

A5. Report Forms  
**M11 EGR**  
**LUBRICANT PERFORMANCE TEST**

**VERSION** 20010328 BETA

**METHOD**

CONDUCTED FOR:

|  |  |
|--|--|
|  | 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   |
|  | N = NOT INTERPRETABLE; THE NON-REFERENCE OIL RESULTS CANNOT BE INTERPRETED AND SHALL NOT BE USED FOR MULTIPLE TEST ACCEPTANCE. |

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

|                         |             |                   |
|-------------------------|-------------|-------------------|
| STAND:                  | ENGINE NO.: | ENGINE RUN NO.:   |
| END OF TEST DATE:       |             | END OF TEST TIME: |
| OIL CODE:               |             |                   |
| FORMULATION/STAND CODE: |             |                   |
| ALTCODE1:               | ALTCODE2:   | ALTCODE3:         |

In my opinion \_\_\_\_\_ been conducted in a valid manner in accordance with the Test and the appropriate amendments through the information letter system. The remarks included in this report describe \_\_\_\_\_

SUBMITTED BY: \_\_\_\_\_

Testing Laboratory

Signature

Typed Name

Typed Name

**M11 EGR LUBRICANT PERFORMANCE TEST  
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**M11 EGR LUBRICANT PERFORMANCE TEST  
FORM 3  
SUMMARY OF TEST METHOD**

The M11 EGR Lubricant Performance Test is a fired engine-dynamometer test which evaluates the ability of a lubricant to minimize crosshead wear, filter plugging, and sludge build-up. This test is a two stage, steady state test (constant speed and load). Stage A is 50 h and is run with retarded fuel injection timing to produce elevated soot levels in the oil. Stage B is 50 h and is run under heavy load conditions to induce wear. The stages are run in sequence (Stage A followed by Stage B) three times for a total test length of 300 h.

The test engine is a Cummins M11 diesel engine with EGR. It is an in-line six cylinder, four stroke, turbocharged engine with

M11 EGR TEST CONDITIONS

| Parameter                     | Stage A     | Stage B     |
|-------------------------------|-------------|-------------|
| Time, h                       | 50          | 50          |
| Injection Timing, °BTDC       | 16 min      | 32          |
| Speed, r/min                  | 1800        | 1600        |
| Fuel Flow, kg/h               | 58.0        | 64.4        |
| EGR Rate, %                   | Record      | 8.5 - 9.8   |
| 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      | Record      | Record      |
| Intake Manifold Pressure, kPa | 300 Minimum | 320 Minimum |
| Exhaust Back Pressure, kPa    | 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      |

**M11 EGR LUBRICANT PERFORMANCE TEST**  
**Test Results Summary**  
**Form 4**

|                   |            |            |
|-------------------|------------|------------|
| Laborator         | EOT Date:  | EOT Time:  |
| Stand:            | Engine     | Engine Run |
| Formulation/Stand |            |            |
| Oil               | Engine Kit |            |

|   |  |                                     |                                      |
|---|--|-------------------------------------|--------------------------------------|
| DATE TEST STARTED                         |  |                                     |                                      |
| START TIME                                |  |                                     |                                      |
| TEST LENGTH                               |  |                                     |                                      |
| TMC OIL CODE <sup>A</sup>                 |  |                                     |                                      |
| LABORATORY OIL CODE                       |  |                                     |                                      |
| SAE VISCOSITY                             |  |                                     |                                      |
| TGA SOOT % AT 50 h (2.8 minimum)          |  |                                     |                                      |
| TGA SOOT % AT 250 h (8.0 - 9.5)           |  |                                     |                                      |
| TOTAL OIL CONSUMPTION, kg                 |  |                                     |                                      |
|   | Adjusted Average<br>Crosshead Mass<br>Loss | Filter Plugging<br>Delta P<br>(kPa) | Average Sludge<br>Rating<br>(merits) |
| Original Result                           |  |                                     |                                      |
| Transformed Result <sup>B</sup>           |  |                                     |                                      |
| Correction Factor <sup>B</sup>            |  |                                     |                                      |
| Corrected Transformed Result <sup>B</sup> |  |                                     |                                      |
| Severity Adjustment <sup>B</sup>          |  |                                     |                                      |
| Final Transformed Result <sup>B</sup>     |  |                                     |                                      |
| Final Result                              |  |                                     |                                      |

**LAST STAND REFERENCE RESULTS**

|   |  |                                     |                                      |
|---|--|-------------------------------------|--------------------------------------|
| TEST NUMBER:                              |  |                                     |                                      |
| OILCODE                                   |  |                                     |                                      |
| TEST LENGTH                               |  |                                     |                                      |
| TMC OIL CODE                              |  |                                     |                                      |
| EOT DATE                                  |  |                                     |                                      |
| EOT TIME                                  |  |                                     |                                      |
| STAND CALIBRATION EXPIRATION DATE         |  |                                     |                                      |
| TGA SOOT % AT 50 h (2.8 minimum)          |  |                                     |                                      |
| TGA SOOT % AT 250 h (8.5 - 9.5)           |  |                                     |                                      |
| TOTAL OIL CONSUMPTION, kg                 |  |                                     |                                      |
|   | Adjusted Average<br>Crosshead Mass<br>Loss | Filter Plugging<br>Delta P<br>(kPa) | Average Sludge<br>Rating<br>(merits) |
| Original Result                           |  |                                     |                                      |
| Transformed Result <sup>B</sup>           |  |                                     |                                      |
| Correction Factor <sup>B</sup>            |  |                                     |                                      |
| Corrected Transformed Result <sup>B</sup> |  |                                     |                                      |
| Final Transformed Result <sup>B</sup>     |  |                                     |                                      |
| Final Result                              |  |                                     |                                      |

<sup>A</sup>Reference Tests Only

<sup>B</sup>Transformed Units

**M11 EGR LUBRICANT PERFORMANCE TEST  
FORM 5  
OPERATIONAL SUMMARY**

|                       |          |            |
|-----------------------|----------|------------|
| Laboratory            | EOT Date | EOT Time   |
| Test Number    Stand: | Engine:  | Engine Run |
| Formulation/Stand     |          |            |
| Oil Code:             |          |            |

| Controlled Parameters     | Parameter             | Units | QI Threshold                | EOT <sup>A</sup><br>QI | Target      | Average | Samples <sup>B</sup> | BQD <sup>C</sup> | Over/Under Range <sup>D</sup> |  |
|---------------------------|-----------------------|-------|-----------------------------|------------------------|-------------|---------|----------------------|------------------|-------------------------------|--|
|                           | Speed                 | r/min | 0.000                       |                        | 1800   1600 |         |                      |                  |                               |  |
|                           | Fuel Flow             | kg/h  | 0.000                       |                        | 58.0   64.4 |         |                      |                  |                               |  |
|                           | Coolant Out           | °C    | 0.000                       |                        | 65.5        |         |                      |                  |                               |  |
|                           | Fuel In               | °C    | 0.000                       |                        | 40          |         |                      |                  |                               |  |
|                           | Oil Gallery           | °C    | 0.000                       |                        | 115         |         |                      |                  |                               |  |
|                           | Intake Manifold       | °C    | 0.000                       |                        | 80.0   65.5 |         |                      |                  |                               |  |
|                           | Exhaust               | kPa   | 0.000                       |                        | 107         |         |                      |                  |                               |  |
| Non-controlled Parameters | Parameter             | Units | Typical Values <sup>E</sup> |                        | Average     |         |                      |                  |                               |  |
|                           | Torque                | N-m   | TBD                         | TBD                    |             |         |                      |                  |                               |  |
|                           | Power                 | kW    | TBD                         | TBD                    |             |         |                      |                  |                               |  |
|                           | EGR Rate <sup>F</sup> | %     | Record                      | 8.5 - 9.8              |             |         |                      |                  |                               |  |
|                           | Blowby                | L/min | TBD                         |                        |             |         |                      |                  |                               |  |
|                           | Coolant In            | °C    | TBD                         |                        |             |         |                      |                  |                               |  |
|                           | Intake Air            | °C    | TBD                         |                        |             |         |                      |                  |                               |  |
|                           | Pre-Turbine (F)       | °C    | TBD                         |                        |             |         |                      |                  |                               |  |
|                           | Pre-Turbine (R)       | °C    | TBD                         |                        |             |         |                      |                  |                               |  |
|                           | Tailpipe              | °C    | TBD                         |                        |             |         |                      |                  |                               |  |
|                           | Fuel                  | kPa   | TBD                         |                        |             |         |                      |                  |                               |  |
|                           | Oil Gallery           | kPa   | TBD                         |                        |             |         |                      |                  |                               |  |
|                           | Coolant               | kPa   | 99 - 107                    |                        |             |         |                      |                  |                               |  |
| Intake Manifold           | kPa                   | TBD   |                             |                        |             |         |                      |                  |                               |  |
| Crankcase                 | kPa                   | TBD   |                             |                        |             |         |                      |                  |                               |  |
| Intake Air                | kPa                   | TBD   |                             |                        |             |         |                      |                  |                               |  |

<sup>A</sup> QI values above the threshold are acceptable by the M11 Surveillance Panel. QI values below the threshold may not be considered acceptable based on

<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

<sup>F</sup> Stage B EGR Rate shall be within specified range for test to be operationally valid.

**M11 EGR LUBRICANT PERFORMANCE TEST  
FORM 6  
CROSSHEAD MASS LOSS SUMMARY**

|                         |          |                 |
|-------------------------|----------|-----------------|
| Laborator               | EOT Date | EOT Time        |
| Test Number             |          |                 |
| STAND:                  | ENGINE:  | ENGINE RUN NO.: |
| FORMULATION/STAND CODE: |          |                 |
| OIL CODE:               |          |                 |

| LOCATION | SERIAL NO. | PRETEST MASS (g) | EOT MASS (g) | MASS LOSS (mg) |
|----------|------------|------------------|--------------|----------------|
| 1E       |            |                  |              |                |
| 1I       |            |                  |              |                |
| 2I       |            |                  |              |                |
| 2E       |            |                  |              |                |
| 3E       |            |                  |              |                |
| 3I       |            |                  |              |                |
| 4I       |            |                  |              |                |
| 4E       |            |                  |              |                |
| 5E       |            |                  |              |                |
| 5I       |            |                  |              |                |
| 6I       |            |                  |              |                |
| 6E       |            |                  |              |                |

| INTAKE/EXHAUST SUMMARY                    | INTAKE      |         | EXHAUST     |         |
|---|-------------|---------|-------------|---------|
|   | As Measured | Outlier | As Measured | Outlier |
| Average Crosshead Mass Loss               |             |         |             |         |
| Minimum Crosshead Mass Loss               |             |         |             |         |
| Maximum Crosshead Mass Loss               |             |         |             |         |
| Standard Deviation (mg)                   |             |         |             |         |
| Outlier Crossheads Locations <sup>A</sup> |             |         |             |         |

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

| Overall Summary             | As Measured | Outlier Screened | Adjusted to X.X% |
|-----------------------------|-------------|------------------|------------------|
| Average Crosshead Mass Loss |             |                  |                  |
| Minimum Crosshead Mass Loss |             |                  |                  |
| Maximum Crosshead Mass Loss |             |                  |                  |
| Standard Deviation (mg)     |             |                  |                  |

M11 EGR LUBRICANT PERFORMANCE TEST  
FORM 7  
OIL FILTER DELTA PRESSURE PLOT

|                         |          |                 |
|-------------------------|----------|-----------------|
| Laboratory              | EOT Date | EOT Time        |
| <b>Test Number</b>      |          |                 |
| STAND:                  | ENGINE:  | ENGINE RUN NO.: |
| FORMULATION/STAND CODE: |          |                 |
| OIL CODE:               |          |                 |

OIL FILTER DELTA PRESSURE vs TEST HOURS

OIL FILTER DELTA P (kPa)



TEST HOURS

**M11 EGR LUBRICANT PERFORMANCE TEST  
FORM 8  
SLUDGE RATING SUMMARY**

|                         |           |                 |
|-------------------------|-----------|-----------------|
| Laboratory              | EOT Date: | EOT Time:       |
| TEST NUMBER             |           |                 |
| STAND:                  | ENGINE:   | ENGINE RUN NO.: |
| FORMULATION/STAND CODE: |           |                 |
| OIL CODE:               |           |                 |

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         |                          |                              |                      |                          |
| 1/2A         |                          |                              |                      |                          |
| 3/4A         |                          |                              |                      |                          |
| A            |                          |                              |                      |                          |
| AB           |                          |                              |                      |                          |
| B            |                          |                              |                      |                          |
| BC           |                          |                              |                      |                          |
| C            |                          |                              |                      |                          |
| D            |                          |                              |                      |                          |
| E            |                          |                              |                      |                          |
| F            |                          |                              |                      |                          |
| G            |                          |                              |                      |                          |
| H            |                          |                              |                      |                          |
| I            |                          |                              |                      |                          |
| J            |                          |                              |                      |                          |
|              | Total Volume             |                              | Total Volume         |                          |
|              | MERIT RATING:            |                              | MERIT RATING:        |                          |
|              |                          | Average Sludge Rating:       |                      |                          |



**M11 EGR LUBRICANT PERFORMANCE TEST  
FORM 9  
ROD BEARING MASS LOSS**

|                         |          |                 |
|-------------------------|----------|-----------------|
| Laboratory              | EOT Date | EOT Time        |
| Test Number             |          |                 |
| STAND:                  | ENGINE:  | ENGINE RUN NO.: |
| FORMULATION/STAND CODE: |          |                 |
| OIL CODE:               |          |                 |

| CYLINDER NUMBER | BEARING LOCATION | PRE-TEST MASS (g) | POST-TEST MASS (g) | MASS LOSS (mg) |
|-----------------|------------------|-------------------|--------------------|----------------|
| 1               | UPPER            |                   |                    |                |
|                 | LOWER            |                   |                    |                |
| 2               | UPPER            |                   |                    |                |
|                 | LOWER            |                   |                    |                |
| 3               | UPPER            |                   |                    |                |
|                 | LOWER            |                   |                    |                |
| 4               | UPPER            |                   |                    |                |
|                 | LOWER            |                   |                    |                |
| 5               | UPPER            |                   |                    |                |
|                 | LOWER            |                   |                    |                |
| 6               | UPPER            |                   |                    |                |
|                 | LOWER            |                   |                    |                |

|                         | BEARING MASS LOSS |
|-------------------------|-------------------|
| AVERAGE (mg)            |                   |
| MINIMUM (mg)            |                   |
| MAXIMUM (mg)            |                   |
| STANDARD DEVIATION (mg) |                   |

**M11 EGR LUBRICANT PERFORMANCE TEST  
FORM 10  
PISTON RATING SUMMARY**

|                          |          |                  |
|--------------------------|----------|------------------|
| Laborator                | EOT Date | EOT Time         |
| TEST NUMBER              |          |                  |
| STAND :                  | ENGINE : | ENGINE RUN NO. : |
| FORMULATION/STAND CODE : |          |                  |
| OILCODE :                |          |                  |

| UNWEIGHTED DEMERITS |       |   |   |   |         |   |   |             |                                   |                |  |
|---------------------|-------|---|---|---|---------|---|---|-------------|-----------------------------------|----------------|--|
| PISTON NUMBER       | Lands |   |   |   | Grooves |   |   | Under Crown | Oil Cooling Gallery               | Total Demerits |  |
|                     | 1     | 2 | 3 | 4 | 1       | 2 | 3 |             |                                   |                |  |
| 1                   |       |   |   |   |         |   |   |             |                                   |                |  |
| 2                   |       |   |   |   |         |   |   |             |                                   |                |  |
| 3                   |       |   |   |   |         |   |   |             |                                   |                |  |
| 4                   |       |   |   |   |         |   |   |             |                                   |                |  |
| 5                   |       |   |   |   |         |   |   |             |                                   |                |  |
| 6                   |       |   |   |   |         |   |   |             |                                   |                |  |
| Average Demerits    |       |   |   |   |         |   |   |             |                                   |                |  |
|                     |       |   |   |   |         |   |   |             | Average Total Unweighted Demerits |                |  |

| PARAMETER | PISTON NUMBER |   |   |   |   |   | AVERAGE |
|-----------|---------------|---|---|---|---|---|---------|
|           | 1             | 2 | 3 | 4 | 5 | 6 |         |
| TGC       |               |   |   |   |   |   |         |
| TLC       |               |   |   |   |   |   |         |

M11 EGR LUBRICANT PERFORMANCE TEST

FORM 11

PISTON 1 DEPOSIT RATINGS

|                         |          |                 |
|-------------------------|----------|-----------------|
| Laboratory              | EOT Date | EOT Time        |
| TEST NUMBER             |          |                 |
| STAND:                  | ENGINE:  | ENGINE RUN NO.: |
| FORMULATION/STAND CODE: |          |                 |
| OILCODE:                |          |                 |

| DEP. FACTOR | GROOVES |      |       |      | LANDS |      |       |      | DEP FACTOR      | GROOVES |      |       |      | LANDS |             |      |      | OIL COOLING GALLERY (2) |                      | UNDER CROWN (1) |  |
|-------------|---------|------|-------|------|-------|------|-------|------|-----------------|---------|------|-------|------|-------|-------------|------|------|-------------------------|----------------------|-----------------|--|
|             | NO. 1   |      | NO. 2 |      | NO. 1 |      | NO. 2 |      |                 | NO. 3   |      | NO. 3 |      | NO. 4 |             | A, % | DEM. | A, %                    | DEM.                 |                 |  |
|             | A, %    | DEM. | A, %  | DEM. | A, %  | DEM. | A, %  | DEM. |                 | A, %    | DEM. | A, %  | DEM. | A, %  | DEM.        | A, % | DEM. | A, %                    | DEM.                 |                 |  |
| CARBON      |         |      |       |      |       |      |       |      |                 |         |      |       |      |       |             |      |      |                         |                      |                 |  |
| HC-1.0      |         |      |       |      |       |      |       |      |                 |         |      |       |      |       |             |      |      |                         |                      |                 |  |
| MC-0.5      |         |      |       |      |       |      |       |      |                 |         |      |       |      |       |             |      |      |                         |                      |                 |  |
| LC-.25      |         |      |       |      |       |      |       |      |                 |         |      |       |      |       |             |      |      |                         |                      |                 |  |
| TOTAL       |         |      |       |      |       |      |       |      |                 |         |      |       |      |       |             |      |      |                         |                      |                 |  |
| VARNISH     |         |      |       |      |       |      |       |      |                 |         |      |       |      |       |             |      |      |                         |                      |                 |  |
| 8 - 9       |         |      |       |      |       |      |       |      |                 |         |      |       |      |       |             |      |      |                         |                      |                 |  |
| 7 - 7.9     |         |      |       |      |       |      |       |      | 7.5             |         |      |       |      |       |             |      |      |                         |                      |                 |  |
| 6 - 6.9     |         |      |       |      |       |      |       |      |                 |         |      |       |      |       |             |      |      |                         |                      |                 |  |
| 5 - 5.9     |         |      |       |      |       |      |       |      |                 |         |      |       |      |       |             |      |      |                         |                      |                 |  |
| 4 - 4.9     |         |      |       |      |       |      |       |      | 4.5             |         |      |       |      |       |             |      |      |                         |                      |                 |  |
| 3 - 3.9     |         |      |       |      |       |      |       |      |                 |         |      |       |      |       |             |      |      |                         |                      |                 |  |
| 2 - 2.9     |         |      |       |      |       |      |       |      |                 |         |      |       |      |       |             |      |      |                         |                      |                 |  |
| 1 - 1.9     |         |      |       |      |       |      |       |      | 1.5             |         |      |       |      |       |             |      |      |                         |                      |                 |  |
| > 0 - 0.9   |         |      |       |      |       |      |       |      |                 |         |      |       |      |       |             |      |      |                         |                      |                 |  |
| TOTAL       |         |      |       |      |       |      |       |      |                 |         |      |       |      |       |             |      |      |                         |                      |                 |  |
| Rating      |         |      |       |      |       |      |       |      |                 |         |      |       |      |       |             |      |      |                         |                      |                 |  |
| TGC %       |         |      |       |      |       |      |       |      | UNWEIGHTED DEP. |         |      |       |      |       | T.L. CARBON |      |      |                         | T.L. FLAKED CARBON % |                 |  |

**M11 EGR LUBRICANT PERFORMANCE TEST  
FORM 12  
PISTON 2 DEPOSIT RATINGS**

|                         |          |                 |
|-------------------------|----------|-----------------|
| Laboratory              | EOT Date | EOT Time        |
| TEST NUMBER             |          |                 |
| STAND:                  | ENGINE:  | ENGINE RUN NO.: |
| FORMULATION/STAND CODE: |          |                 |
| OILCODE:                |          |                 |

| DEP.<br>FACTOR | GROOVES |      |       |      | LANDS |      |       |      | DEP<br>FACTOR   | GROOVES     |      |       |      | LANDS                |      |      |      | OIL COOLING<br>GALLERY (2) |      | UNDER<br>CROWN (1) |  |
|----------------|---------|------|-------|------|-------|------|-------|------|-----------------|-------------|------|-------|------|----------------------|------|------|------|----------------------------|------|--------------------|--|
|                | NO. 1   |      | NO. 2 |      | NO. 1 |      | NO. 2 |      |                 | NO. 3       |      | NO. 3 |      | NO. 4                |      | A, % | DEM. | A, %                       | DEM. |                    |  |
|                | A, %    | DEM. | A, %  | DEM. | A, %  | DEM. | A, %  | DEM. |                 | A, %        | DEM. | A, %  | DEM. | A, %                 | DEM. | A, % | DEM. | A, %                       | DEM. |                    |  |
| CARBON         |         |      |       |      |       |      |       |      |                 |             |      |       |      |                      |      |      |      |                            |      |                    |  |
| HC-1.0         |         |      |       |      |       |      |       |      |                 |             |      |       |      |                      |      |      |      |                            |      |                    |  |
| MC-0.5         |         |      |       |      |       |      |       |      |                 |             |      |       |      |                      |      |      |      |                            |      |                    |  |
| LC-.25         |         |      |       |      |       |      |       |      |                 |             |      |       |      |                      |      |      |      |                            |      |                    |  |
| TOTAL          |         |      |       |      |       |      |       |      |                 |             |      |       |      |                      |      |      |      |                            |      |                    |  |
| VARNISH        |         |      |       |      |       |      |       |      |                 |             |      |       |      |                      |      |      |      |                            |      |                    |  |
| 8 - 9          |         |      |       |      |       |      |       |      |                 |             |      |       |      |                      |      |      |      |                            |      |                    |  |
| 7 - 7.9        |         |      |       |      |       |      |       |      | 7.5             |             |      |       |      |                      |      |      |      |                            |      |                    |  |
| 6 - 6.9        |         |      |       |      |       |      |       |      |                 |             |      |       |      |                      |      |      |      |                            |      |                    |  |
| 5 - 5.9        |         |      |       |      |       |      |       |      |                 |             |      |       |      |                      |      |      |      |                            |      |                    |  |
| 4 - 4.9        |         |      |       |      |       |      |       |      | 4.5             |             |      |       |      |                      |      |      |      |                            |      |                    |  |
| 3 - 3.9        |         |      |       |      |       |      |       |      |                 |             |      |       |      |                      |      |      |      |                            |      |                    |  |
| 2 - 2.9        |         |      |       |      |       |      |       |      |                 |             |      |       |      |                      |      |      |      |                            |      |                    |  |
| 1 - 1.9        |         |      |       |      |       |      |       |      | 1.5             |             |      |       |      |                      |      |      |      |                            |      |                    |  |
| >0 - 0.9       |         |      |       |      |       |      |       |      |                 |             |      |       |      |                      |      |      |      |                            |      |                    |  |
| TOTAL          |         |      |       |      |       |      |       |      |                 |             |      |       |      |                      |      |      |      |                            |      |                    |  |
| Rating         |         |      |       |      |       |      |       |      |                 |             |      |       |      |                      |      |      |      |                            |      |                    |  |
| TGC %          |         |      |       |      |       |      |       |      | UNWEIGHTED DEP. | T.L. CARBON |      |       |      | T.L. FLAKED CARBON % |      |      |      |                            |      |                    |  |





**M11 EGR LUBRICANT PERFORMANCE TEST  
FORM 15  
PISTON 5 DEPOSIT RATINGS**

|                         |          |                 |
|-------------------------|----------|-----------------|
| Laboratory              | EOT Date | EOT Time        |
| TEST NUMBER             |          |                 |
| STAND:                  | ENGINE:  | ENGINE RUN NO.: |
| FORMULATION/STAND CODE: |          |                 |
| OILCODE:                |          |                 |

| DEP.<br>FACTOR | GROOVES |      |       |      | LANDS |      |       |      | DEP<br>FACTOR   | GROOVES |      |       |      | LANDS |             |      |      | OIL COOLING<br>GALLERY (2) |                      | UNDER<br>CROWN (1) |  |
|----------------|---------|------|-------|------|-------|------|-------|------|-----------------|---------|------|-------|------|-------|-------------|------|------|----------------------------|----------------------|--------------------|--|
|                | NO. 1   |      | NO. 2 |      | NO. 1 |      | NO. 2 |      |                 | NO. 3   |      | NO. 3 |      | NO. 4 |             | A, % | DEM. | A, %                       | DEM.                 |                    |  |
|                | A, %    | DEM. | A, %  | DEM. | A, %  | DEM. | A, %  | DEM. |                 | A, %    | DEM. | A, %  | DEM. | A, %  | DEM.        | A, % | DEM. | A, %                       | DEM.                 |                    |  |
| CARBON         |         |      |       |      |       |      |       |      |                 |         |      |       |      |       |             |      |      |                            |                      |                    |  |
| HC-1.0         |         |      |       |      |       |      |       |      |                 |         |      |       |      |       |             |      |      |                            |                      |                    |  |
| MC-0.5         |         |      |       |      |       |      |       |      |                 |         |      |       |      |       |             |      |      |                            |                      |                    |  |
| LC-.25         |         |      |       |      |       |      |       |      |                 |         |      |       |      |       |             |      |      |                            |                      |                    |  |
| TOTAL          |         |      |       |      |       |      |       |      |                 |         |      |       |      |       |             |      |      |                            |                      |                    |  |
| VARNISH        |         |      |       |      |       |      |       |      |                 |         |      |       |      |       |             |      |      |                            |                      |                    |  |
| 8 - 9          |         |      |       |      |       |      |       |      |                 |         |      |       |      |       |             |      |      |                            |                      |                    |  |
| 7 - 7.9        |         |      |       |      |       |      |       |      | 7.5             |         |      |       |      |       |             |      |      |                            |                      |                    |  |
| 6 - 6.9        |         |      |       |      |       |      |       |      |                 |         |      |       |      |       |             |      |      |                            |                      |                    |  |
| 5 - 5.9        |         |      |       |      |       |      |       |      |                 |         |      |       |      |       |             |      |      |                            |                      |                    |  |
| 4 - 4.9        |         |      |       |      |       |      |       |      | 4.5             |         |      |       |      |       |             |      |      |                            |                      |                    |  |
| 3 - 3.9        |         |      |       |      |       |      |       |      |                 |         |      |       |      |       |             |      |      |                            |                      |                    |  |
| 2 - 2.9        |         |      |       |      |       |      |       |      |                 |         |      |       |      |       |             |      |      |                            |                      |                    |  |
| 1 - 1.9        |         |      |       |      |       |      |       |      | 1.5             |         |      |       |      |       |             |      |      |                            |                      |                    |  |
| >0 - 0.9       |         |      |       |      |       |      |       |      |                 |         |      |       |      |       |             |      |      |                            |                      |                    |  |
| TOTAL          |         |      |       |      |       |      |       |      |                 |         |      |       |      |       |             |      |      |                            |                      |                    |  |
| Rating         |         |      |       |      |       |      |       |      |                 |         |      |       |      |       |             |      |      |                            |                      |                    |  |
| TGC %          |         |      |       |      |       |      |       |      | UNWEIGHTED DEP. |         |      |       |      |       | T.L. CARBON |      |      |                            | T.L. FLAKED CARBON % |                    |  |

**M11 EGR LUBRICANT PERFORMANCE TEST  
FORM 16  
PISTON 6 DEPOSIT RATINGS**

|                         |          |                 |
|-------------------------|----------|-----------------|
| Laboratory              | EOT Date | EOT Time        |
| TEST NUMBER             |          |                 |
| STAND:                  | ENGINE:  | ENGINE RUN NO.: |
| FORMULATION/STAND CODE: |          |                 |
| OILCODE:                |          |                 |

| DEP.<br>FACTOR | GROOVES |      |       |      | LANDS |      |       |      | DEP<br>FACTOR | GROOVES         |      | GROOVES |      |       |             | OIL COOLING<br>GALLERY (2) |      | UNDER<br>CROWN (1) |                      |
|----------------|---------|------|-------|------|-------|------|-------|------|---------------|-----------------|------|---------|------|-------|-------------|----------------------------|------|--------------------|----------------------|
|                | NO. 1   |      | NO. 2 |      | NO. 1 |      | NO. 2 |      |               | NO. 3           |      | NO. 3   |      | NO. 4 |             | A, %                       | DEM. | A, %               | DEM.                 |
|                | A, %    | DEM. | A, %  | DEM. | A, %  | DEM. | A, %  | DEM. |               | A, %            | DEM. | A, %    | DEM. | A, %  | DEM.        | A, %                       | DEM. | A, %               | DEM.                 |
| CARBON         |         |      |       |      |       |      |       |      |               |                 |      |         |      |       |             |                            |      |                    |                      |
| HC-1.0         |         |      |       |      |       |      |       |      |               |                 |      |         |      |       |             |                            |      |                    |                      |
| MC-0.5         |         |      |       |      |       |      |       |      |               |                 |      |         |      |       |             |                            |      |                    |                      |
| LC-.25         |         |      |       |      |       |      |       |      |               |                 |      |         |      |       |             |                            |      |                    |                      |
| TOTAL          |         |      |       |      |       |      |       |      |               |                 |      |         |      |       |             |                            |      |                    |                      |
| VARNISH        |         |      |       |      |       |      |       |      |               |                 |      |         |      |       |             |                            |      |                    |                      |
| 8 - 9          |         |      |       |      |       |      |       |      | 7.5           |                 |      |         |      |       |             |                            |      |                    |                      |
| 7 - 7.9        |         |      |       |      |       |      |       |      |               |                 |      |         |      |       |             |                            |      |                    |                      |
| 6 - 6.9        |         |      |       |      |       |      |       |      |               |                 |      |         |      |       |             |                            |      |                    |                      |
| 5 - 5.9        |         |      |       |      |       |      |       |      | 4.5           |                 |      |         |      |       |             |                            |      |                    |                      |
| 4 - 4.9        |         |      |       |      |       |      |       |      |               |                 |      |         |      |       |             |                            |      |                    |                      |
| 3 - 3.9        |         |      |       |      |       |      |       |      |               |                 |      |         |      |       |             |                            |      |                    |                      |
| 2 - 2.9        |         |      |       |      |       |      |       |      | 1.5           |                 |      |         |      |       |             |                            |      |                    |                      |
| 1 - 1.9        |         |      |       |      |       |      |       |      |               |                 |      |         |      |       |             |                            |      |                    |                      |
| >0 - 0.9       |         |      |       |      |       |      |       |      |               |                 |      |         |      |       |             |                            |      |                    |                      |
| TOTAL          |         |      |       |      |       |      |       |      |               |                 |      |         |      |       |             |                            |      |                    |                      |
| Rating         |         |      |       |      |       |      |       |      |               |                 |      |         |      |       |             |                            |      |                    |                      |
| TGC %          |         |      |       |      |       |      |       |      |               | UNWEIGHTED DEP. |      |         |      |       | T.L. CARBON |                            |      |                    | T.L. FLAKED CARBON % |



**M11 EGR LUBRICANT PERFORMANCE TEST  
FORM 17**

|                         |          |                 |
|-------------------------|----------|-----------------|
| Laborator               | EOT Date | EOT Time        |
| TEST NUMBER             |          |                 |
| STAND:                  | ENGINE:  | ENGINE RUN NO.: |
| FORMULATION/STAND 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 |                |  |
| 1                        |          |     |                |             |     |                |          |     |                |  |
| 2                        |          |     |                |             |     |                |          |     |                |  |
| 3                        |          |     |                |             |     |                |          |     |                |  |
| 4                        |          |     |                |             |     |                |          |     |                |  |
| 5                        |          |     |                |             |     |                |          |     |                |  |
| 6                        |          |     |                |             |     |                |          |     |                |  |
| AVERAGE MASS LOSS (mg)   |          |     |                |             |     |                |          |     |                |  |
| STD. DEV. MASS LOSS (mg) |          |     |                |             |     |                |          |     |                |  |
| MAXIMUM MASS LOSS (mg)   |          |     |                |             |     |                |          |     |                |  |
| MINIMUM MASS LOSS (mg)   |          |     |                |             |     |                |          |     |                |  |



**M11 EGR LUBRICANT PERFORMANCE TEST  
FORM 19  
TEST FUEL ANALYSIS (LAST BATCH)**

|                         |          |                 |
|-------------------------|----------|-----------------|
| Laborator               | EOT Date | EOT Time        |
| TEST NUMBER             |          |                 |
| STAND:                  | ENGINE:  | ENGINE RUN NO.: |
| FORMULATION/STAND CODE: |          |                 |
| OILCODE:                |          |                 |

| FUEL SUPPLIER | FUEL BATCH IDENTIFIER |
|---------------|-----------------------|
|               |                       |

| Measurement                       | Specifications | Analysis |     | Test Method            |
|-----------------------------------|----------------|----------|-----|------------------------|
|                                   |                | NEW      | EOT |                        |
| Total Sulfur, % Weight            | 0.04 - 0.05    |          |     | D 2662                 |
| Gravity, 'API                     | 34.5 - 36.5    |          |     | D 1298                 |
| <b>Hydrocarbon Composition</b>    |                |          |     |                        |
| Aromatics % Volume                | 28 - 33        |          |     | D 1319                 |
| Olefin                            | Report         |          |     | D 1319                 |
| Cetane Index                      | Report         |          |     | D 4737                 |
| Cetane Number                     | 42 - 48        |          |     | D 613                  |
| Copper Strip Corrosion            | 1 Maximum      |          |     | D 130                  |
| Flash Point, °C                   | 54 Maximum     |          |     | D 93                   |
| Pour Point, °C                    | -18 Maximum    |          |     | D 97                   |
| Carbon Residue on 10% Residuum, % | 0.35 Maximum   |          |     | D 524<br>(10% Bottoms) |
| Water & Sediment, % Volume        | 0.05 Maximum   |          |     | D 2709                 |
| Viscosity, cSt @ 40 °C            | 2.4 - 3.0      |          |     | D 445                  |
| Total Acid Number                 | 0.05 Maximum   |          |     | D 664                  |
| Strong Acid Number                | 0.00 Maximum   |          |     | D 664                  |
| Accelerated Stability             | tbd            |          |     | D 2274                 |
| Saturates, %                      | Report         |          |     | D 1319                 |
| Cloud Point, °C                   | Report         |          |     | D 2500                 |
| <b>Distillation, °C</b>           |                |          |     |                        |
| IBP                               | Report         |          |     | D 86                   |
| 10%                               | Report         |          |     | D 86                   |
| 50%                               | Report         |          |     | D 86                   |
| 90%                               | 282 - 338      |          |     | D 86                   |
| EP                                | Report         |          |     | D 86                   |

**M11 EGR LUBRICANT PERFORMANCE TEST  
FORM 20  
INJECTOR ADJUSTING SCREW MASS LOSS**

|                         |          |                 |
|-------------------------|----------|-----------------|
| Laborator               | EOT Date | EOT Time        |
| TEST NUMBER             |          |                 |
| STAND:                  | ENGINE:  | ENGINE RUN NO.: |
| FORMULATION/STAND CODE: |          |                 |
| OILCODE:                |          |                 |

| SCREW # | PRE-TEST MASS, g | POST-TEST MASS, g | MASS LOSS, mg |
|---------|------------------|-------------------|---------------|
| 1       |                  |                   |               |
| 2       |                  |                   |               |
| 3       |                  |                   |               |
| 4       |                  |                   |               |
| 5       |                  |                   |               |
| 6       |                  |                   |               |
|         |                  | TOTAL             |               |
|         |                  | AVERAGE           |               |

**M11 EGR LUBRICANT PERFORMANCE TEST  
FORM 21  
UNSCHEDULED DOWNTIME & MAINTENANCE SUMMARY**

|                         |          |                 |
|-------------------------|----------|-----------------|
| Laborator               | EOT Date | EOT Time        |
| TEST NUMBER             |          |                 |
| STAND:                  | ENGINE:  | ENGINE RUN NO.: |
| FORMULATION/STAND CODE: |          |                 |
| OILCODE:                |          |                 |

| Number of Downtime     |      |          |         |
|------------------------|------|----------|---------|
| Test Hours             | Date | Downtime | Reasons |
|                        |      |          |         |
|                        |      |          |         |
|                        |      |          |         |
|                        |      |          |         |
|                        |      |          |         |
|                        |      |          |         |
|                        |      |          |         |
|                        |      |          |         |
|                        |      |          |         |
|                        |      |          |         |
| Total Downtime (hours) |      |          |         |

|                         |  |  |
|-------------------------|--|--|
| Other Comments          |  |  |
| Number of Comment Lines |  |  |
|                         |  |  |

**M11 EGR LUBRICANT PERFORMANCE TEST  
FORM 22  
CHARACTERISTICS OF THE DATA ACQUISITION SYSTEM**

|                         |          |                 |
|-------------------------|----------|-----------------|
| Laboratory              | EOT Date | EOT Time        |
| TEST NUMBER             |          |                 |
| STAND:                  | ENGINE:  | ENGINE RUN NO.: |
| FORMULATION/STAND CODE: |          |                 |
| OIL CODE:               |          |                 |

| PARAMETER<br>(1)   | SENSING<br>DEVICE<br>(2) | CALIBRATION<br>FREQUENCY<br>(3) | RECORD<br>DEVICE<br>(4) | OBSERVATION<br>FREQUENCY<br>(5) | RECORD<br>FREQUENCY<br>(6) | LOG<br>FREQUENCY<br>(7) | SYSTEM<br>RESPONSE<br>(8) |
|--------------------|--------------------------|---------------------------------|-------------------------|---------------------------------|----------------------------|-------------------------|---------------------------|
| <b>Temperature</b> |                          |                                 |                         |                                 |                            |                         |                           |
| Oil                |                          |                                 |                         |                                 |                            |                         |                           |
| Fuel In            |                          |                                 |                         |                                 |                            |                         |                           |
| Intake             |                          |                                 |                         |                                 |                            |                         |                           |
| Intake             |                          |                                 |                         |                                 |                            |                         |                           |
| Pre-Turb.          |                          |                                 |                         |                                 |                            |                         |                           |
| Cool. Out          |                          |                                 |                         |                                 |                            |                         |                           |
| <b>Pressure</b>    |                          |                                 |                         |                                 |                            |                         |                           |
| Inlet Air          |                          |                                 |                         |                                 |                            |                         |                           |
| Exhaust            |                          |                                 |                         |                                 |                            |                         |                           |
| Oil                |                          |                                 |                         |                                 |                            |                         |                           |
| <b>Other</b>       |                          |                                 |                         |                                 |                            |                         |                           |
| Fuel Flow          |                          |                                 |                         |                                 |                            |                         |                           |
| Speed              |                          |                                 |                         |                                 |                            |                         |                           |
| Load               |                          |                                 |                         |                                 |                            |                         |                           |

**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  
DL - AUTOMATIC DATA LOGGER  
C/D - COMPUTER, USING DIRECT I/O ENTRY
- (5) DATA ARE OBSERVED BUT ONLY IF RECORDED 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 IN SECONDS FOR THE OUTPUT TO REACH 63.2% OF FINAL VALUE  
FOR STEP CHANGE AT INPUT

**M11 EGR LUBRICANT PERFORMANCE TEST**  
**Liner Wear Summary**  
**Form 23**

|                   |         |            |
|-------------------|---------|------------|
| Laborato          | EOT     | EOT Time   |
| Stand:            | Engine: | Engine Run |
| Oil               |         |            |
| Formulation/Stand |         |            |

| POSITION      | WEAR STEP ( $\mu\text{m}$ ) |   |   |   |   |   |
|---------------|-----------------------------|---|---|---|---|---|
|               | Cylinder Number             |   |   |   |   |   |
|               | 1                           | 2 | 3 | 4 | 5 | 6 |
| 1:00          |                             |   |   |   |   |   |
| 2:00          |                             |   |   |   |   |   |
| 3:00 (Thrust) |                             |   |   |   |   |   |
| 4:00          |                             |   |   |   |   |   |
| 5:00          |                             |   |   |   |   |   |
| 6:00 (Rear)   |                             |   |   |   |   |   |
| 7:00          |                             |   |   |   |   |   |
| 8:00          |                             |   |   |   |   |   |
| 9:00          |                             |   |   |   |   |   |
| 10:00         |                             |   |   |   |   |   |
| 11:00         |                             |   |   |   |   |   |
| 12:00 (Front) |                             |   |   |   |   |   |
| Average       |                             |   |   |   |   |   |

| Summary                  | As Measured | Outlier | Adjusted to X.XX% |
|--------------------------|-------------|---------|-------------------|
| Average, $\mu\text{m}$   |             |         |                   |
| Std. Dev., $\mu\text{m}$ |             |         |                   |
| Minimum, $\mu\text{m}$   |             |         |                   |
| Maximum, $\mu\text{m}$   |             |         |                   |
| Ring Flaked Liners       |             |         |                   |
| Outlier Liners           |             |         |                   |