STAND - STRUN - LABRUN	Oil Code: OILCODE
Formulation/ Stand FORM		

Laboratory Oil	LABOCODE	Fuel Batch	FUELBTID	SAE Grade	SAEVISC
Date Started	DTSTRT	Date Completed	DTCOMP	Test Length	TESTLEN
Time Started	STRTIME	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
Corr. Blowby, L/min @ hour 5	BLWBH005
Corr. Blowby, L/min @ hour 100	BLWBH100

**Most Recent Stand Reference Oil Test History<sup>B</sup>**

Test Number	RSTAND - RSTRUN - RLABRUN				
Oilcode	ROILCODE				
Date	RDTCOMP	TMC Oil Code	RIND		
Final Average Camshaft Wear,	RACWFNL				

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

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

Sequence IVA Valve Train Wear Test

Form 5

Camshaft Lobe Wear

Laboratory: LAB	Test Number: STAND	- STRUN	- LABRUN	Oil Code: OILCODE
Formulation/Stand		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	
Intake	1	1	W14B01	W10B01	W04B01	WN01	W04A01	W10A01	W14A01	CAMW01	
		3	W14B03	W10B03	W04B03	WN03	W04A03	W10A03	W14A03	CAMW03	
		4	W14B04	W10B04	W04B04	WN04	W04A04	W10A04	W14A04	CAMW04	
	2	6	W14B06	W10B06	W04B06	WN06	W04A06	W10A06	W14A06	CAMW06	
		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	
		Max. of Intake	MW14BI	MW10BI	MW04BI	MWNI	MW04AI	MW10AI	MW14AI	MCWI	
	Avg. of Intake	<b>AW14BI</b>	<b>AW10BI</b>	<b>AW04BI</b>	<b>AWN1</b>	<b>AW04AI</b>	<b>AW10AI</b>	<b>AW14AI</b>	<b>ACWI</b>		
	Exhaust	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	
Max. of Exhaust		MW14BE	MW10BE	MW04BE	MWNE	MW04AE	MW10AE	MW14AE	MCWE		
Avg. of Exhaust		<b>AW14BE</b>	<b>AW10BE</b>	<b>AW04BE</b>	<b>AWN1</b>	<b>AW04AE</b>	<b>AW10AE</b>	<b>AW14AE</b>	<b>ACWE</b>		
Over-all Maximum		MW14B	MW10B	MW04B	MNW	MW04A	MW10A	MW14A	MCW		
Over-all Average		<b>AW14B</b>	<b>AW10B</b>	<b>AW04B</b>	<b>ANW</b>	<b>AW04A</b>	<b>AW10A</b>	<b>AW14A</b>	<b>ACW</b>		

Note: Plus direction is before top center of cam nose

**Sequence IVA  
Valve Train Wear Test  
Form 6  
Operational Summary**

Laboratory: LAB	Test Number: STAND	-STRUN	-LABRUN	Oil Code: OILCODE
Formulation/Stand Code: FORM				

Parameter	Units	Oil Threshold	EOT Oil	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	OTORQUE	25.0		ATORQUE1	ATORQUE2	NTORQUE	BTORQUE	OTORQUE
Coolant Out	°C	0.000	QCOLOUT	50.0	55.0	ACOLOUT1	ACOLOUT2	NCOLOUT	BCOLOUT	OCOLOUT
Humidity	g/kg	0.000	QHUMID	11.5		AHUMID		NHUMID	BHUMID	OHUMID
Intake Air	°C	0.000	QINAIPT	32		AINAIPT		NINAIPT	BINAIPT	OINAIPT
Intake Air	kPa	0.000	QINAIPT	0.05		AINAIPT		NINAIPT	BINAIPT	OINAIPT
Exhaust - abs	kPa	0.000	QEXHBKP	103.5		AEXHBKP		NEXHBKP	BEXHBKP	OEXHBKP
Engine Coolant	L/min	0.000	QCOLFRT	30.0		ACOLFRT		NCOLFRT	BCOLFRT	OCOLFRT
Oil Cylinder Head	°C	0.000	QCYLOT	49.0	59.0	ACYLOT1	ACYLOT2	NCYLOT	BCYLOT	OCYLOT
Fresh Air Flow	SL/min	0.000	OFAF	10.0		AFAF		NFAF	BFAF	OFAF
<b>Controlled Parameters</b>										
Parameter	Units	Typical Values		Average						
Oil Sump	°C	49 - 54	57 - 65	ASUMPT1	ASUMPT2					
Oil Gallery	°C	46.5 - 50.5	58.5 - 61.5	AOILT1	AOILT2					
Coolant In	°C	44 - 46	49 - 50	ACOLIN1	ACOLIN2					
Exhaust Gas	°C	306 - 332	414 - 434	AEXHT1	AEXHT2					
Fuel Rail	°C	15 - 30	15 - 30	AFUFLT1	AFUFLT2					
Oil Gallery	kPa	99.5 - 145.5	210.5 - 280.5	AOILPRS1	AOILPRS2					
Oil Cylinder Head	kPa	30 - 60	50 - 90	ACYLOPR1	ACYLOPR2					
Fuel	kPa	230 - 380	230 - 380	AFUELPR1	AFUELPR2					
Manifold Vacuum	°C	57.7 - 59.9	63.8 - 65.8	AIMNVAC1	AIMNVAC2					
Air-to-Fuel Ratio	kPa	14.1 - 14.7	14.1 - 14.7	AAFR1	AAFR2					
Crankcase	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	°C	47 - 49	52 - 55	ARACGT1	ARACGT2					
Rocker Cover Coolant	L/min	3.0 - 4.5	3.0 - 4.5	ARACFLO1	ARACFLO2					
<b>Non-controlled Parameters</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 under range limits of the statistical measures.

# Sequence IVA Valve Train Wear Test

## Form 7

### Used Oil Analysis

Laboratory: LAB	Test Number: STAND	- STRUN	- LABRUN	Oil Code: OILCODE
Formulation/Stand Code: FORM				

### Chemical Analysis: 0, 25, 50, 75 & 100 Hour Engine Oil

ASTM Method	Analysis Description	Units	TST_HNEW	TST_H025	TST_H050	TST_H075	TST_H100
D 445	Kinematic Viscosity @ 40°C	cSt	V040HNEW	---	---	---	V040H100
D 3525-M	Fuel Dilution, Gasoline	%	---	---	---	---	FUELH100
D 5185 (ICP)	Fe by ICP	ppm	---	FEWMH025	FEWMH050	FEWMH075	FEWMH100
D 5185 (ICP)	Cu by ICP	ppm	---	CUWMH025	CUWMH050	CUWMH075	CUWMH100

# Sequence IVA Valve Train Wear Test

## Form 8

### Camshaft Bore/Journal Measurements

Laboratory: LAB	Test Number: STAND - STRUN - LABRUN	Oil Code: OILCODE
Formulation/Stand Code: FORM		

### Camshaft Bearing Bore Diameter (mm)

Bore Gauge Set: 33.000 mm

Diameter (Standard): 33.000 - 33.025 mm

Bore Number	X		V		Y		Maximum Run-Out	
	F	R	F	R	F	R	F	R
1	CBFX001	CBRX001	CBFV001	CBRV001	CBFY001	CBRY001	XCBF001	XCBR001
2	CBFX002	CBRX002	CBFV002	CBRV002	CBFY002	CBRY002	XCBF002	XCBR002
3	CBFX003	CBRX003	CBFV003	CBRV003	CBFY003	CBRY003	XCBF003	XCBR003
4	CBFX004	CBRX004	CBFV004	CBRV004	CBFY004	CBRY004	XCBF004	XCBR004
5	CBFX005	CBRX005	CBFV005	CBRV005	CBFY005	CBRY005	XCBF005	XCBR005

### Camshaft Bearing Journal Diameter (mm)

Diameter (Standard) 32.935 - 32.955 mm

Clearance (Limit) : 0.120 mm

Journal 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
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End Play (Limit): 0.20 mm

<b>Camshaft Sprocket Run Out, mm</b>	CAMSROUT
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Run-Out (Limit): 0.12 mm

<b>Camshaft Run-Out (Bend), mm</b>	CAMBEND
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Run-Out (Limit): 0.02 mm

### Cylinder Compression (kPa)

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



# Sequence IVA Valve Train Wear Test

Form 9

## Special Maintenance Record

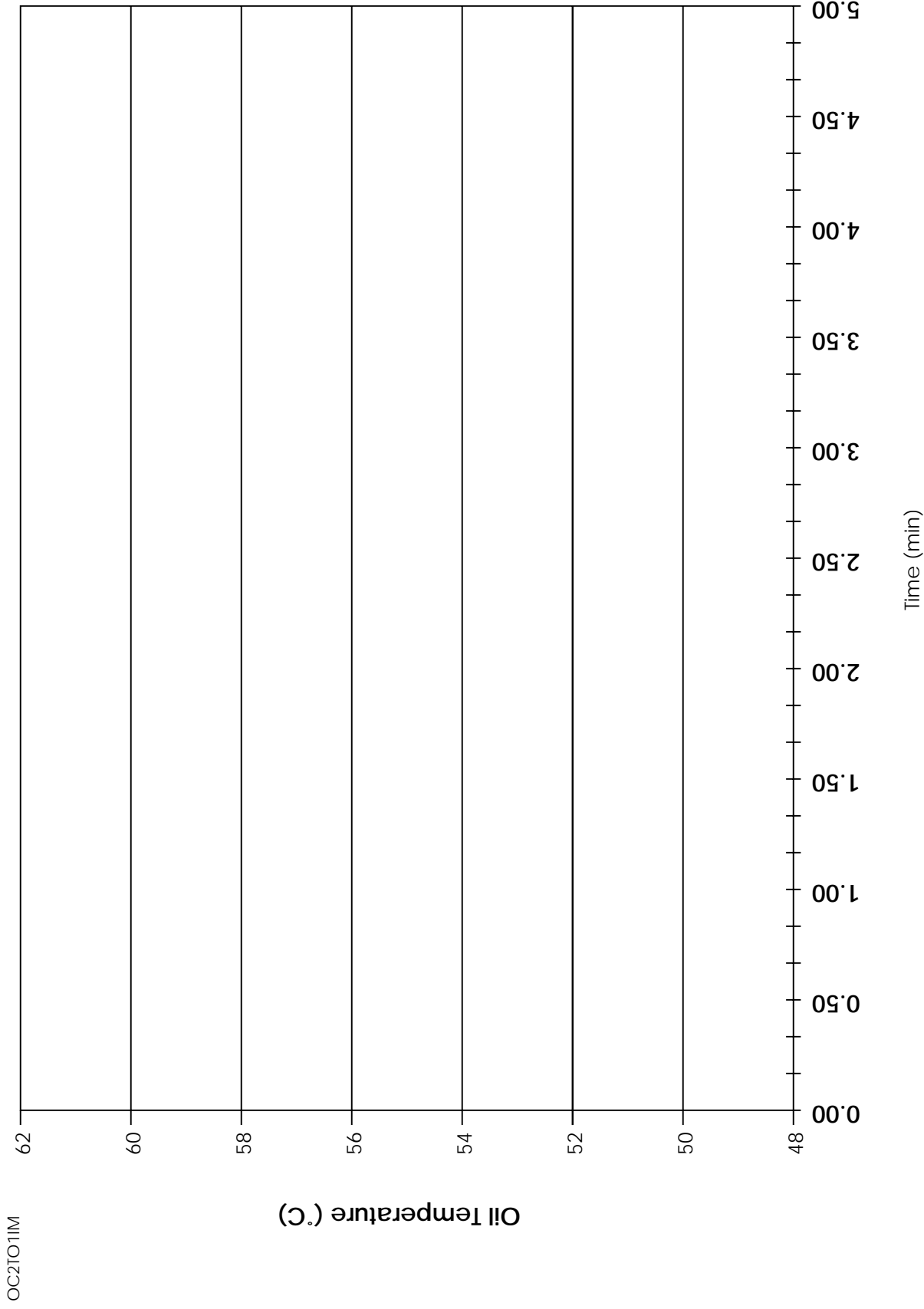
Laboratory: LAB	Test Number: STAND - STRUN - LABRUN	Oil Code: OILCODE
Formulation/Stand Code: FORM		

Number of Downtime Occurrences		DWNOCR	
Test Hours	Date	Downtime	Reasons
DOWNR001	DDATR001	DTIMR001	DREAR001
TOTLDOWN			Total Downtime

Other Comments		
Number of Comment Lines	TOTCOM	
OCOMR001		

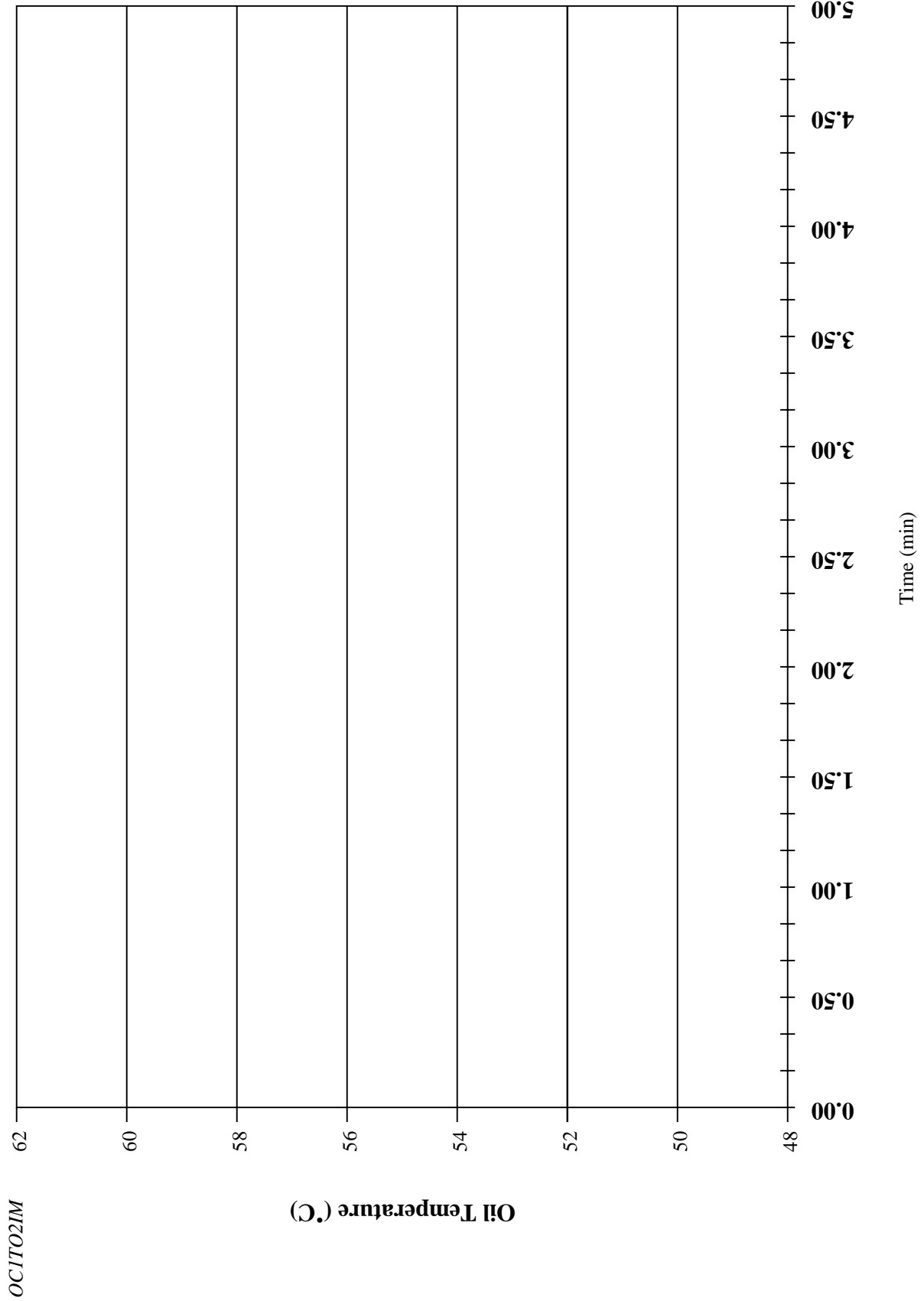
Sequence IVA Valve Train Wear Evaluation  
Form 10  
Stage 2 to 1 Transition: Oil Cylinder Head Temperature  
Cycle 5

Laboratory: LAB	Test Number: STAND	- STRUN	- LABRUN	Oil Code: OILCODE
Formulation/Stand Code: FORM				



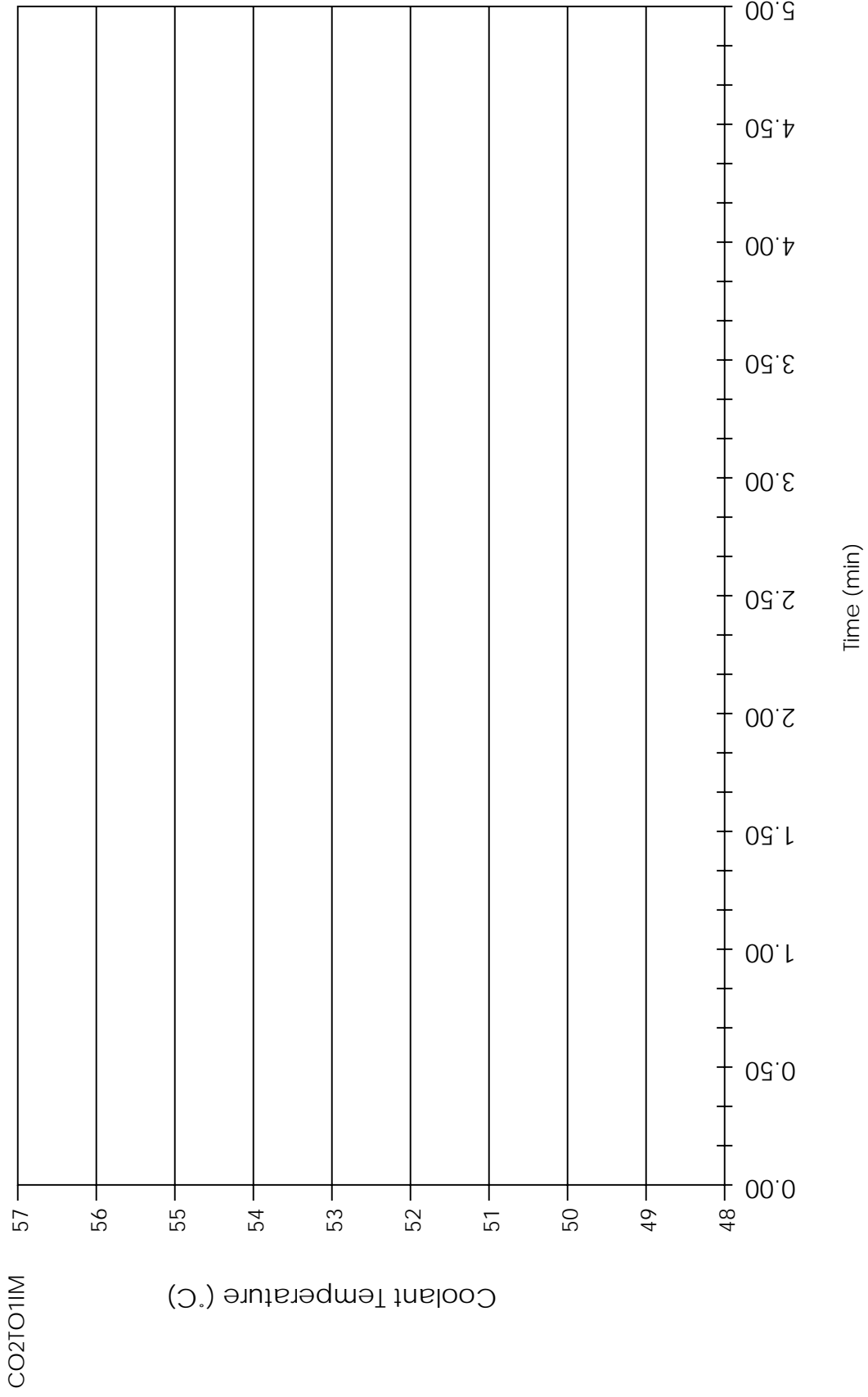
**Sequence IVA Valve Train Wear Evaluation  
Form 11  
Stage 1 to 2 Transition: Oil Cylinder Head Temperature  
Cycle 5**

Laboratory: LAB	Test Number: STAND	- STRUN	- LABRUN	Oil Code: OILCODE
Formulation/Stand Code: FORM				



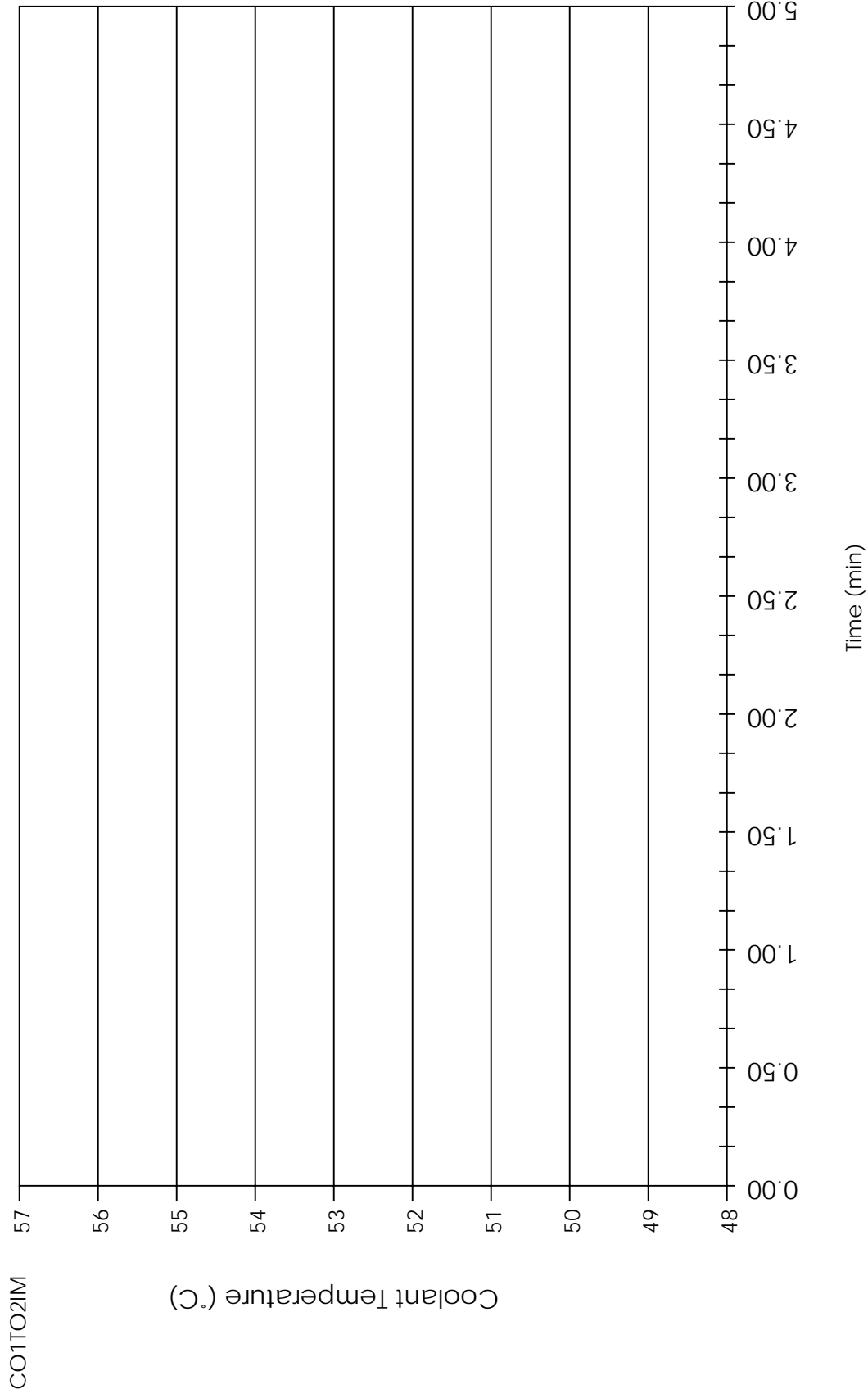
Sequence IVA Valve Train Wear Evaluation  
Form 12  
Stage 2 to 1 Transition: Coolant Out Temperature  
Cycle 5

Laboratory: LAB	Test Number: STAND	- STRUN	- LABRUN	Oil Code: OILCODE
Formulation/Stand Code: FORM				



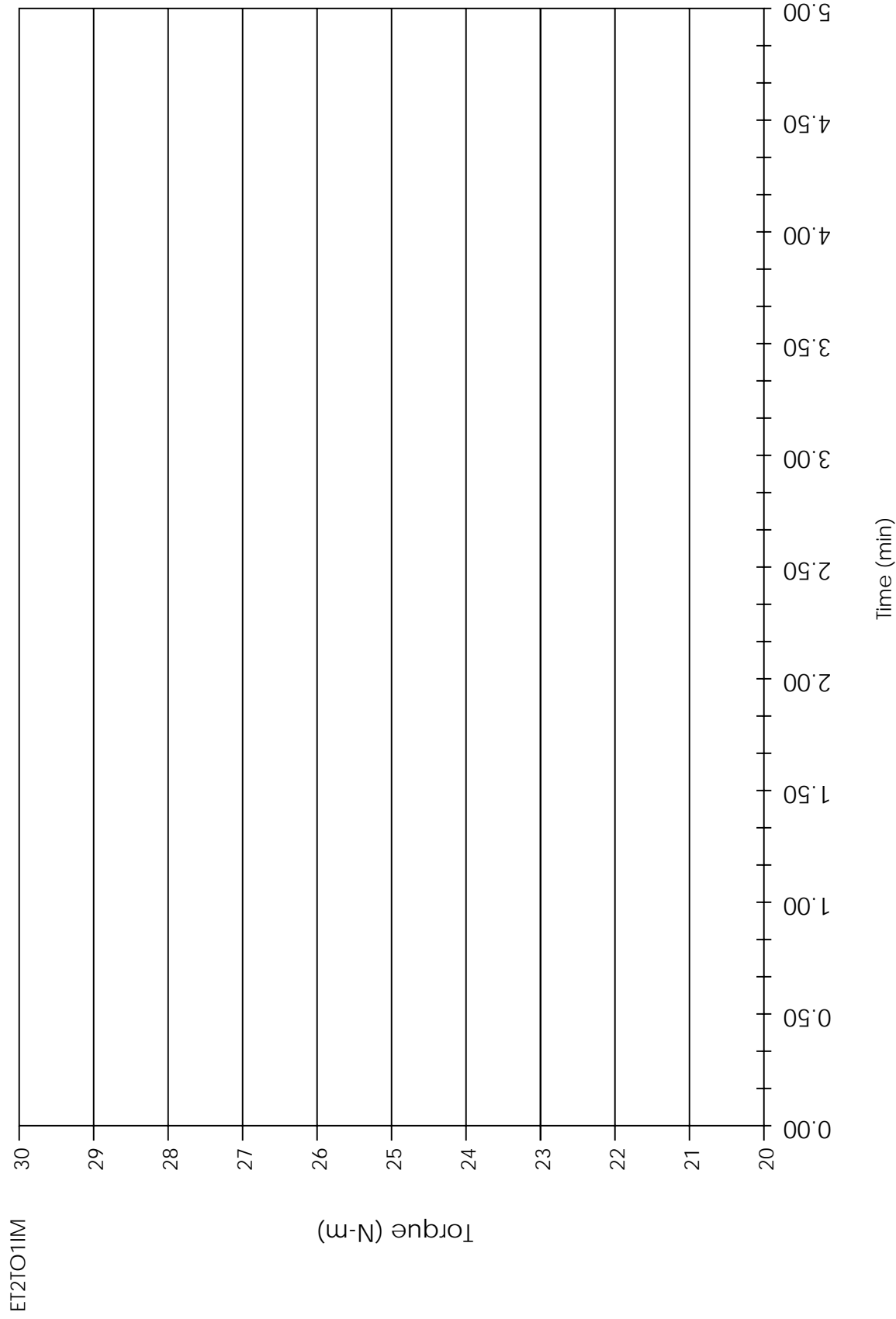
Sequence IVA Valve Train Wear Evaluation  
Form 13  
Stage 1 to 2 Transition: Coolant Out Temperature  
Cycle 5

Laboratory: LAB	Test Number: STAND	- STRUN	- LABRUN	Oil Code: OILCODE
Formulation/Stand Code: FORM				



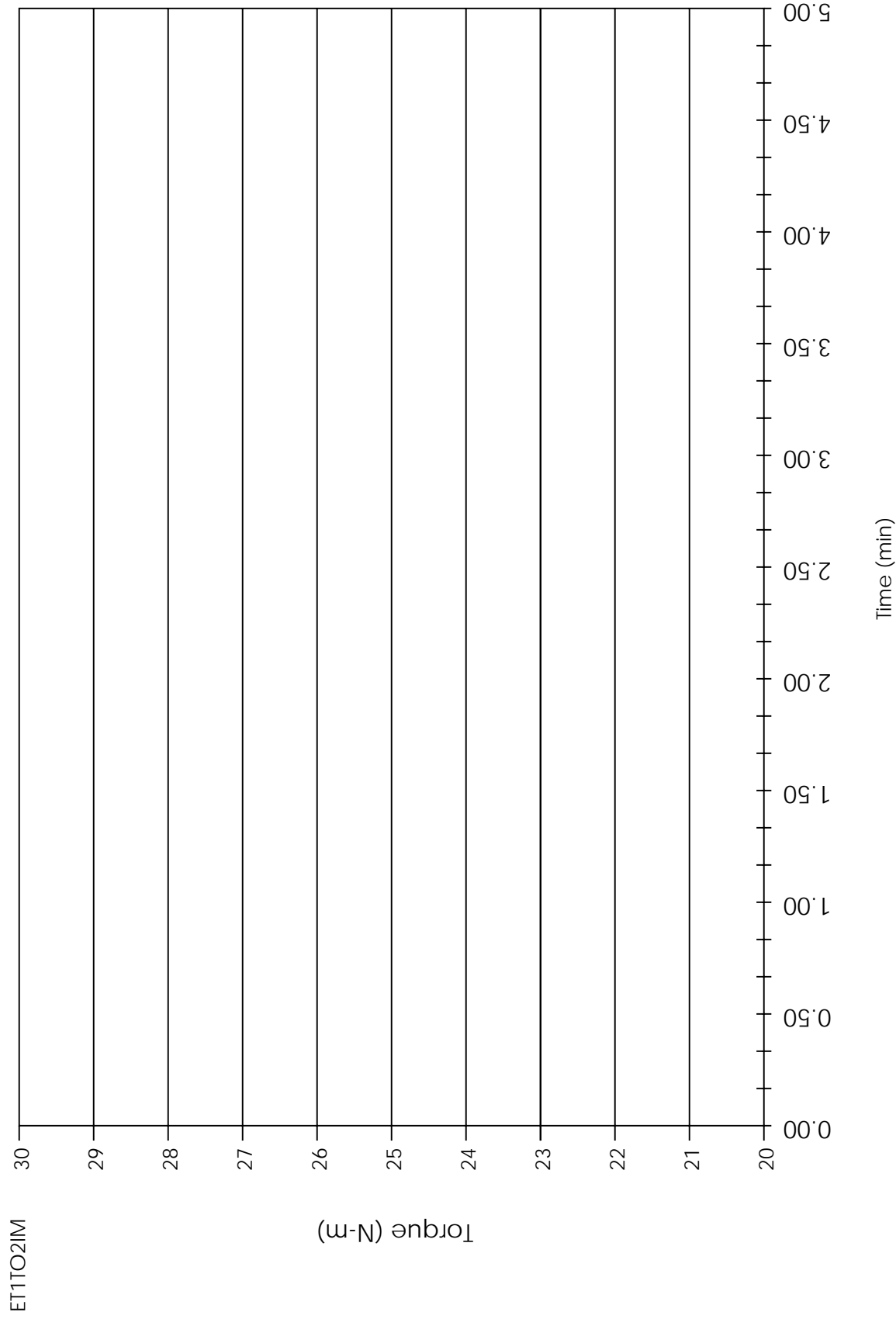
Sequence IVA Valve Train Wear Evaluation  
Form 14  
Stage 2 to 1 Transition: Engine Torque  
Cycle 5

Laboratory: LAB	Test Number: STAND	- STRUN	- LABRUN	Oil Code: OILCODE
Formulation/Stand Code: FORM				



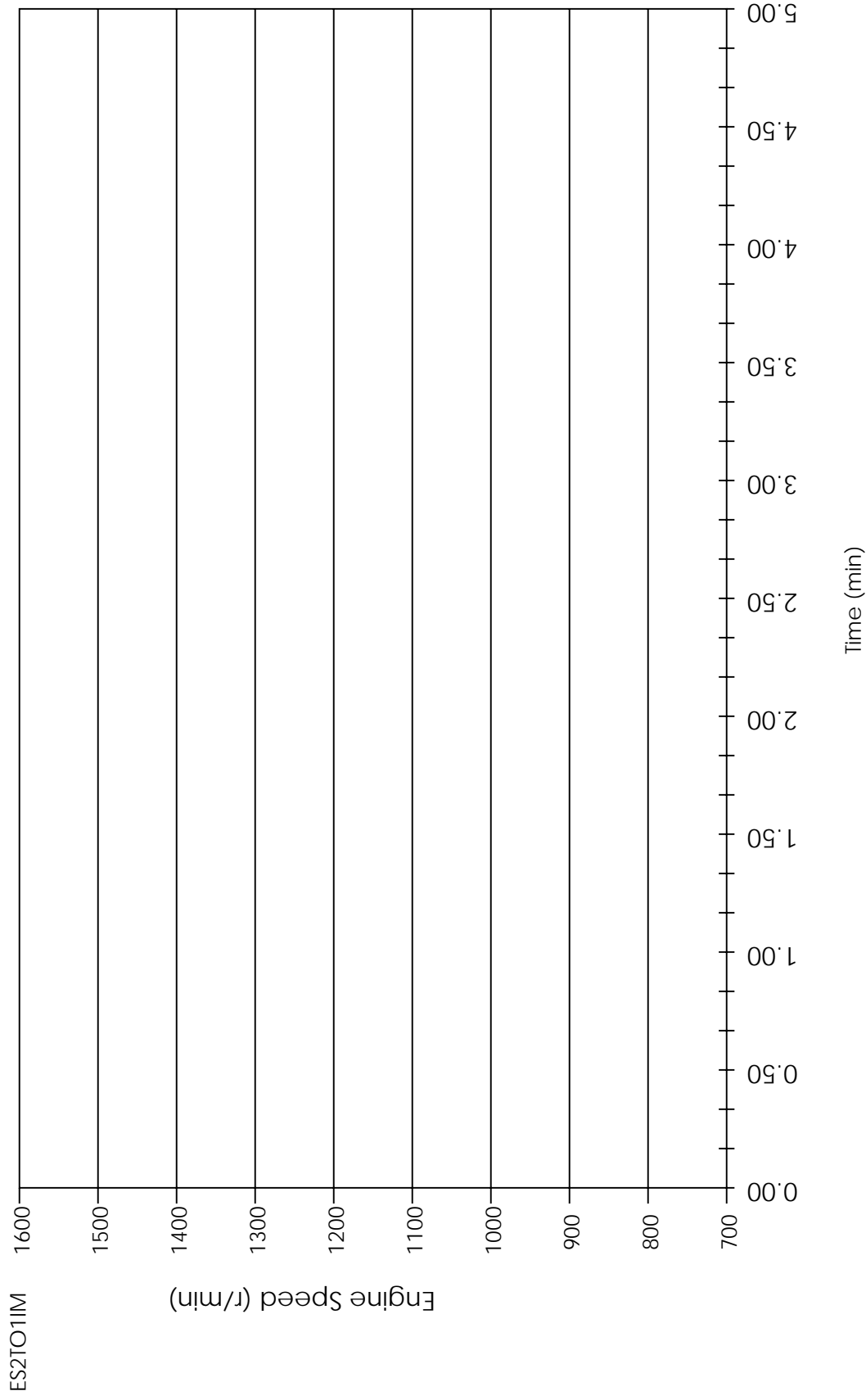
Sequence IVA Valve Train Wear Evaluation  
Form 15  
Stage 1 to 2 Transition: Engine Torque  
Cycle 5

Laboratory: LAB	Test Number: STAND	- STRUN	- LABRUN	Oil Code: OILCODE
Formulation/Stand Code: FORM				



Sequence IVA Valve Train Wear Evaluation  
Form 16  
Stage 2 to 1 Transition: Engine Speed  
Cycle 5

Laboratory: LAB	Test Number: STAND	- STRUN	- LABRUN	Oil Code: OILCODE
Formulation/Stand Code: FORM				





Sequence IVA Valve Train Wear Evaluation  
Form 17  
Stage 1 to 2 Transition: Engine Speed  
Cycle 5

Laboratory: LAB	Test Number: STAND	- STRUN	- LABRUN	Oil Code: OILCODE
Formulation/Stand Code: FORM				

