

**ISM  
Lubricant Performance Test**

**Report Packet Version No.**  
ISM VERSION 20041119 BETA

**Method**  
METHOD

**Conducted For:**

TSTSPON1

TSTSPON2

|          |     |  |
|----------|-----|--|
| LABVALID | V = | Valid; The reference oil / non-reference oil was evaluated in accordance with the test procedure.  |
|          | I = | Invalid; The reference oil / non-reference oil was not evaluated in accordance with the test procedure.  |
|          | N = | Results cannot be interpreted as representative of oil performance (non-reference oil) and shall not be used in determining an average test result using multiple test criteria. |

|        |                             |
|--------|-----------------------------|
| TSTOIL | NR = Non-Reference Oil Test |
|        | RO = Reference Oil Test     |

|                           |          |                   |          |                |       |
|---------------------------|----------|-------------------|----------|----------------|-------|
| Stand:                    | STAND    | Engine:           | ENGINE   | Engine Run No: | ENRUN |
| End Of Test Date:         | DTCOMP   | End Of Test Time: | EOTTIME  |                |       |
| Oil Code:                 | OILCODE  |                   |          |                |       |
| Formulation / Stand Code: | FORM     |                   |          |                |       |
| Alternate Codes:          | ALTCODE1 | ALTCODE2          | ALTCODE3 |                |       |

In my opinion the test OPVALID been conducted in a valid manner in accordance with Test Method Dxxxx and the appropriate amendments through the information letter system. The remarks included in this report describe the anomalies associated with this test.

Submitted By:

SUBLAB

Testing Laboratory

SUBSIGIM

Signature

SUBNAME

Typed Name

SUBTITLE

Title

**ISM Lubricant Performance Test  
Form 2  
Table of Contents**

|     |  |         |
|-----|--|---------|
| 1.  | Final Report Cover Sheet                       | Form 1  |
| 2.  | Table of Contents                              | Form 2  |
| 3.  | Summary of Test Method                         | Form 3  |
| 4.  | Test Results Summary                           | Form 4  |
| 5.  | Operational Summary                            | Form 5  |
| 6.  | Crosshead Mass Loss Summary                    | Form 6  |
| 7.  | Oil Filter Delta Pressure Plot                 | Form 7  |
| 8.  | Sludge Rating Summary                          | Form 8  |
| 9.  | Rod Bearing Mass Loss                          | Form 9  |
| 10. | Ring Mass Loss Summary                         | Form 10 |
| 11. | Oil Analysis Summary                           | Form 11 |
| 12. | Test Fuel Analysis                             | Form 12 |
| 13. | Injector Adjusting Screw Mass Loss             | Form 13 |
| 14. | Unscheduled Downtime & Maintenance Summary     | Form 14 |
| 15. | Characteristics of the Data Acquisition System | Form 15 |
| 16. | Valve Adjusting Screw Mass Loss Summary        | Form 16 |

**ISM Lubricant Performance Test  
Form 3  
Summary Of Test Method**

The ISM Lubricant Performance Test is an engine-dynamometer test which evaluates the ability of a lubricant to minimize crosshead wear, filter plugging, sludge build-up, and top ring weight loss. This test is a two-stage, steady state test (constant speed and load). Stage A is 50 hours and is run with retarded fuel injection timing to produce elevated soot levels in the oil. Stage B is 50 hours and is run under heavy load conditions to induce wear. The stages are run in sequence (Stage A followed by Stage B) twice for a total test length of 200 hours.

The test engine is a Cummins ISM diesel engine with EGR. It is an in-line six cylinder, four-stroke, turbocharged engine with electronically controlled fuel injection. A two-h break-in is conducted prior to each test since a new engine build is used for each test.

**ISM Test Conditions**

| <b>Parameter</b>                       | <b>Stage A</b> | <b>Stage B</b> |
|--|----------------|----------------|
| Time, h                                | 50             | 50             |
| Injection Timing, °BTDC                | Variable       | Variable       |
| Speed, r/min                           | 1800           | 1600           |
| Fuel Flow, kg/h                        | 58.0           | 64.4           |
| Intake CO 2%                           | 0.97 - 1.09    | 0.97 - 1.09    |
| Inlet Manifold Temp., °C               | 80             | 65.5           |
| Coolant Out Temp., °C                  | 65.5           | 65.5           |
| Fuel In Temp., °C                      | 40             | 40             |
| Oil Gallery Temp., °C                  | 115            | 115            |
| Intake Air Temp., °C                   | Record         | Record         |
| Intake Air Pressure, kPa absolute      | Record         | Record         |
| Intake Manifold Pressure, kPa absolute | 300 Minimum    | 320 Minimum    |
| Exhaust Back Pressure, kPa absolute    | 107            | 107            |
| Crankcase Pressure, kPa                | Record         | Record         |
| Coolant System Pressure, kPa           | 99 - 107       | 99 - 107       |
| Power, kW                              | Record         | Record         |
| Torque, Nm                             | Record         | Record         |
| Pre-turbine Exhaust Temp., °C          | Record         | Record         |
| Tailpipe Exhaust Temp., °C             | Record         | Record         |
| Oil Sump Temp., °C                     | Record         | Record         |
| Inlet Air Dew Point, °C                | Record         | Record         |
| Inlet Air Humidity, kg/kg              | Record         | Record         |
| Oil Gallery Pressure, kPa              | Record         | Record         |
| Oil Filter Delta P, kPa                | Record         | Record         |

**ISM Lubricant Performance Test  
Test Results Summary  
Form 4**

|                         |                       |                       |
|-------------------------|-----------------------|-----------------------|
| Laboratory: LAB         | EOT Date: DTCOMP      | EOT Time: EOTTIME     |
| Stand: STAND            | Engine: ENGINE        | Engine Run No.: ENRUN |
| Formulation/Stand Code: |                       | FORM                  |
| Oil Code: OILCODE       | Engine Kit S/N: ENKIT |                       |

|                              |          |
|------------------------------|----------|
| Date Test Started            | DTSTRT   |
| Start Time                   | STRTTIME |
| Test Length                  | TESTLEN  |
| TMC Oil Code <sup>A</sup>    | IND      |
| Laboratory Oil Code          | LABOCODE |
| SAE Viscosity                | SAEVISC  |
| TGA Soot % At 50 h           | TGA050   |
| TGA Soot % At 150 h          | TGA150   |
| Average TGA Soot % 0 - 200 h | TGAAVG   |
| Total Oil Consumption, kg    | TOTOCON  |

|   | Adj. Average<br>Crosshead Mass<br>Loss<br>(mg) | Filter Plugging<br>Delta P<br>(kPa) | Average Sludge<br>Rating<br>(merits) | Avg. Top Ring<br>Weight Loss<br>(mg) |
|---|--|-------------------------------------|--------------------------------------|--------------------------------------|
| Original Result                           | ACWL   | OILDLP                              | ASRT                                 | ARWLT                                |
| Transformed Result <sup>B</sup>           | TRNACWL  | TRNODP                              | TRNASRT                              | TRNARWLT                             |
| Correction Factor <sup>B</sup>            | ACWLCF   | OILDPCF                             | ASRCTF                               | ARWLTCF                              |
| Corrected Transformed Result <sup>B</sup> | ACWLCOR  | OILDPCOR                            | ASRTCOR                              | ARWLTCOR                             |
| Severity Adjustment <sup>B</sup>          | ACWL_SA  | OILDPA_SA                           | ASRT_SA                              | ARWL_SA                              |
| Final Transformed Result <sup>B</sup>     | TACWLFNL                                       | TODPFNL                             | TASRTFNL                             | TARWLT                               |
| <b>Final Result</b>                       | ACWLFNL  | OILDPFNL                            | ASRTFNL                              | ARWTFNL                              |

| Last Stand Reference Results      |                 |                        |  |
|-----------------------------------|-----------------|------------------------|--|
| Stand: STAND                      | Engine: RENGINE | Engine Run No.: RENRUN |  |
| Oil Code                          | ROILCODE        |                        |  |
| Test Length                       | RTESTLEN        |                        |  |
| TMC Oil Code                      | RIND            |                        |  |
| EOT Date                          | RDTCOMP         |                        |  |
| EOT Time                          | REOTTIME        |                        |  |
| Stand Calibration Expiration Date | DTCALEXP        |                        |  |
| TGA Soot % AT 50 h                | RTGA050         |                        |  |
| TGA Soot % AT 150 h               | RTGA150         |                        |  |
| Average TGA Soot % 0 - 200 h      | RTGAAVG         |                        |  |
| Total Oil Consumption, kg         | RTOTOCON        |                        |  |

|   | Adj. Average<br>Crosshead Mass<br>Loss<br>(mg) | Filter Plugging<br>Delta P<br>(kPa) | Average Sludge<br>Rating<br>(merits) | Avg. Top Ring<br>Weight Loss<br>(mg) |
|---|--|-------------------------------------|--------------------------------------|--------------------------------------|
| Original Result                           | RACWL  | ROILDLP                             | RASRT                                | RARWLT                               |
| Transformed Result <sup>B</sup>           | RTRNACWL                                       | RTRNODP                             | RTRNASRT                             | RTRNARWT                             |
| Correction Factor <sup>B</sup>            | RACWLCF  | ROILDPCF                            | RASRCTF                              | RARWLTCF                             |
| Corrected Transformed Result <sup>B</sup> | RACWLCOR                                       | RTODPCOR                            | RASRTCOR                             | RARWTCOR                             |
| Final Transformed Result <sup>B</sup>     | RTCWLFNL                                       | RTODPFNL                            | RTSRTFNL                             | RTARWLT                              |
| <b>Final Result</b>                       | RACWLFNL                                       | RFPDPFNL                            | RASRTFNL                             | RARWTFNL                             |

<sup>A</sup> Reference Tests Only

<sup>B</sup> Filter Plugging Delta P Value in Transformed Units

**ISM Lubricant Performance Test  
Form 5  
Operational Summary**

|                              |       |        |                 |        |
|------------------------------|-------|--------|-----------------|--------|
| Laboratory:                  | LAB   | DTCOMP | EOT Time:       | EOTIME |
| Stand:                       | STAND | ENGINE | Engine Run No.: | ENRUN  |
| Formulation/Stand Code: FORM |       |        |                 |        |
| Oil Code: OILCODE            |       |        |                 |        |

| Parameter        | Units        | QI Threshold                      | EOT QI <sup>A</sup> | Target  |      | Average  |          | Samples <sup>B</sup> | BQD <sup>C</sup> | Over/Under Range <sup>D</sup> |
|------------------|--------------|-----------------------------------|---------------------|---------|------|----------|----------|----------------------|------------------|-------------------------------|
|                  |              |                                   |                     | 1800    | 1600 | ARPMA    | ARPMB    |                      |                  |                               |
| Speed            | r/min        | 0.000                             | QRPM                | 58.0    | 64.4 | AFFLOA   | AFFLOB   | NFFLO                | BFFLO            | OFFLO                         |
| Fuel Flow        | kg/h         | 0.000                             | QFLO                | 65.5    |      | ACOLOUT  |          | NCOLOUT              | BCOLOUT          | OCOLOUT                       |
| Coolant Out      | °C           | 0.000                             | QCLOUT              | 40      |      | AFUELT   |          | NFUELT               | BFUELT           | OFUELT                        |
| Fuel In          | °C           | 0.000                             | QFUELT              | 115     |      | AOILTEM  |          | NOILTEM              | BOILTEM          | OILTEM                        |
| Oil Gallery      | °C           | 0.000                             | QOILTEM             | 80.0    | 65.5 | AINMANTA | AINMANTB | NINMANT              | BINMANT          | OINMANT                       |
| Intake Manifold  | °C           | 0.000                             | QINMANT             | 107     |      | AEXHSTP  |          | NEXHSTP              | BEXHSTP          | OEXHSTP                       |
| Exhaust          | kPa          | 0.000                             | QEXHSTP             |         |      |          |          |                      |                  |                               |
| <b>Parameter</b> | <b>Units</b> | <b>Typical Values<sup>E</sup></b> |                     |         |      |          |          |                      |                  |                               |
| Torque           | N-m          | TBD                               | TBD                 | ALOADA  |      | ALOADB   |          |                      |                  |                               |
| Power            | kW           | TBD                               | TBD                 | APWRA   |      | APWRB    |          |                      |                  |                               |
| Intake CO        | %            | 0.97 – 1.09                       | 0.97 – 1.09         | AICO2A  |      | AICO2B   |          |                      |                  |                               |
| Blowby           | L/min        |                                   | TBD                 | ABLOBY  |      |          |          |                      |                  |                               |
| Coolant In       | °C           |                                   | TBD                 | ACOLIN  |      |          |          |                      |                  |                               |
| Intake Air       | °C           |                                   | TBD                 | AINAIRT |      |          |          |                      |                  |                               |
| Pre-Turbine      | °C           |                                   | TBD                 | APTURT  |      |          |          |                      |                  |                               |
| Tailpipe         | °C           |                                   | TBD                 | ATAILPT |      |          |          |                      |                  |                               |
| Fuel             | kPa          |                                   | TBD                 | AFPMP   |      |          |          |                      |                  |                               |
| Oil Gallery      | kPa          |                                   | TBD                 | AOILPRS |      |          |          |                      |                  |                               |
| Coolant          | kPa          |                                   | 99 - 107            | ACOLOUP |      |          |          |                      |                  |                               |
| Intake Manifold  | kPa          |                                   | TBD                 | AINMANP |      |          |          |                      |                  |                               |
| Crankcase        | kPa          |                                   | TBD                 | ACCASEP |      |          |          |                      |                  |                               |
| Intake Air       | kPa          |                                   | TBD                 | AINAIRR |      |          |          |                      |                  |                               |

<sup>A</sup> QI values above the threshold are acceptable by the Cummins Surveillance Panel. QI values below the threshold may not be considered acceptable based on an engineering review. See the comments section of this report.

<sup>B</sup> Total number of data points taken

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

<sup>D</sup> Number of points clipped by over/under range limits

<sup>E</sup> Typical values determined from reference oil test database

**ISM Lubricant Performance Test  
Form 6  
Crosshead Mass Loss Summary**

|                           |                  |                       |
|---------------------------|------------------|-----------------------|
| Laboratory: LAB           | EOT Date: DTCOMP | EOT Time: EOTTIME     |
| <b>Test Number</b>        |                  |                       |
| Stand: STAND              | Engine: ENGINE   | Engine Run No.: ENRUN |
| Formulation / Stand Code: |                  | FORM                  |
| Oil Code:                 |                  | OILCODE               |

| Location | Serial No. | Pretest Mass (g) | EOT Mass (g) | Mass Loss (mg) |
|----------|------------|------------------|--------------|----------------|
| 1E       | CHDSN1E    | CHDPTW1E         | CHDEW1E      | CHDEWL1E       |
| 1I       | CHDSN1I    | CHDPTW1I         | CHDEW1I      | CHDEWL1I       |
| 2I       | CHDSN2I    | CHDPTW2I         | CHDEW2I      | CHDEWL2I       |
| 2E       | CHDSN2E    | CHDPTW2E         | CHDEW2E      | CHDEWL2E       |
| 3E       | CHDSN3E    | CHDPTW3E         | CHDEW3E      | CHDEWL3E       |
| 3I       | CHDSN3I    | CHDPTW3I         | CHDEW3I      | CHDEWL3I       |
| 4I       | CHDSN4I    | CHDPTW4I         | CHDEW4I      | CHDEWL4I       |
| 4E       | CHDSN4E    | CHDPTW4E         | CHDEW4E      | CHDEWL4E       |
| 5E       | CHDSN5E    | CHDPTW5E         | CHDEW5E      | CHDEWL5E       |
| 5I       | CHDSN5I    | CHDPTW5I         | CHDEW5I      | CHDEWL5I       |
| 6I       | CHDSN6I    | CHDPTW6I         | CHDEW6I      | CHDEWL6I       |
| 6E       | CHDSN6E    | CHDPTW6E         | CHDEW6E      | CHDEWL6E       |

| Intake / Exhaust Summary                  | Intake      |                  | Exhaust     |                  |
|---|-------------|------------------|-------------|------------------|
|   | As Measured | Outlier Screened | As Measured | Outlier Screened |
| Average Crosshead Mass Loss (mg)          | ACHDWLI     | OACHDWLI         | ACHDWLE     | OACHDWLE         |
| Minimum Crosshead Mass Loss (mg)          | ICHDWLI     | OICHDWLI         | ICHDWLE     | OICHDWLE         |
| Maximum Crosshead Mass Loss (mg)          | XCHDWLI     | OXCHDWLI         | XCHDWLE     | OXCHDWLE         |
| Standard Deviation (mg)                   | SCHDWLI     | OSCHDWLI         | SCHDWLE     | OSCHDWLE         |
| Outlier Crossheads Locations <sup>4</sup> | CHDOUTI     |                  | CHDOUTE     |                  |

<sup>4</sup> Location Designation. Example: 3E

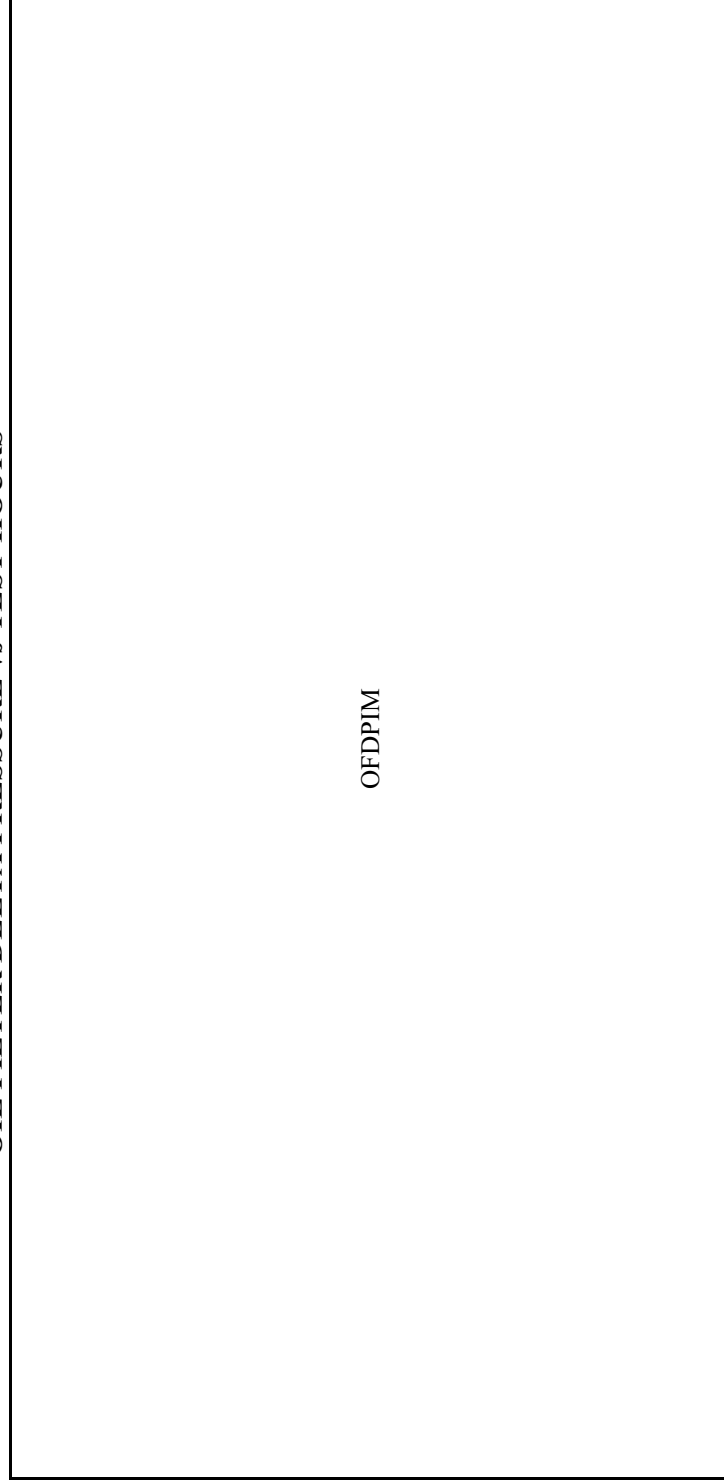
| Overall Summary                  | As Measured | Outlier Screened | Adjusted to x.x% Soot |
|----------------------------------|-------------|------------------|-----------------------|
| Average Crosshead Mass Loss (mg) | AMACAWL     | CAWL             | ACWL                  |
| Minimum Crosshead Mass Loss (mg) | AMICAWL     | ICHDEWL          |                       |
| Maximum Crosshead Mass Loss (mg) | AMXCAWL     | XCHDEWL          |                       |
| Standard Deviation (mg)          | AMSCAWL     | SCHDEWL          |                       |

**ISM Lubricant Performance Test  
Form 7**

**Oil Filter Delta Pressure Plot**

|                                |       |           |        |                 |         |
|--------------------------------|-------|-----------|--------|-----------------|---------|
| Laboratory:                    | LAB   | EOT Date: | DTCOMP | EOT Time:       | EOTTIME |
| <b>Test Number</b>             |       |           |        |                 |         |
| Stand:                         | STAND | Engine:   | ENGINE | Engine Run No.: | ENRUN   |
| Formulation / Stand Code: FORM |       |           |        |                 |         |
| Oil code: OILCODE              |       |           |        |                 |         |

**OIL FILTER DELTA PRESSURE vs TEST HOURS**



**OIL FILTER DELTA P (kPa)**

OFDPIM

**TEST HOURS**

**ISM Lubricant Performance Test  
Form 8  
Sludge Rating Summary**

|                           |                  |                       |
|---------------------------|------------------|-----------------------|
| Laboratory: LAB           | EOT Date: DTCOMP | EOT Time: EOTTIME     |
| <b>Test Number</b>        |                  |                       |
| Stand: STAND              | Engine: ENGINE   | Engine Run No.: ENRUN |
| Formulation / Stand Code: |                  | FORM                  |
| Oil Code:                 |                  | OILCODE               |

**Sludge Rating Summary**

| Sludge Depth | Valve Cover<br>% of Area | Valve Cover<br>Volume Factor | Oil Pan<br>% of Area          | Oil Pan<br>Volume Factor |
|--------------|--------------------------|------------------------------|-------------------------------|--------------------------|
| 1/4A         | RCSEA01                  | RCSEV01                      | OILPSA01                      | OILPSV01                 |
| 1/2A         | RCSEA02                  | RCSEV02                      | OILPSA02                      | OILPSV02                 |
| 3/4A         | RCSEA03                  | RCSEV03                      | OILPSA03                      | OILPSV03                 |
| A            | RCSEA04                  | RCSEV04                      | OILPSA04                      | OILPSV04                 |
| AB           | RCSEA05                  | RCSEV05                      | OILPSA05                      | OILPSV05                 |
| B            | RCSEA06                  | RCSEV06                      | OILPSA06                      | OILPSV06                 |
| BC           | RCSEA07                  | RCSEV07                      | OILPSA07                      | OILPSV07                 |
| C            | RCSEA08                  | RCSEV08                      | OILPSA08                      | OILPSV08                 |
| D            | RCSEA09                  | RCSEV09                      | OILPSA09                      | OILPSV09                 |
| E            | RCSEA10                  | RCSEV10                      | OILPSA10                      | OILPSV10                 |
| F            | RCSEA11                  | RCSEV11                      | OILPSA11                      | OILPSV11                 |
| G            | RCSEA12                  | RCSEV12                      | OILPSA12                      | OILPSV12                 |
| H            | RCSEA13                  | RCSEV13                      | OILPSA13                      | OILPSV13                 |
| I            | RCSEA14                  | RCSEV14                      | OILPSA14                      | OILPSV14                 |
| J            | RCSEA15                  | RCSEV15                      | OILPSA15                      | OILPSV15                 |
|              | Total Volume Factor:     | RCSEVT                       | Total Volume Factor:          | OILPSVT                  |
|              | Merit Rating:            | RCSEMRT                      | Merit Rating:                 | OILPSMRT                 |
|              |                          |                              | <b>Average Sludge Rating:</b> | ASRT                     |



**ISM Lubricant Performance Test  
Form 9  
Rod Bearing Mass Loss**

|                           |       |           |         |                 |         |
|---------------------------|-------|-----------|---------|-----------------|---------|
| Laboratory:               | LAB   | EOT Date: | DTCOMP  | EOT Time:       | EOTTIME |
| <b>Test Number</b>        |       |           |         |                 |         |
| Stand:                    | STAND | Engine    | ENGINE  | Engine Run No.: | ENRUN   |
| Formulation / Stand Code: |       |           | FORM    |                 |         |
| Oil Code:                 |       |           | OILCODE |                 |         |

| Cylinder Number | Bearing Location | Pretest Mass (g) | Post-Test Mass (g) | Mass Loss (mg) |
|-----------------|------------------|------------------|--------------------|----------------|
| 1               | Upper            | BWCYL1TP         | BWCYL1TE           | BWL1T          |
|                 | Lower            | BWCYL1BP         | BWCYL1BE           | BWL1B          |
| 2               | Upper            | BWCYL2TP         | BWCYL2TE           | BWL2T          |
|                 | Lower            | BWCYL2BP         | BWCYL2BE           | BWL2B          |
| 3               | Upper            | BWCYL3TP         | BWCYL3TE           | BWL3T          |
|                 | Lower            | BWCYL3BP         | BWCYL3BE           | BWL3B          |
| 4               | Upper            | BWCYL4TP         | BWCYL4TE           | BWL4T          |
|                 | Lower            | BWCYL4BP         | BWCYL4BE           | BWL4B          |
| 5               | Upper            | BWCYL5TP         | BWCYL5TE           | BWL5T          |
|                 | Lower            | BWCYL5BP         | BWCYL5BE           | BWL5B          |
| 6               | Upper            | BWCYL6TP         | BWCYL6TE           | BWL6T          |
|                 | Lower            | BWCYL6BP         | BWCYL6BE           | BWL6B          |

|                         | Bearing Mass Loss |
|-------------------------|-------------------|
| Average (mg)            | ASBWL             |
| Minimum (mg)            | ISBWL             |
| Maximum (mg)            | XSBWL             |
| Standard Deviation (mg) | SSBWL             |

**ISM Lubricant Performance Test  
Form 10  
Ring Mass Loss Summary**

|                           |         |           |        |                 |         |
|---------------------------|---------|-----------|--------|-----------------|---------|
| Laboratory:               | LAB     | EOT Date: | DTCOMP | EOT Time:       | EOTTIME |
| <b>Test Number</b>        |         |           |        |                 |         |
| Stand:                    | STAND   | Engine:   | ENGINE | Engine Run No.: | ENRUN   |
| Formulation / Stand Code: | FORM    |           |        |                 |         |
| Oil Code:                 | OILCODE |           |        |                 |         |

| Cylinder                                  | Top Ring |          |                | Second Ring |          |                | Oil Ring |          |                |
|---|----------|----------|----------------|-------------|----------|----------------|----------|----------|----------------|
|   | Mass (g) |          | Mass Loss (mg) | Mass (g)    |          | Mass Loss (mg) | Mass (g) |          | Mass Loss (mg) |
|   | Pretest  | EOT      |                | Pretest     | EOT      |                | Pretest  | EOT      |                |
| <b>1</b>                                  | RWCYL1PT | RWCYL1ET | RWLCYL1T       | RWCYL1PS    | RWCYL1ES | RWLCYL1S       | RWCYL1PO | RWCYL1EO | RWLCYL1O       |
| <b>2</b>                                  | RWCYL2PT | RWCYL2ET | RWLCYL2T       | RWCYL2PS    | RWCYL2ES | RWLCYL2S       | RWCYL2PO | RWCYL2EO | RWLCYL2O       |
| <b>3</b>                                  | RWCYL3PT | RWCYL3ET | RWLCYL3T       | RWCYL3PS    | RWCYL3ES | RWLCYL3S       | RWCYL3PO | RWCYL3EO | RWLCYL3O       |
| <b>4</b>                                  | RWCYL4PT | RWCYL4ET | RWLCYL4T       | RWCYL4PS    | RWCYL4ES | RWLCYL4S       | RWCYL4PO | RWCYL4EO | RWLCYL4O       |
| <b>5</b>                                  | RWCYL5PT | RWCYL5ET | RWLCYL5T       | RWCYL5PS    | RWCYL5ES | RWLCYL5S       | RWCYL5PO | RWCYL5EO | RWLCYL5O       |
| <b>6</b>                                  | RWCYL6PT | RWCYL6ET | RWLCYL6T       | RWCYL6PS    | RWCYL6ES | RWLCYL6S       | RWCYL6PO | RWCYL6EO | RWLCYL6O       |
| <b>As Measured Results</b>                |          |          |                |             |          |                |          |          |                |
| <b>Average Mass Loss (mg)</b>             |          |          | AMARWLT        |             |          | ARWLS          |          |          | ARWLO          |
| <b>Std. Dev. Mass Loss (mg)</b>           |          |          | SRWLT          |             |          | SRWLS          |          |          | SRWLO          |
| <b>Maximum Mass Loss (mg)</b>             |          |          | XRWLT          |             |          | XRWLS          |          |          | XRWLO          |
| <b>Minimum Mass Loss (mg)</b>             |          |          | IRWLT          |             |          | IRWLS          |          |          | IRWLO          |
| <b>Outlier Top Ring (cylinder number)</b> |          |          | RINGOUT        |             |          |                |          |          |                |
| <b>Outlier Screened Results</b>           |          |          |                |             |          |                |          |          |                |
| <b>Average Mass Loss (mg)</b>             |          |          | ARWLT          |             |          |                |          |          |                |

**ISM Lubricant Performance Test  
Form 11  
Oil Analysis Summary**

|                                |       |           |        |                 |         |
|--------------------------------|-------|-----------|--------|-----------------|---------|
| Laboratory:                    | LAB   | EOT Date: | DTCOMP | EOT Time:       | EOTTIME |
| <b>Test Number</b>             |       |           |        |                 |         |
| Stand:                         | STAND | Engine:   | ENGINE | Engine Run No.: | ENRUN   |
| Formulation / Stand Code: FORM |       |           |        |                 |         |
| Oil Code: OILCODE              |       |           |        |                 |         |

| Test Hours | Viscosity @<br>100°C, cSt | TGA % Soot | TBN<br>D4739 | TAN<br>D664 | Copper<br>(ppm) | Iron<br>(ppm) | Lead<br>(ppm) | Aluminum<br>(ppm) | Chromium<br>(ppm) |
|------------|---------------------------|------------|--------------|-------------|-----------------|---------------|---------------|-------------------|-------------------|
| NEW        | V100NEW                   | TGANEW     | TBNNEW       | TANNEW      | CUWMNEW         | FEWMNEW       | PBWNEW        | ALWNEW            | CRWNEW            |
| TST_H025   | V100H025                  | TGA_H025   | TBN_H025     | TAN_H025    | CUWMH025        | FEWMH025      | PBWMH025      | ALWMH025          | CRWMH025          |
| TST_H050   | V100H050                  | TGA050     | TBN_H050     | TAN_H050    | CUWMH050        | FEWMH050      | PBWMH050      | ALWMH050          | CRWMH050          |
| TST_H075   | V100H075                  | TGA_H075   | TBN_H075     | TAN_H075    | CUWMH075        | FEWMH075      | PBWMH075      | ALWMH075          | CRWMH075          |
| TST_H100   | V100H100                  | TGA_H100   | TBN_H100     | TAN_H100    | CUWMH100        | FEWMH100      | PBWMH100      | ALWMH100          | CRWMH100          |
| TST_H125   | V100H125                  | TGA_H125   | TBN_H125     | TAN_H125    | CUWMH125        | FEWMH125      | PBWMH125      | ALWMH125          | CRWMH125          |
| TST_H150   | V100H150                  | TGA150     | TBN_H150     | TAN_H150    | CUWMH150        | FEWMH150      | PBWMH150      | ALWMH150          | CRWMH150          |
| TST_H175   | V100H175                  | TGA_H175   | TBN_H175     | TAN_H175    | CUWMH175        | FEWMH175      | PBWMH175      | ALWMH175          | CRWMH175          |
| TST_H200   | V100H200                  | TGA_H200   | TBN_H200     | TAN_H200    | CUWMH200        | FEWMH200      | PBWMH200      | ALWMH200          | CRWMH200          |

**ISM Lubricant Performance Test  
Form 12  
Test Fuel Analysis (Last Batch)**

|                           |       |           |         |                 |         |
|---------------------------|-------|-----------|---------|-----------------|---------|
| Laboratory:               | LAB   | EOT Date: | DTCOMP  | EOT Time:       | EOTTIME |
| <b>Test Number</b>        |       |           |         |                 |         |
| Stand:                    | STAND | Engine:   | ENGINE  | Engine Run No.: | ENRUN   |
| Formulation / Stand Code: |       |           | FORM    |                 |         |
| Oil Code:                 |       |           | OILCODE |                 |         |

|                      |                              |
|----------------------|------------------------------|
| <b>Fuel Supplier</b> | <b>Fuel Batch Identifier</b> |
| FUELSUP              | FUELBTID                     |

| Measurement                       | Specifications | Analysis |          | Test Method            |
|-----------------------------------|----------------|----------|----------|------------------------|
|                                   |                | New      | EOT      |                        |
| Total Sulfur, % Weight            | 0.04 - 0.05    | FUELSNEW | FUELSEOT | D 2662                 |
| Gravity, °API                     | 34.5 - 36.5    | APIGRNEW | APIGREOT | D 1298                 |
| <b>Hydrocarbon Composition</b>    |                |          |          |                        |
| Aromatics % Volume                | 28 – 33        | FUELAROM |          | D 1319                 |
| Olefin                            | Report         | FUELOLEF |          | D 1319                 |
| Cetane Index                      | Report         | CETANEIN |          | D 4737                 |
| Cetane Number                     | 42 – 48        | CETANENO |          | D 613                  |
| Copper Strip Corrosion            | 1 Maximum      | FUELUCU  |          | D 130                  |
| Flash Point, °C                   | 54 Maximum     | FLASHPT  |          | D 93                   |
| Pour Point, °C                    | -18 Maximum    | FUELPOUR |          | D 97                   |
| Carbon Residue on 10% Residuum, % | 0.35 Maximum   | FUELGRES |          | D 524<br>(10% Bottoms) |
| Water & Sediment, % Volume        | 0.05 Maximum   | FUELH2O  |          | D 2709                 |
| Viscosity, cSt @ 40 °C            | 2.4 - 3.0      | KINVIS   |          | D 445                  |
| Total Acid Number                 | 0.05 Maximum   | FUELTAN  |          | D 664                  |
| Strong Acid Number                | 0.00 Maximum   | FUELSAN  |          | D 664                  |
| Accelerated Stability             | Tbd            | FUELACS  |          | D 2274                 |
| Saturates, %                      | Report         | FUELSATU |          | D 1319                 |
| Cloud Point, °C                   | Report         | FUELCLOU |          | D 2500                 |
| <b>Distillation, °C</b>           |                |          |          |                        |
| IBP                               | Report         | FUELIBP  |          | D 86                   |
| 10%                               | Report         | FUEL10   |          | D 86                   |
| 50%                               | Report         | FUEL50   |          | D 86                   |
| 90%                               | 282 – 338      | FUEL90   |          | D 86                   |
| EP                                | Report         | FUELEP   |          | D 86                   |

**ISM Lubricant Performance Test  
Form 13  
Injector Adjusting Screw Mass Loss**

|                           |       |           |         |                 |         |
|---------------------------|-------|-----------|---------|-----------------|---------|
| Laboratory:               | LAB   | EOT Date: | DTCOMP  | EOT Time:       | EOTTIME |
| <b>Test Number</b>        |       |           |         |                 |         |
| Stand:                    | STAND | Engine:   | ENGINE  | Engine Run No.: | ENRUN   |
| Formulation / Stand Code: |       |           | FORM    |                 |         |
| Oil Code:                 |       |           | OILCODE |                 |         |

| Screw #        | Pretest Mass, g | Post-Test Mass, g | Mass Loss, mg |
|----------------|-----------------|-------------------|---------------|
| <b>1</b>       | BOTIAS1         | EOTIAS1           | IASWL1        |
| <b>2</b>       | BOTIAS2         | EOTIAS2           | IASWL2        |
| <b>3</b>       | BOTIAS3         | EOTIAS3           | IASWL3        |
| <b>4</b>       | BOTIAS4         | EOTIAS4           | IASWL4        |
| <b>5</b>       | BOTIAS5         | EOTIAS5           | IASWL5        |
| <b>6</b>       | BOTIAS6         | EOTIAS6           | IASWL6        |
| <b>Total</b>   |                 |                   | IASWLTOT      |
| <b>Average</b> |                 |                   | AVGIAS        |

**ISM Lubricant Performance Test  
Form 14  
Unscheduled Downtime & Maintenance Summary**

|                           |                  |                       |
|---------------------------|------------------|-----------------------|
| Laboratory: LAB           | EOT Date: DTCOMP | EOT Time: EOTTIME     |
| <b>Test Number</b>        |                  |                       |
| Stand: STAND              | Engine: ENGINE   | Engine Run No.: ENRUN |
| Formulation / Stand Code: |                  | FORM                  |
| Oil Code:                 |                  | OILCODE               |

| Number of Downtime Occurrences |          |          | DWNOCR                 |
|--------------------------------|----------|----------|------------------------|
| Test Hours                     | Date     | Downtime | 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               |
| <b>TOTLDOWN</b>                |          |          | Total Downtime (hours) |

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

**ISM Lubricant Performance Test  
Form 14a  
Unscheduled Downtime & Maintenance Summary**

|                           |                  |                       |
|---------------------------|------------------|-----------------------|
| Laboratory: LAB           | EOT Date: DTCOMP | EOT Time: EOTTIME     |
| <b>Test Number</b>        |                  |                       |
| Stand: STAND              | Engine: ENGINE   | Engine Run No.: ENRUN |
| Formulation / Stand Code: |                  | FORM                  |
| Oil Code:                 |                  | OILCODE               |

| Number of Downtime Occurrences |          |          | DWNOCR                 |
|--------------------------------|----------|----------|------------------------|
| Test Hours                     | Date     | Downtime | 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               |
| TOTLDOWN                       |          |          | Total Downtime (hours) |

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

**ISM Lubricant Performance Test  
Form 14b  
Unscheduled Downtime & Maintenance Summary**

|                           |                  |                       |
|---------------------------|------------------|-----------------------|
| Laboratory: LAB           | EOT Date: DTCOMP | EOT Time: EOTIME      |
| <b>Test Number</b>        |                  |                       |
| Stand: STAND              | Engine: ENGINE   | Engine Run No.: ENRUN |
| Formulation / Stand Code: |                  | FORM                  |
| Oil Code:                 |                  | OILCODE               |

| Number of Downtime Occurrences |          |          | DWNOCR                 |
|--------------------------------|----------|----------|------------------------|
| Test Hours                     | Date     | Downtime | 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               |
| <b>TOTLDOWN</b>                |          |          | Total Downtime (hours) |

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



**ISM Lubricant Performance Test  
Form 15  
Characteristics Of The Data Acquisition System**

|                           |       |           |         |                 |         |
|---------------------------|-------|-----------|---------|-----------------|---------|
| Laboratory:               | LAB   | EOT Date: | DTCOMP  | EOT Time:       | EOTTIME |
| <b>Test Number</b>        |       |           |         |                 |         |
| Stand:                    | STAND | Engine:   | ENGINE  | Engine Run No.: | ENRUN   |
| Formulation / Stand Code: |       |           | FORM    |                 |         |
| Oil Code:                 |       |           | OILCODE |                 |         |

| Parameter<br>(1)    | Sensing Device<br>(2) | Calibration Frequency<br>(3) | Record Device<br>(4) | Observation Frequency<br>(5) | Record Frequency<br>(6) | Log Frequency<br>(7) | System Response<br>(8) |
|---------------------|-----------------------|------------------------------|----------------------|------------------------------|-------------------------|----------------------|------------------------|
| <b>Temperatures</b> |                       |                              |                      |                              |                         |                      |                        |
| Oil @ Filt.         | OTEMSENS              | OTEMCALF                     | OTEMRECD             | OTEMOBSF                     | OTEMRECF                | OTEMLOGF             | OTEMSYSR               |
| Fuel In.            | FTEMSSENS             | FTEMCALF                     | FTEMRECD             | FTEMOBSF                     | FTEMRECF                | FTEMLOGF             | FTEMSYSR               |
| Intake Air          | AITSENS               | AITCALF                      | AITRECD              | AITOBSF                      | AITRECF                 | AITLOGF              | AITSYSR                |
| Intake Man.         | IMANSENS              | IMANCALF                     | IMANRECD             | IMANOBSF                     | IMANRECF                | IMANLOGF             | IMANSYSR               |
| Pre-Turb.           | PTURSENS              | PTURCALF                     | PTURRECD             | PTUROBSF                     | PTURRECF                | PTURLOGF             | PTURSYSR               |
| Cool. Out           | COTSENS               | COTCALF                      | COTRECD              | COTOBSF                      | COTRECF                 | COTLOGF              | COTSYSR                |
| <b>Pressure</b>     |                       |                              |                      |                              |                         |                      |                        |
| Inlet Air           | INRESENS              | INRECALF                     | INRERECD             | INREOBSF                     | INRERECF                | INRELOGF             | INRESYSR               |
| Exhaust             | EXPRSENS              | EXPRCALF                     | EXPRECD              | EXPROBSF                     | EXPRECF                 | EXPRLOGF             | EXPRSYSR               |
| Oil Gallery         | OILGSENS              | OILGCALF                     | OILGRECD             | OILGOBSF                     | OILGRECF                | OILGLOGF             | OILGSYSR               |
| <b>Other</b>        |                       |                              |                      |                              |                         |                      |                        |
| Fuel Flow           | FFLOSENS              | FFLOCALF                     | FFLORECD             | FFLOOBSF                     | FFLORECF                | FFLOLOGF             | FFLOSYSR               |
| Speed               | RPMSSENS              | RPMCALF                      | RPMRECD              | RPMOBSF                      | RPMRECF                 | RPMLOGF              | RPMSYSR                |
| Load                | LOADSENS              | LOADCALF                     | LOADRECD             | LOADOBSF                     | LOADRECF                | LOADLOGF             | LOADSYSR               |

**Legend:**

- (1) Operating Parameter
- (2) The type of device used to measure temperature, pressure, or flow
- (3) Frequency at which the measurement system is calibrated
- (4) The type of device where data is recorded  
DL – Automatic data logger  
C/D – Computer, using direct I/O entry
- (5) Data are observed but only recorded if off spec.
- (6) Data are recorded but are not retained at EOT
- (7) Data are logged as permanent record, note specify if:  
SS – snapshot taken at specified frequency  
AG/X – Average of X data points at specified frequency
- (8) Time for the output to reach 63.2% of final value for step change at input

**ISM Lubricant Performance Test  
Form 16  
Valve Adjusting Screw Mass Loss Summary**

|                           |       |           |        |                 |         |
|---------------------------|-------|-----------|--------|-----------------|---------|
| Laboratory:               | LAB   | EOT Date: | DTCOMP | EOT Time:       | EOTTIME |
| <b>Test Number</b>        |       |           |        |                 |         |
| Stand:                    | STAND | Engine:   | ENGINE | Engine Run No.: | ENRUN   |
| Formulation / Stand Code: |       |           | FORM   |                 |         |
| Oil Code:                 |       | OILCODE   |        |                 |         |

| Location | Pretest Mass (g) | EOT Mass (g) | Mass Loss (mg) |
|----------|------------------|--------------|----------------|
| 1E       | VASPTW1E         | VASEW1E      | VASEWL1E       |
| 1I       | VASPTW1I         | VASEW1I      | VASEWL1I       |
| 2I       | VASPTW2I         | VASEW2I      | VASEWL2I       |
| 2E       | VASPTW2E         | VASEW2E      | VASEWL2E       |
| 3E       | VASPTW3E         | VASEW3E      | VASEWL3E       |
| 3I       | VASPTW3I         | VASEW3I      | VASEWL3I       |
| 4I       | VASPTW4I         | VASEW4I      | VASEWL4I       |
| 4E       | VASPTW4E         | VASEW4E      | VASEWL4E       |
| 5E       | VASPTW5E         | VASEW5E      | VASEWL5E       |
| 5I       | VASPTW5I         | VASEW5I      | VASEWL5I       |
| 6I       | VASPTW6I         | VASEW6I      | VASEWL6I       |
| 6E       | VASPTW6E         | VASEW6E      | VASEWL6E       |

| Intake / Exhaust Summary       | Intake      |                  | Exhaust     |                  |
|--------------------------------|-------------|------------------|-------------|------------------|
|                                | As Measured | Outlier Screened | As Measured | Outlier Screened |
| Average Mass Loss (mg)         | AVASWLI     | OAVASWLI         | AVASWLE     | OAVASWLE         |
| Minimum Mass Loss (mg)         | IVASWLI     | OIVASWLI         | IVASWLE     | OIVASWLE         |
| Maximum Mass Loss (mg)         | XVASWLI     | OXVASWLI         | XVASWLE     | OXVASWLE         |
| Standard Deviation (mg)        | SVASWLI     | OSVASWLI         | SVASWLE     | OSVASWLE         |
| Outlier Locations <sup>A</sup> | VASOUTI     |                  | VASOUTE     |                  |

<sup>A</sup> Location Designation. Example: 3E

| Overall Summary         | As Measured | Outlier Screened | Adjusted to x.x% Soot |
|-------------------------|-------------|------------------|-----------------------|
| Average Mass Loss (mg)  | AMAVSWL     | OVSWL            | VSWL                  |
| Minimum Mass Loss (mg)  | AMIVSWL     | IVASWL           |                       |
| Maximum Mass Loss (mg)  | AMXVSWL     | XVASWL           |                       |
| Standard Deviation (mg) | AMSVSWL     | SVASWL           |                       |