

**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 Engine        |                            |
| Lab Head Number        |  | Total Runs on Cylinder Head |                            |
| 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 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> |
|--|

Submitted By:

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

\_\_\_\_\_ Signature

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

\_\_\_\_\_ Title

**Sequence IVA Valve Train Wear  
Form 2**

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<sup>A</sup> ACC Conformance Statement is required for only ACC registered tests

**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:

| <b>Parameter</b>              | <b>Units</b> | <b>Stage 1</b> | <b>Stage 2</b> |
|-------------------------------|--------------|----------------|----------------|
| 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     |                |                           |  |

**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, $\mu\text{m}$          |  |

**Additional Camshaft Lobe Wear Measurements**

|              |                        |  |
|--------------|------------------------|--|
| 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 |  |

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



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

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

|                                  | Parameter                     | Units        | QI Limit              | EOT QI | Target      |                | Average |  | Samples <sup>A</sup> | BQD <sup>B</sup> | Over/Under Range <sup>C</sup> |
|----------------------------------|-------------------------------|--------------|-----------------------|--------|-------------|----------------|---------|--|----------------------|------------------|-------------------------------|
|                                  |                               |              |                       |        |             |                |         |  |                      |                  |                               |
| <b>Controlled Parameters</b>     | 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        |                |         |  |                      |                  |                               |
| <b>Non-controlled Parameters</b> | <b>Parameter</b>              | <b>Units</b> | <b>Typical Values</b> |        |             | <b>Average</b> |         |  |                      |                  |                               |
|                                  | Oil Sump Temperature          | °C           | 53.5 ± 3              |        | 63.5 ± 3    |                |         |  |                      |                  |                               |
|                                  | Oil Gallery Temperature       | °C           | 50 ± 3                |        | 60 ± 3      |                |         |  |                      |                  |                               |
|                                  | Coolant In Temperature        | °C           | 45.5 ± 3              |        | 49 ± 3      |                |         |  |                      |                  |                               |
|                                  | Exhaust Gas Temperature       | °C           | 340 ± 50              |        | 450 ± 50    |                |         |  |                      |                  |                               |
|                                  | Fuel Rail Temperature         | °C           | 22.5 ± 10             |        | 22.5 ± 10   |                |         |  |                      |                  |                               |
|                                  | Oil Gallery Pressure          | kPa          | 130 ± 40              |        | 260 ± 80    |                |         |  |                      |                  |                               |
|                                  | Oil Cylinder Head Pressure    | kPa          | 40 ± 20               |        | 65 ± 30     |                |         |  |                      |                  |                               |
|                                  | Fuel Pressure                 | kPa          | 238 ± 10              |        | 234 ± 10    |                |         |  |                      |                  |                               |
|                                  | Manifold Vacuum               | kPa          | 60 ± 5                |        | 65 ± 5      |                |         |  |                      |                  |                               |
|                                  | Air-to-Fuel Ratio             | -            | 14.1 – 14.7           |        | 14.1 – 14.7 |                |         |  |                      |                  |                               |
|                                  | Crankcase Pressure            | kPa          | -0.3 ± 0.1            |        | -0.3 ± 0.1  |                |         |  |                      |                  |                               |
|                                  | Fuel Flow                     | kg/h         | 1.3 ± 0.3             |        | 2.15 ± 0.3  |                |         |  |                      |                  |                               |
|                                  | 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   |                |         |  |                      |                  |                               |
|                                  | Coolant Pressure              | kPa          | 70±5                  |        | 70±5        |                |         |  |                      |                  |                               |
| Rocker Cover Coolant In Temp.    | °C                            | Record       |                       | Record |             |                |         |  |                      |                  |                               |
| Rocker Cover Coolant Out Temp.   | °C                            | Record       |                       | Record |             |                |         |  |                      |                  |                               |
| Front Cover Fresh Air Flow       | SL/min                        | Record       |                       | Record |             |                |         |  |                      |                  |                               |

<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 Used Engine Oil Samples**

| Test Hours | Kinematic Viscosity @<br>40°C<br>D 445<br>cSt | Fuel Dilution<br>D3525-M<br>% | ICP<br>D 5185<br>ppm |    |
|------------|---|-------------------------------|----------------------|----|
|            |   |                               | Fe                   | Cu |
| NEW        |   |                               |                      |    |
|            |   |                               |                      |    |
|            |   |                               |                      |    |
|            |   |                               |                      |    |
|            |   |                               |                      |    |

**Sequence IVA Valve Train Wear  
Form 8**

**Camshaft Measurements**

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

**Camshaft Bearing Journal Diameter (mm)**

Diameter (Standard): 32.935 – 32.955mm

Clearance (Limit): 0.120mm

| Bore<br>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): 0.22mm |
|------------------------------|--|--------------------------|

|                                      |  |                         |
|--------------------------------------|--|-------------------------|
| <b>Camshaft Sprocket Run-out, mm</b> |  | Run-out (Limit): 0.12mm |
|--------------------------------------|--|-------------------------|

|                                    |  |                         |
|------------------------------------|--|-------------------------|
| <b>Camshaft Run-out (bend), mm</b> |  | Run-out (Limit): 0.02mm |
|------------------------------------|--|-------------------------|

**Cylinder Compression, kPa**

| Cylinder Number | 1 | 2 | 3 | 4 |
|-----------------|---|---|---|---|
| Before Test     |   |   |   |   |





## 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> |

|                         |  |
|-------------------------|--|
| 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               |
|                                |      |           |                       |
|                                |      |           |                       |
|                                |      |           |                       |
|                                |      |           |                       |
|                                |      |           |                       |
|                                |      |           |                       |
|                                |      |           |                       |
|                                |      |           |                       |
|                                |      |           |                       |
|                                |      |           |                       |
|                                |      |           |                       |
|                                |      |           |                       |
|                                |      |           |                       |
|                                |      |           |                       |
|                                |      |           | <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: |              |

|  |
|--|
|  |
|--|

**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: |              |

**Sequence IVA Valve Train Wear Evaluation  
Form 12**

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

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

**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: |              |

**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: |              |



**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: |              |

**Sequence IVA Valve Train Wear Evaluation  
Form 16**

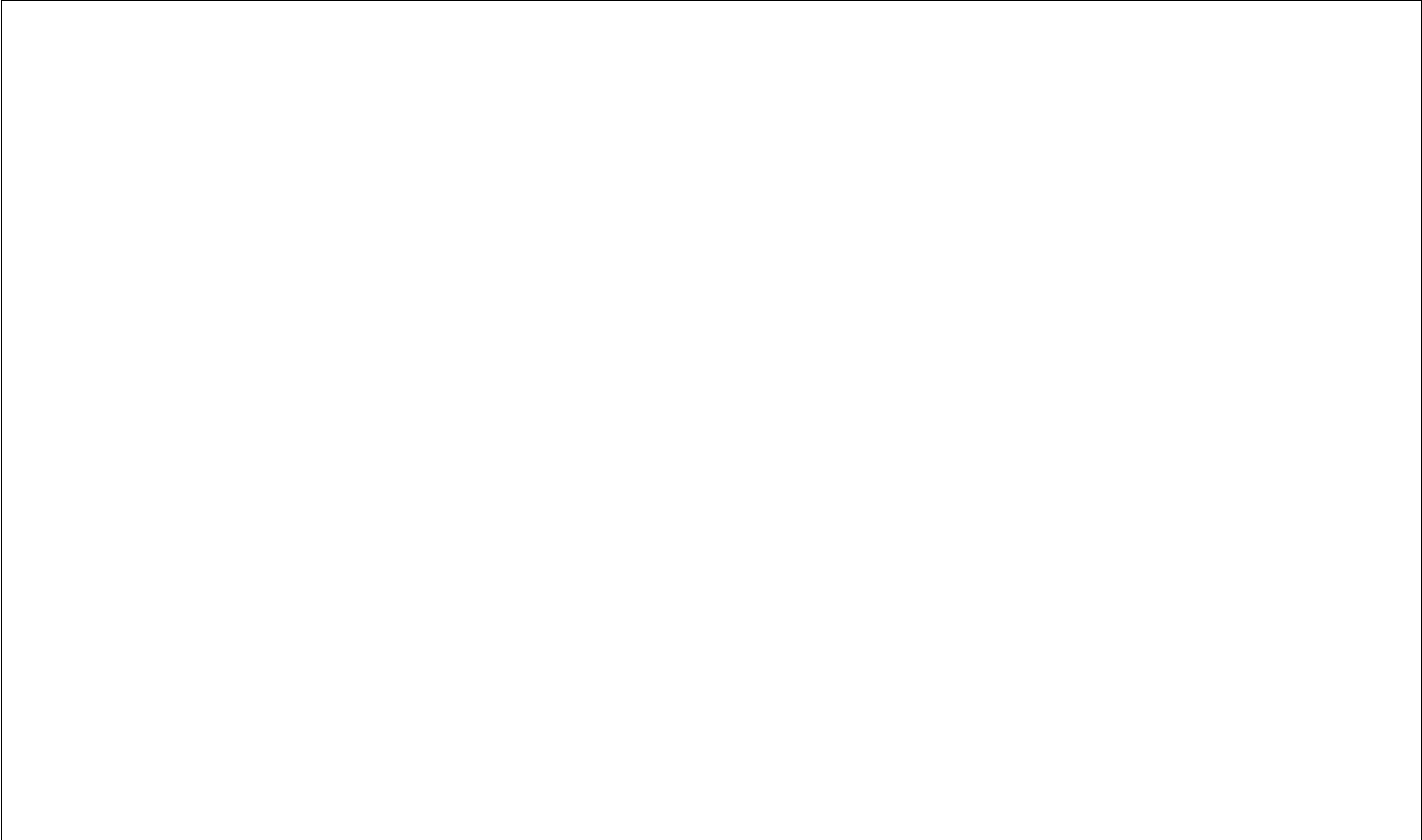
**Cycle 5 Stage 2 to 1 Transition: Engine Speed**

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

**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: |              |



## Sequence IVA Valve Train Wear Evaluation

### Form 18

### Hardware Information

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

|                       | Position | Part Number | Lot Number |
|-----------------------|----------|-------------|------------|
| Rocker<br>Arm         | 1        |             |            |
|                       | 2        |             |            |
|                       | 3        |             |            |
|                       | 4        |             |            |
|                       | 5        |             |            |
|                       | 6        |             |            |
|                       | 7        |             |            |
|                       | 8        |             |            |
|                       | 9        |             |            |
|                       | 10       |             |            |
|                       | 11       |             |            |
|                       | 12       |             |            |
| Camshaft              |          |             |            |
| Cylinder Head         |          |             |            |
| Rocker Shaft, Exhaust |          |             |            |
| Rocker Shaft, Intake  |          |             |            |
| Spark Plug            |          |             |            |
| Oil Filter            |          |             |            |
| Reground Camshaft s/n |          |             |            |

**Sequence IVA Valve Train Wear Evaluation**

**Form 19**

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