

DD13 Engine Scuffing Test

Version

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 |

| Test Number | | | |
|--------------------|------------|-------------------|----------------|
| Stand: | Stand Run: | Engine: | Engine Kit ID: |
| End of Test Date: | | End of Test Time: | |
| Oil Code: | | | |
| Formulation/Stand: | | | |
| Alternate Codes: | | | |

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

Submitted By:

Testing Laboratory

Signature

Typed Name

Title

DD13 Engine Scuffing Test

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DD13 Engine Scuffing Test

Form 3
Summary of Test Method

DD13 Engine Scuffing Test

Form 4 Test Result Summary

| | | |
|-------------------------|-----------|--------------|
| Laboratory: | EOT Date: | EOT Time: |
| Test Number: | | Test Length: |
| Oil Code: | | |
| Formulation Stand Code: | | |

| | |
|---------------|---|
| Lab Oil Code | TMC Oil Code ^A |
| SAE Viscosity | Number of Tests Since Last Calibration ^C |

| Start Dates and Times | |
|-----------------------|-----------------------|
| Oil Charge Date | Oil Charge Time |
| Engine Start Date | Engine Start Time |
| Test Clock Start Date | Test Clock Start Time |
| Test Length | |

| | Hours @ 0.5 kPa Increase | Hours @ 2.0 kPa Increase |
|---|--------------------------|--------------------------|
| Original Result | | |
| Transformed Result ^B | | |
| Correction Factor ^B | | |
| Corrected Transformed Result ^B | | |
| Severity Adjustment ^B | | |
| Final Transformed Result ^B | | |
| Final Original Unit Result | | |

| Additional Result | |
|-------------------|--|
| EOT Iron | |

| Last Stand Reference Results ^B | | |
|---|--------------------------|--------------------------|
| Test Number: | | |
| Oil Code: | | |
| Test Length: | TMC Oil Code: | |
| EOT Date: | EOT Time: | |
| Stand Calibration Expiration Date: | | |
| | Hours @ 0.5 kPa Increase | Hours @ 2.0 kPa Increase |
| Final Original Unit Result | | |

A - Reference Tests Only

B - Non-Reference Tests Only

C - Operationally Valid Tests Only, including current test

DD13 Engine Scuffing Test

Form 5
Operational Summary
Controlled Parameters

| | | |
|-------------------------|--------------|-----------|
| Laboratory: | EOT Date: | EOT Time: |
| Test Number: | Test Length: | |
| Oil Code: | | |
| Formulation Stand Code: | | |

| Controlled Parameters | Parameter | Units | QI Threshold | EOT QI A | Target | | Stage 1 | | | | Stage 2 | | | | No of Samples | BQD |
|--------------------------------|-----------|-------|--------------|----------|---------|---------|---------|---------|------|------|---------|---------|-----|-----|---------------|-----|
| | | | | | Stage 1 | Stage 2 | Avg | Std Dev | Max | Min | Avg | Std Dev | Max | Min | | |
| | | | | | Speed | r/min | 0.000 | | 1800 | 1800 | | | | | | |
| Fuel Flow | kg/h | 0.000 | | 32 | 71 | | | | | | | | | | | |
| Intake Manifold Temperature | °C | 0.000 | | 75 | 87 | | | | | | | | | | | |
| Coolant Jacket Out Temperature | °C | 0.000 | | 105 | 105 | | | | | | | | | | | |
| Fuel In Temperature | °C | 0.000 | | 38 | 38 | | | | | | | | | | | |
| Oil Gallery Temperature | °C | 0.000 | | 118 | 118 | | | | | | | | | | | |
| Intake Air Temperature | °C | 0.000 | | 35 | 35 | | | | | | | | | | | |
| Intake Air Restriction | kPaA | 0.000 | | 96.4 | 94.75 | | | | | | | | | | | |
| Intake Manifold Pressure | kPaA | 0.000 | | 202.5 | 327.5 | | | | | | | | | | | |
| Exhaust Pressure | kPaA | 0.000 | | 105.5 | 125.5 | | | | | | | | | | | |
| Coolant Tank Pressure | kPa | 0.000 | | 100 | 100 | | | | | | | | | | | |
| Coolant Jacket In Pressure | kPa | 0.000 | | 250 | 250 | | | | | | | | | | | |
| Coolant Flow | L/min | 0.000 | | 350 | 350 | | | | | | | | | | | |

A - QI values above the threshold are acceptable by then surveillance panel. QI values below the threshold may not be considered acceptable based on engineer review.

DD13 Engine Scuffing Test

Form 7 Cylinder Scuffing Summary

| | | |
|-------------------------|--------------|-----------|
| Laboratory: | EOT Date: | EOT Time: |
| Test Number: | Test Length: | |
| Oil Code: | | |
| Formulation Stand Code: | | |

| Cylinder | 1 | 2 | 3 | 4 | 5 | 6 |
|-----------------|---|---|---|---|---|---|
| Position 1 (%) | | | | | | |
| Position 2 (%) | | | | | | |
| Position 3 (%) | | | | | | |
| Position 4 (%) | | | | | | |
| Position 5 (%) | | | | | | |
| Position 6 (%) | | | | | | |
| Position 7 (%) | | | | | | |
| Position 8 (%) | | | | | | |
| Position 9 (%) | | | | | | |
| Position 10 (%) | | | | | | |
| Average (%) | | | | | | |

| As Measured | |
|---------------|--|
| Average | |
| Std Deviation | |
| Minimum | |
| Maximum | |

| Additional Liner Deposit and Condition Ratings | |
|--|--|
| Cylinder | |
| 1 | |
| 2 | |
| 3 | |
| 4 | |
| 5 | |
| 6 | |

DD13 Engine Scuffing Test

Form 8 Top Ring Scuffing Summary

| | | |
|-------------------------|--------------|-----------|
| Laboratory: | EOT Date: | EOT Time: |
| Test Number: | Test Length: | |
| Oil Code: | | |
| Formulation Stand Code: | | |

| Cylinder | 1 | 2 | 3 | 4 | 5 | 6 |
|-------------------|---|---|---|---|---|---|
| Position 1 (%) | | | | | | |
| Position 2 (%) | | | | | | |
| Position 3 (%) | | | | | | |
| Position 4 (%) | | | | | | |
| Position 5 (%) | | | | | | |
| Position 6 (%) | | | | | | |
| Position 7 (%) | | | | | | |
| Position 8 (%) | | | | | | |
| Position 9 (%) | | | | | | |
| Position 10 (%) | | | | | | |
| Average (%) | | | | | | |
| Ring Gap Location | | | | | | |

| As Measured | |
|---------------|--|
| Average | |
| Std Deviation | |
| Minimum | |
| Maximum | |

| Additional Top Ring Deposit and Condition Ratings | |
|---|--|
| Cylinder | |
| 1 | |
| 2 | |
| 3 | |
| 4 | |
| 5 | |
| 6 | |

DD13 Engine Scuffing Test

Form 9 2nd Ring Scuffing Summary

| | | |
|-------------------------|--------------|-----------|
| Laboratory: | EOT Date: | EOT Time: |
| Test Number: | Test Length: | |
| Oil Code: | | |
| Formulation Stand Code: | | |

| Cylinder | 1 | 2 | 3 | 4 | 5 | 6 |
|-------------------|---|---|---|---|---|---|
| Position 1 (%) | | | | | | |
| Position 2 (%) | | | | | | |
| Position 3 (%) | | | | | | |
| Position 4 (%) | | | | | | |
| Position 5 (%) | | | | | | |
| Position 6 (%) | | | | | | |
| Position 7 (%) | | | | | | |
| Position 8 (%) | | | | | | |
| Position 9 (%) | | | | | | |
| Position 10 (%) | | | | | | |
| Average (%) | | | | | | |
| Ring Gap Location | | | | | | |

| As Measured | |
|---------------|--|
| Average | |
| Std Deviation | |
| Minimum | |
| Maximum | |

| Additional 2 nd Ring Deposit and Condition Ratings | |
|---|--|
| Cylinder | |
| 1 | |
| 2 | |
| 3 | |
| 4 | |
| 5 | |
| 6 | |

DD13 Engine Scuffing Test

Form 10 Oil Ring Scuffing Summary

| | | |
|-------------------------|--------------|-----------|
| Laboratory: | EOT Date: | EOT Time: |
| Test Number: | Test Length: | |
| Oil Code: | | |
| Formulation Stand Code: | | |

| Cylinder | 1 | 2 | 3 | 4 | 5 | 6 |
|-------------------|---|---|---|---|---|---|
| Position 1 (%) | | | | | | |
| Position 2 (%) | | | | | | |
| Position 3 (%) | | | | | | |
| Position 4 (%) | | | | | | |
| Position 5 (%) | | | | | | |
| Position 6 (%) | | | | | | |
| Position 7 (%) | | | | | | |
| Position 8 (%) | | | | | | |
| Position 9 (%) | | | | | | |
| Position 10 (%) | | | | | | |
| Average (%) | | | | | | |
| Ring Gap Location | | | | | | |

| As Measured | |
|---------------|--|
| Average | |
| Std Deviation | |
| Minimum | |
| Maximum | |

| Additional Oil Ring Deposit and Condition Ratings | |
|---|--|
| Cylinder | |
| 1 | |
| 2 | |
| 3 | |
| 4 | |
| 5 | |
| 6 | |

DD13 Engine Scuffing Test

Form 11 Piston Top Groove Rating

| | | |
|-------------------------|--------------|-----------|
| Laboratory: | EOT Date: | EOT Time: |
| Test Number: | Test Length: | |
| Oil Code: | | |
| Formulation Stand Code: | | |

| Cylinder | | 1 | 2 | 3 | 4 | 5 | 6 |
|--------------|----------------|---|---|---|---|---|---|
| HC | Area | | | | | | |
| | Demerit | | | | | | |
| MC | Area | | | | | | |
| | Demerit | | | | | | |
| LC | Area | | | | | | |
| | Demerit | | | | | | |
| Total | Area | | | | | | |
| | Demerit | | | | | | |

| | | | | | | |
|--------------|--|--|--|--|--|--|
| TGF % | | | | | | |
|--------------|--|--|--|--|--|--|

| Additional Piston Top Groove Deposit and Condition Ratings | |
|---|--|
| Cylinder | |
| 1 | |
| 2 | |
| 3 | |
| 4 | |
| 5 | |
| 6 | |

DD13 Engine Scuffing Test

Form 12 Ring Weight Measurements

| | | |
|-------------------------|--------------|-----------|
| Laboratory: | EOT Date: | EOT Time: |
| Test Number: | Test Length: | |
| Oil Code: | | |
| Formulation Stand Code: | | |

| Cylinder | Top Ring Weight, mg | | |
|----------|-----------------------------------|--------|-----------------|
| | SOT, g | EOT, g | Weight Loss, mg |
| 1 | | | |
| 2 | | | |
| 3 | | | |
| 4 | | | |
| 5 | | | |
| 6 | | | |
| | Top Ring Weight Average, mg | | |
| | Top Ring Weight Std Deviation, mg | | |
| | Top Ring Weight Minimum, mg | | |
| | Top Ring Weight Maximum, mg | | |

| Cylinder | 2nd Ring Weight, mg | | |
|----------|-----------------------------------|--------|-----------------|
| | SOT, g | EOT, g | Weight Loss, mg |
| 1 | | | |
| 2 | | | |
| 3 | | | |
| 4 | | | |
| 5 | | | |
| 6 | | | |
| | 2nd Ring Weight Average, mg | | |
| | 2nd Ring Weight Std Deviation, mg | | |
| | 2nd Ring Weight Minimum, mg | | |
| | 2nd Ring Weight Maximum, mg | | |

| Cylinder | Oil Ring Weight, mg | | |
|----------|-----------------------------------|--------|-----------------|
| | SOT, g | EOT, g | Weight Loss, mg |
| 1 | | | |
| 2 | | | |
| 3 | | | |
| 4 | | | |
| 5 | | | |
| 6 | | | |
| | Oil Ring Weight Average, mg | | |
| | Oil Ring Weight Std Deviation, mg | | |
| | Oil Ring Weight Minimum, mg | | |
| | Oil Ring Weight Maximum, mg | | |

DD13 Engine Scuffing Test

Form 13 Ring Gap Measurements

| | | |
|-------------------------|--------------|-----------|
| Laboratory: | EOT Date: | EOT Time: |
| Test Number: | Test Length: | |
| Oil Code: | | |
| Formulation Stand Code: | | |

| Cylinder | Top Ring Gap, mm | | |
|----------|--------------------------------|-----|-------------------|
| | SOT | EOT | Delta (EOT - SOT) |
| 1 | | | |
| 2 | | | |
| 3 | | | |
| 4 | | | |
| 5 | | | |
| 6 | | | |
| | Top Ring Gap Average, mm | | |
| | Top Ring Gap Std Deviation, mm | | |
| | Top Ring Gap Minimum, mm | | |
| | Top Ring Gap Maximum, mm | | |

| Cylinder | 2nd Ring Gap, mm | | |
|----------|--------------------------------|-----|-------------------|
| | SOT | EOT | Delta (EOT - SOT) |
| 1 | | | |
| 2 | | | |
| 3 | | | |
| 4 | | | |
| 5 | | | |
| 6 | | | |
| | 2nd Ring Gap Average, mm | | |
| | 2nd Ring Gap Std Deviation, mm | | |
| | 2nd Ring Gap Minimum, mm | | |
| | 2nd Ring Gap Maximum, mm | | |

| Cylinder | Oil Ring Gap, mm | | |
|----------|--------------------------------|-----|-------------------|
| | SOT | EOT | Delta (EOT - SOT) |
| 1 | | | |
| 2 | | | |
| 3 | | | |
| 4 | | | |
| 5 | | | |
| 6 | | | |
| | Oil Ring Gap Average, mm | | |
| | Oil Ring Gap Std Deviation, mm | | |
| | Oil Ring Gap Minimum, mm | | |
| | Oil Ring Gap Maximum, mm | | |

DD13 Engine Scuffing Test

Form 17
Crankcase Pressure Plot

| | | |
|-------------------------|--------------|-----------|
| Laboratory: | EOT Date: | EOT Time: |
| Test Number: | Test Length: | |
| Oil Code: | | |
| Formulation Stand Code: | | |



DD13 Engine Scuffing Test

Form 18
Blow-By Flow Plot

| | | |
|-------------------------|--------------|-----------|
| Laboratory: | EOT Date: | EOT Time: |
| Test Number: | Test Length: | |
| Oil Code: | | |
| Formulation Stand Code: | | |



DD13 Engine Scuffing Test

Form 19 Hardware

| | | |
|-------------------------|--------------|-----------|
| Laboratory: | EOT Date: | EOT Time: |
| Test Number: | Test Length: | |
| Oil Code: | | |
| Formulation Stand Code: | | |

| Part | Part Number | Serial Number |
|---------------------------------|-------------|---------------|
| Blowby Meter | | |
| Piston Assembly | | |
| Piston Skirt | | |
| Piston Crown | | |
| Uncoated Top Ring | | |
| 2nd Ring | | |
| Oil Ring | | |
| Wrist Pin | | |
| Wrist Pin Retainer | | |
| Connecting Rod | | |
| Connecting Rod Bearings - Upper | | |
| Connecting Rod Bearings - Lower | | |
| Main Bearing - Upper | | |
| Main Bearing - Lower | | |
| Carbon Scrapper Ring | | |
| Piston Cooling Nozzle | | |
| Intake Rocker Arm | | |
| Exhaust Rocker Arm - A | | |
| Exhaust Rocker Arm - B | | |
| Exhaust Rocker Arm - C | | |
| Intake Camshaft | | |
| Exhaust Camshaft | | |
| Oil Pump | | |
| Number of Runs on Oil Pump | | |
| Engine Kit ID | | |

DD13 Engine Scuffing Test

Form 20 Supplemental Hardware

| | | |
|-------------------------|--------------|-----------|
| Laboratory: | EOT Date: | EOT Time: |
| Test Number: | Test Length: | |
| Oil Code: | | |
| Formulation Stand Code: | | |

| Position | Upper Main Serial No. | Lower Main Serial No. | Upper Main DateCode | Lower Main DateCode |
|----------|-----------------------|-----------------------|---------------------|---------------------|
| 1 | | | | |
| 2 | | | | |
| 3 | | | | |
| 4 | | | | |
| 5 | | | | |
| 6 | | | | |
| 7 | | | | |

| Cylinder | Connecting Rod Serial No. | Upper Connecting Rod Bearing Serial No. | Lower Connecting Rod Bearing Serial No. | Upper Connecting Rod Bearing Date Code | Lower Connecting Rod Bearing Date Code |
|----------|---------------------------|---|---|--|--|
| 1 | | | | | |
| 2 | | | | | |
| 3 | | | | | |
| 4 | | | | | |
| 5 | | | | | |
| 6 | | | | | |

| Cylinder | Liner Serial No. | Liner Part No. | Liner Date Code | Liner Source |
|----------|------------------|----------------|-----------------|--------------|
| 1 | | | | |
| 2 | | | | |
| 3 | | | | |
| 4 | | | | |
| 5 | | | | |
| 6 | | | | |

| Cylinder | Piston Serial No. | Piston Part No. | Piston Date Code | Piston Other |
|----------|-------------------|-----------------|------------------|--------------|
| 1 | | | | |
| 2 | | | | |
| 3 | | | | |
| 4 | | | | |
| 5 | | | | |
| 6 | | | | |

| Cylinder | Piston Cooling Nozzle SN | Top Ring Batch ID |
|----------|--------------------------|-------------------|
| 1 | | |
| 2 | | |
| 3 | | |
| 4 | | |
| 5 | | |
| 6 | | |

DD13 Engine Scuffing Test

Form 21 Engine Kit Results Summary

| | | |
|-------------------------|--------------|-----------|
| Laboratory: | EOT Date: | EOT Time: |
| Test Number: | Test Length: | |
| Oil Code: | | |
| Formulation Stand Code: | | |

| Top Ring | | | | | | | | | | |
|----------|---------------|---------------|---------------|--------------|---------------|---------------|--------------|---------------|---------------|--------------|
| Cyl | Serial Number | Rpk | | | Rvk | | | Rz | | |
| | | 1" Before Gap | 180° From Gap | 1" After Gap | 1" Before Gap | 180° From Gap | 1" After Gap | 1" Before Gap | 180° From Gap | 1" After Gap |
| 1 | | | | | | | | | | |
| 2 | | | | | | | | | | |
| 3 | | | | | | | | | | |
| 4 | | | | | | | | | | |
| 5 | | | | | | | | | | |
| 6 | | | | | | | | | | |

| Top Ring | | | | | | | | | | |
|----------|-------------------|----------------------|---------------|--------------|---------------------|---------------|--------------|--------------------------------|---------------|--------------|
| Cyl | Ring Tension @132 | Peak Height Location | | | Back of Ring Height | | | Ring Thickness (Front to Rear) | | |
| | | 1" Before Gap | 180° From Gap | 1" After Gap | 1" Before Gap | 180° From Gap | 1" After Gap | 1" Before Gap | 180° From Gap | 1" After Gap |
| 1 | | | | | | | | | | |
| 2 | | | | | | | | | | |
| 3 | | | | | | | | | | |
| 4 | | | | | | | | | | |
| 5 | | | | | | | | | | |
| 6 | | | | | | | | | | |

| 2d Ring | | |
|---------|---------------|-------------------|
| Cyl | Serial Number | Ring Tension @132 |
| 1 | | |
| 2 | | |
| 3 | | |
| 4 | | |
| 5 | | |
| 6 | | |

| Oil Ring | | | | | |
|----------|---------------|-------------------|--------------------------|---------------|--------------|
| Cyl | Serial Number | Ring Tension @132 | Rail Height Differential | | |
| | | | 1" Before Gap | 180° From Gap | 1" After Gap |
| 1 | | | | | |
| 2 | | | | | |
| 3 | | | | | |
| 4 | | | | | |
| 5 | | | | | |
| 6 | | | | | |

| Liners | | | |
|--------|-----|-----|------------------|
| Cyl | Rpk | Rvk | Crosshatch Angle |
| 1 | | | |
| 2 | | | |
| 3 | | | |
| 4 | | | |
| 5 | | | |
| 6 | | | |

DD13 Engine Scuffing Test

Form 24
Test Fuel Analysis (Last Batch)

| | | |
|-------------------------|----------------|-----------|
| Laboratory: | EOT Date: | EOT Time: |
| Test Number: | Test Length: | |
| Oil Code: | | |
| Formulation Stand Code: | | |
| Fuel Supplier: | Fuel Batch ID: | |

| Measurement | Specs. | Analysis | | Test Method |
|---------------------------------|---------|----------|-----|-------------|
| | | New | EOT | |
| Total Sulfur ^A , ppm | 7 - 15 | | | D 5453 |
| Gravity ^A , °API | 34 - 37 | | | D 4052 |

^A Measurements are stand samples.