

**ISM
Lubricant Performance Test**

Report Packet Version No.

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 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. |

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

| | | |
|---------------------------|-------------------|----------------|
| Stand: | Engine: | Engine Run No: |
| End Of Test Date: | End Of Test Time: | |
| Oil Code: | | |
| Formulation / Stand Code: | | |
| Alternate Codes: | | |

In my opinion the test _____ 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:

_____ Testing Laboratory

_____ Signature

_____ Typed Name

_____ Title

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**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 and sludge build-up. 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

| Parameter | Stage A | Stage 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: | EOT Date: | EOT Time: |
| Stand: | Engine: | Engine Run No.: |
| Formulation/Stand Code: | | |
| Oil Code: | Engine Kit S/N: | |

| | | | |
|---|---|--|---|
| Date Test Started | | | |
| Start Time | | | |
| Test Length | | | |
| TMC Oil Code ^A | | | |
| Laboratory Oil Code | | | |
| SAE Viscosity | | | |
| TGA Soot % At 50 h | | | |
| TGA Soot % At 150 h | | | |
| Average TGA Soot % 0 - 200 h | | | |
| Total Oil Consumption, kg | | | |
| | Average Crosshead Mass Loss (mg) | Filter Plugging Delta P (kPa) | Average Sludge Rating (merits) |
| Original Result | | | |
| Transformed Result ^B | | | |
| Correction Factor ^B | | | |
| Corrected Transformed Result ^B | | | |
| Severity Adjustment ^B | | | |
| Final Transformed Result ^B | | | |
| Final Result | | | |

| Last Stand Reference Results | | | |
|-----------------------------------|---|--|---|
| Stand: | Engine: | Engine Run No.: | |
| Oil Code : | | | |
| Test Length | | | |
| TMC Oil Code | | | |
| EOT Date | | | |
| EOT Time | | | |
| Stand Calibration Expiration Date | | | |
| TGA Soot % At 50 h | | | |
| TGA Soot % At 150 h | | | |
| Average TGA Soot % 0 - 200 h | | | |
| Total Oil Consumption, kg | | | |
| | Average Crosshead Mass Loss (mg) | Filter Plugging Delta P (kPa) | Average Sludge Rating (merits) |
| Final Result | | | |

^A Reference Tests Only

^B Filter Plugging Delta P Value in Transformed Units

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

| | | | |
|-------------------------|-----------|-----------------|--|
| Laboratory: | EOT Date: | EOT Time: | |
| Stand: | Engine: | Engine Run No.: | |
| Formulation/Stand Code: | | | |
| Oil Code: | | | |

| Parameter | Units | QI Threshold | EOT QI ^A | Target | Average | Samples ^B | BQD ^C | Over/Under Range ^D |
|------------------|--------------|---------------------|-----------------------------------|----------------|---------|----------------------|------------------|-------------------------------|
| 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 | | | | |
| Parameter | Units | QI Threshold | Typical Values^E | Average | | | | |
| Torque | N-m | TBD | TBD | | | | | |
| Power | kW | TBD | TBD | | | | | |
| Intake CO | % | 0.97 - 1.09 | 0.97 - 1.09 | | | | | |
| Blowby | L/min | | TBD | | | | | |
| Coolant In | °C | | TBD | | | | | |
| Intake Air | °C | | TBD | | | | | |
| Pre-Turbine | °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 | | | | | |

^A 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.

^B Total number of data points taken

^C Number of Bad Quality Data points not used in the calculation of the statistical measures

^D Number of points clipped by over/under range limits

^E Typical values determined from reference oil test database

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

| | | |
|---------------------------|-----------|-----------------|
| Laboratory: | 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 Screened | As Measured | Outlier Screened |
| Average Crosshead Mass Loss (mg) | | | | |
| Minimum Crosshead Mass Loss (mg) | | | | |
| Maximum Crosshead Mass Loss (mg) | | | | |
| Standard Deviation (mg) | | | | |
| Outlier Crossheads Locations ⁴ | | | | |

⁴ Location Designation. Example: 3E

| Overall Summary | As Measured | Outlier Screened | Result |
|----------------------------------|-------------|------------------|--------|
| Average Crosshead Mass Loss (mg) | | | |
| Minimum Crosshead Mass Loss (mg) | | | |
| Maximum Crosshead Mass Loss (mg) | | | |
| Standard Deviation (mg) | | | |

**ISM Lubricant Performance Test
Form 7
Oil Filter Delta Pressure Plot**

| | | |
|---------------------------|-----------|-----------------|
| Laboratory: | EOT Date: | EOT Time: |
| Test Number | | |
| Stand: | Engine: | Engine Run No.: |
| Formulation / Stand Code: | | |
| Oil code: | | |

OIL FILTER DELTA PRESSURE vs TEST HOURS



TEST HOURS

**ISM 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 % of Area | Valve Cover Volume Factor | Oil Pan % of Area | Oil Pan Volume Factor |
|-------------------------------|--------------------------|------------------------------|----------------------|--------------------------|
| 1/4A | | | | |
| 1/2A | | | | |
| 3/4A | | | | |
| A | | | | |
| AB | | | | |
| B | | | | |
| BC | | | | |
| C | | | | |
| D | | | | |
| E | | | | |
| F | | | | |
| G | | | | |
| H | | | | |
| I | | | | |
| J | | | | |
| Total Volume Factor: | | Total Volume Factor: | | |
| Merit Rating: | | Merit Rating: | | |
| Average Sludge Rating: | | | | |

**ISM Lubricant Performance Test
Form 9
Ring Mass Loss Summary**

| | | | |
|---------------------------|-----------|-----------------|--|
| Laboratory: | EOT Date: | EOT Time: | |
| Test Number | | | |
| Stand: | Engine: | Engine Run No.: | |
| Formulation / Stand Code: | | | |
| Oil Code: | | | |

| Cylinder | Top Ring | | Second Ring | | Oil Ring | | Mass Loss (mg) |
|------------------------------------|----------|-----|-------------|-----|----------|-----|----------------|
| | Pretest | EOT | Pretest | EOT | Pretest | EOT | |
| 1 | | | | | | | |
| 2 | | | | | | | |
| 3 | | | | | | | |
| 4 | | | | | | | |
| 5 | | | | | | | |
| 6 | | | | | | | |
| As Measured Results | | | | | | | |
| Average Mass Loss (mg) | | | | | | | |
| Std. Dev. Mass Loss (mg) | | | | | | | |
| Maximum Mass Loss (mg) | | | | | | | |
| Minimum Mass Loss (mg) | | | | | | | |
| Outlier Top Ring (cylinder number) | | | | | | | |
| Outlier Screened Results | | | | | | | |
| Average Mass Loss (mg) | | | | | | | |

**ISM Lubricant Performance Test
Form 11
Test Fuel Analysis (Last Batch)**

| | | |
|---------------------------|-----------|-----------------|
| Laboratory: | EOT Date: | EOT Time: |
| Test Number | | |
| Stand: | Engine: | Engine Run No.: |
| Formulation / Stand Code: | | |
| Oil Code: | | |

| | |
|----------------------|------------------------------|
| 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 |
| Hydrocarbon Composition | | | | |
| 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 (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 |
| Distillation, °C | | | | |
| IBP | Report | | | D 86 |
| 10% | Report | | | D 86 |
| 50% | Report | | | D 86 |
| 90% | 282 – 338 | | | D 86 |
| EP | Report | | | D 86 |

**ISM Lubricant Performance Test
Form 12
Injector Adjusting Screw Mass Loss**

| | | |
|---------------------------|-----------|-----------------|
| Laboratory: | EOT Date: | EOT Time: |
| Test Number | | |
| Stand: | Engine: | Engine Run No.: |
| Formulation / Stand Code: | | |
| Oil Code: | | |

| Screw # | Pretest Mass, g | Post-Test Mass, g | Mass Loss, mg |
|---------|-----------------|-------------------|---------------|
| 1 | | | |
| 2 | | | |
| 3 | | | |
| 4 | | | |
| 5 | | | |
| 6 | | | |
| | | Total | |
| | | Average | |

**ISM Lubricant Performance Test
Form 14
Characteristics Of The Data Acquisition System**

| | | |
|---------------------------|-----------|-----------------|
| Laboratory: | EOT Date: | EOT Time: |
| Test Number | | |
| Stand: | Engine: | Engine Run No.: |
| Formulation / Stand Code: | | |
| Oil Code: | | |

| Parameter (1) | Sensing Device (2) | Calibration Frequency (3) | Record Device (4) | Observation Frequency (5) | Record Frequency (6) | Log Frequency (7) | System Response (8) |
|---------------------|-----------------------|------------------------------|----------------------|------------------------------|-------------------------|----------------------|------------------------|
| Temperatures | | | | | | | |
| Oil @ Filt. | | | | | | | |
| Fuel In. | | | | | | | |
| Intake Air | | | | | | | |
| Intake Man. | | | | | | | |
| Pre-Turb. | | | | | | | |
| Cool. Out | | | | | | | |
| Pressure | | | | | | | |
| Inlet Air | | | | | | | |
| Exhaust | | | | | | | |
| Oil Gallery | | | | | | | |
| Other | | | | | | | |
| 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 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