

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:			

<p>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.</p>

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

This test method evaluates the liner scuffing and ring distress performance of engine oils in turbocharged and intercooled four-cycle diesel engines equipped with EGR, uncoated top rings, and running on ultra-low sulfur diesel fuel. Results are obtained from used oil analysis, operational data, and component measurements before and after test.

The test engine is a four stroke Detroit Diesel DD13 12.8 L, six-cylinder diesel engine with EGR. The engine is disassembled prior to each test, the parts solvent-cleaned and measured, and rebuilt using all new pistons, uncoated rings, cylinder liners, and connecting rod bearings.

Schedule of Conditions for the Test Procedure

	Set Point for Stage 1	Set Point for Stage 2
Time, h	30	170 standard ^A
Controlled Quantities, units		
Engine Speed, r/min	1800	1800
Fuel Flow Rate, kg/h	32	71
Air Temperature in Engine Intake, °C	35	35
Coolant Temperature at Jacket Outlet, °C	105	105
Oil Temperature in Gallery, °C	118	118
Fuel Temperature at Engine Inlet, °C	38	38
Air Temperature in Intake Manifold, °C	75	87
Coolant Pressure at Jacket Inlet, kPa (gauge)	250	250
Exhaust Pressure in Tailpipe, kPa (absolute)	105.5	125.5
Air Pressure in Intake Manifold, kPa (absolute)	202.5	327.5
Air Pressure in Engine Intake, kPa (absolute)	96.4	94.8
Ranged Quantities^C, units		
Coolant Flow Rate, L/min	340 to 360	340 to 360

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 Time	
Oil Charge Date	Oil Charge Time
Engine Start Date	Engine Start Time
Test Clock Start Date	Test Clock Start Time
Test Length	
Total Test Hours on Engine Block	
Total Number of Test on Engine Block	

	Hours to Scuff
Original Result	
Transformed Result	
Correction Factor	
Corrected Transformed Result	
Severity Adjustment ^B	
Final Transformed Result	
Final Original Unit Result	

Additional Result						
Delta Iron @ Hours to Scuff						
Cylinder	1	2	3	4	5	6
Average % Liner Scuff						
Top Ring Weight Loss						

Last Stand Reference Results ^B	
Test Number:	
Oil Code:	
Test Length:	TMC Oil Code:
EOT Date:	EOT Time:
Stand Calibration Expiration Date:	
	Hours to Scuff
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	94.8											
Intake Manifold Pressure	kPaA	0.000		202.5	327.5											
Exhaust Pressure	kPaA	0.000		105.5	125.5											
Coolant Jacket In Pressure	kPa	0.000		250	250											
Coolant Flow	L/min			340-360	340-360											

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.

Counts Above Control Limit					
	Transition	Steady State		Transition	Steady State
Oil Gallery Temperature			Intake Air Temperature		
Intake Manifold Temperature			Intake Manifold Pressure		
Coolant Jacket Out Temperature			Torque		

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 16
Crankcase Pressure Plot

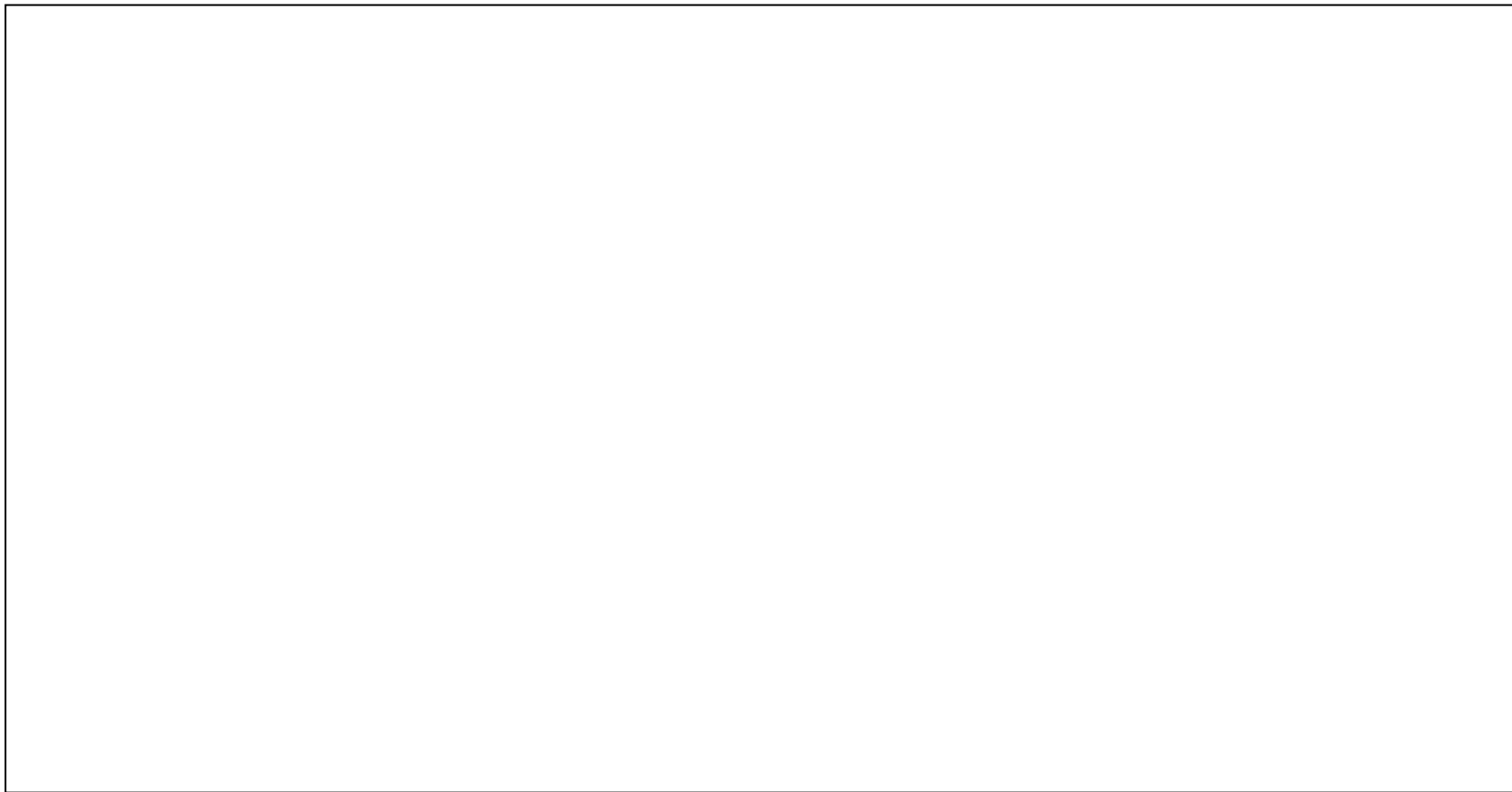
Laboratory:	EOT Date:	EOT Time:
Test Number:	Test Length:	
Oil Code:		
Formulation Stand Code:		



DD13 Engine Scuffing Test

Form 17
Blow-By Flow Plot

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



DD13 Engine Scuffing Test

Form 18

Intake Manifold Pressure Transition Plot

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



DD13 Engine Scuffing Test

Form 19

Intake Manifold Temperature Transition Plot

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



DD13 Engine Scuffing Test

Form 20

Oil Gallery Temperature Transition Plot

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



DD13 Engine Scuffing Test

Form 21

Coolant Jacket Temperature Transition Plot

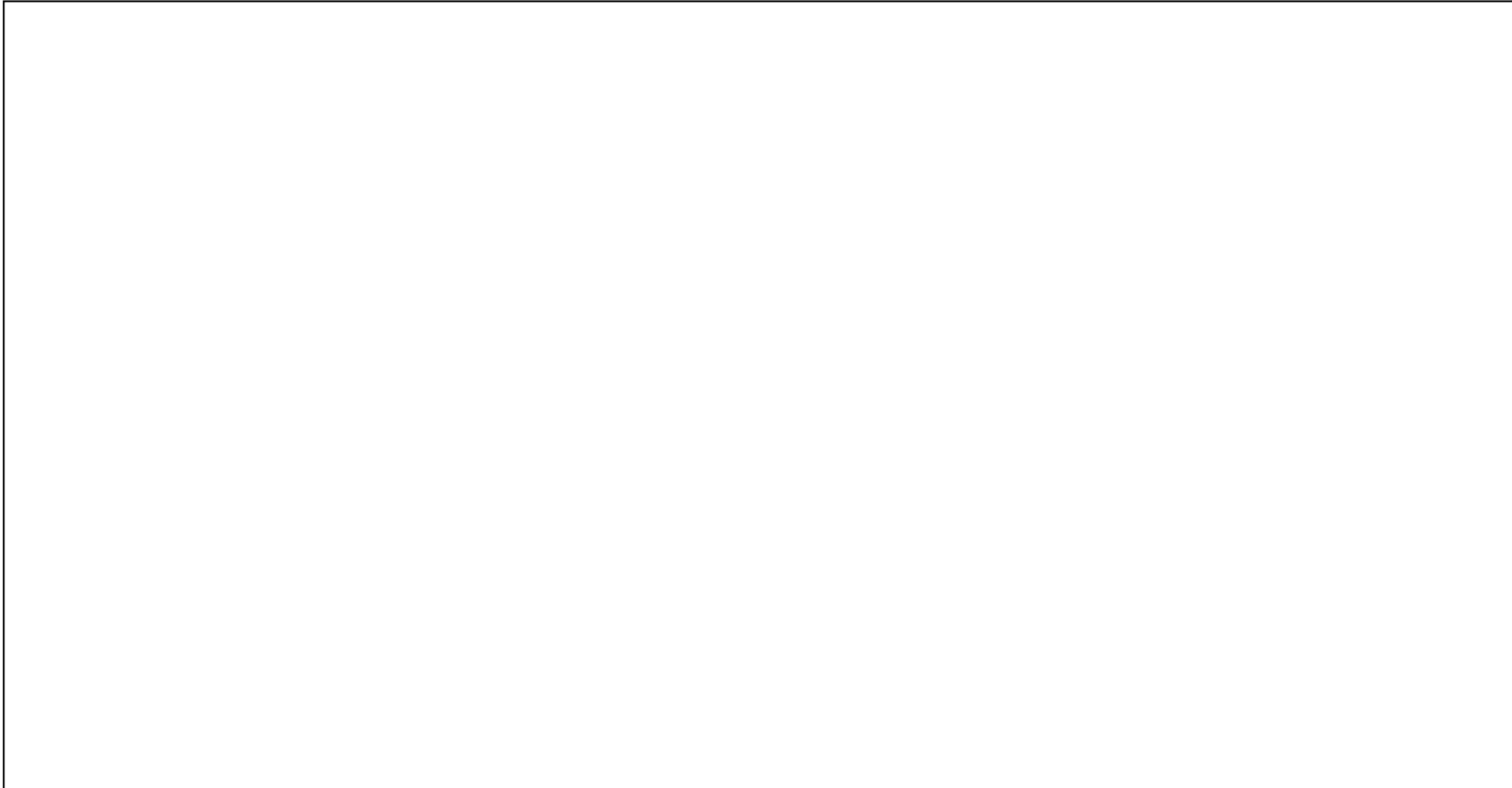
Laboratory:	EOT Date:	EOT Time:
Test Number:	Test Length:	
Oil Code:		
Formulation Stand Code:		



DD13 Engine Scuffing Test

Form 22
Torque Transition Plot

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



DD13 Engine Scuffing Test

Form 23 Hardware

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

Part	Part Number	Serial Number
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 Scraper 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		

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Form 24
Supplemental Hardware Information

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

Position	Upper Main Serial No.	Upper Main Date Code	Lower Main Serial No.	Lower Main Date Code
1				
2				
3				
4				
5				
6				
7				

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

DD13 Engine Scuffing Test

Form 25
Supplemental Hardware - Continued

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

Cylinder	Liner Serial No.	Liner Part No.	Liner Manufacture Date	Liner Semi-Finish Part No.	Liner Source	Liner Semi Finish Date
1						
2						
3						
4						
5						
6						

Cylinder	Piston Serial No.	Piston Part No.	Piston Date Code	Piston Batch ID
1				
2				
3				
4				
5				
6				

Cylinder	Top Ring Batch ID
1	
2	
3	
4	
5	
6	

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Form 26
Top Ring Measurements

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

Top Ring			
Cylinder	Serial Number	Ring Tension @ 132 mm (N)	Ring Gap @ 132 mm (mm)
1			
2			
3			
4			
5			
6			

Top Ring								
		Cylinder						
		1	2	3	4	5	6	
1" Before Gap	Ring Face	Rpk (µm)						
		Rvk (µm)						
		Rz (µm)						
		Ra (µm)						
		Rk (µm)						
		Rmr1 (%)						
		Rmr2 (%)						
		Vo ((µm*µm)/µm)						
		Width (mm)						
		Peak Height	Peak Height (µm)					
	Location (mm)							
	To 0.2 mm Diff (µm)							
	To 2.75 mm Diff (µm)							
	Back of Ring width (Top-Bottom) (mm)							
Ring Thickness (Front-Rear) (mm)								

DD13 Engine Scuffing Test

Form 27
Top Ring Measurements –Continued

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

			Top Ring						
			Cylinder						
			1	2	3	4	5	6	
180° From Gap	Ring Face	Rpk (µm)							
		Rvk (µm)							
		Rz (µm)							
		Ra (µm)							
		Rk (µm)							
		Rmr1 (%)							
		Rmr2 (%)							
		Vo ((µm*µm)/µm)							
		Width (mm)							
	Peak Height	Peak Height (µm)							
		Location (mm)							
		To 0.2 mm Diff (µm)							
		To 2.75 mm Diff (µm)							
Back of Ring width (Top-Bottom) (mm)									
Ring Thickness (Front-Rear) (mm)									

			Top Ring						
			Cylinder						
			1	2	3	4	5	6	
1" After Gap	Ring Face	Rpk (µm)							
		Rvk (µm)							
		Rz (µm)							
		Ra (µm)							
		Rk (µm)							
		Rmr1 (%)							
		Rmr2 (%)							
		Vo ((µm*µm)/µm)							
		Width (mm)							
	Peak Height	Peak Height (µm)							
		Location (mm)							
		To 0.2 mm Diff (µm)							
		To 2.75 mm Diff (µm)							
Back of Ring width (Top-Bottom) (mm)									
Ring Thickness (Front-Rear) (mm)									

DD13 Engine Scuffing Test

Form 28
2nd Ring Measurements

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

2nd Ring			
Cylinder	Serial Number	Ring Tension @ 132 mm (N)	Ring Gap @ 132 mm (mm)
1			
2			
3			
4			
5			
6			

2nd Ring							
		Cylinder					
		1	2	3	4	5	6
1" Before Gap	Face Width (mm)						
	Witness Line Width (mm)						
	Base Angle (°)						
180° From Gap	Face Width (mm)						
	Witness Line Width (mm)						
	Base Angle (°)						
1" After Gap	Face Width (mm)						
	Witness Line Width (mm)						
	Base Angle (°)						

DD13 Engine Scuffing Test

Form 29
Oil Ring Measurements

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

Oil Ring			
Cylinder	Serial Number	Ring Tension @ 132 mm (N)	Ring Gap @ 132 mm (mm)
1			
2			
3			
4			
5			
6			

Oil Ring							
		Cylinder					
		1	2	3	4	5	6
1" Before Gap	Gap Between Rails (mm)						
	Ring Width (mm)						
	Top Rail Width (mm)						
	Bottom Rail Width (mm)						
	Rail Height Differential (µm)						
180° From Gap	Gap Between Rails (mm)						
	Ring Width (mm)						
	Top Rail Width (mm)						
	Bottom Rail Width (mm)						
	Rail Height Differential (µm)						
1" After Gap	Gap Between Rails (mm)						
	Ring Width (mm)						
	Top Rail Width (mm)						
	Bottom Rail Width (mm)						
	Rail Height Differential (µm)						

DD13 Engine Scuffing Test

Form 30
Liner and Piston Cooling Jet Measurements

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

Liner	
Cylinder	Serial Number
1	
2	
3	
4	
5	
6	

		Liner					
		Cylinder					
		1	2	3	4	5	6
Average of Surface Traces at 0°, 90°, 180° and 270°	Ra (µm)						
	Rk (µm)						
	Rmr1 (%)						
	Rmr2 (%)						
	Rpk (µm)						
	Rvk (µm)						
	Vo ((µm*µm)/µm)						
Crosshatch Angle (°)							

P-Tube	
Cylinder	Serial Number
1	
2	
3	
4	
5	
6	

		P-Tube					
		Cylinder					
		1	2	3	4	5	6
Hole Diameter (mm)							

DD13 Engine Scuffing Test

Form 33
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 [^] , ppm	7 - 15			D 5453
Gravity [^] , °API	34 - 37			D 4052

[^] Measurements are stand samples.