A5. Report Forms

M11 EGR
LUBRICANT PERFORMANCE TEST

VERSION *20011030*

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 = 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 this test been conducted in a valid manner in accordance with the Test Procedure 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

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 an engine-dynamometer test which evaluates the ability of a lubricant to minimize crosshead wear, filter plugging, sludge build-up , and topring weight loss. 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 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.

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
Intake CO_2%	0.97 - 1.09	0.78 - 0.85
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

M11 EGR 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 (2.8 minimum)	
TGA SOOT % AT 250 h (8.0 - 9.5)	
TOTAL OIL CONSUMPTION, kg	

	Adjusted Average Crosshead Mass Loss (mg)	Filter Plugging Delta P (kPa)	Average Sludge Rating (merits)	Avg. Top Ring Weight Loss (mg)
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
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 Crosshead Mass Loss (mg)	Filter Plugging Delta P (kPa)	Average Sludge Rating (merits)	Avg. Top Ring Weight Loss (mg)
Original Result				
Transformed Result [B]				
Correction Factor [B]				
Corrected Transformed Result [B]				
Final Transformed Result [B]				
Final Result				

[A] Reference Tests Only

[B] Filter Plugging Delta P Value in Transformed Units

M11 EGR LUBRICANT PERFORMANCE TEST
FORM 5
OPERATIONAL SUMMARY

Laboratory	EOT Date	EOT Time
Test Number 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]
Controlled Parameters	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	Typical Values [E]		Average	
Non-controlled Parameters	Torque	N-m	TBD	TBD		
	Power	kW	TBD	TBD		
	EGR Rate	%	Record	8.5 - 9.8 [F]		
	Intake CO_2	%	0.97 - 1.09	0.78 - 0.85		
	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			

A QI values above the threshold are acceptable by the M11 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

F 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

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 [A]				

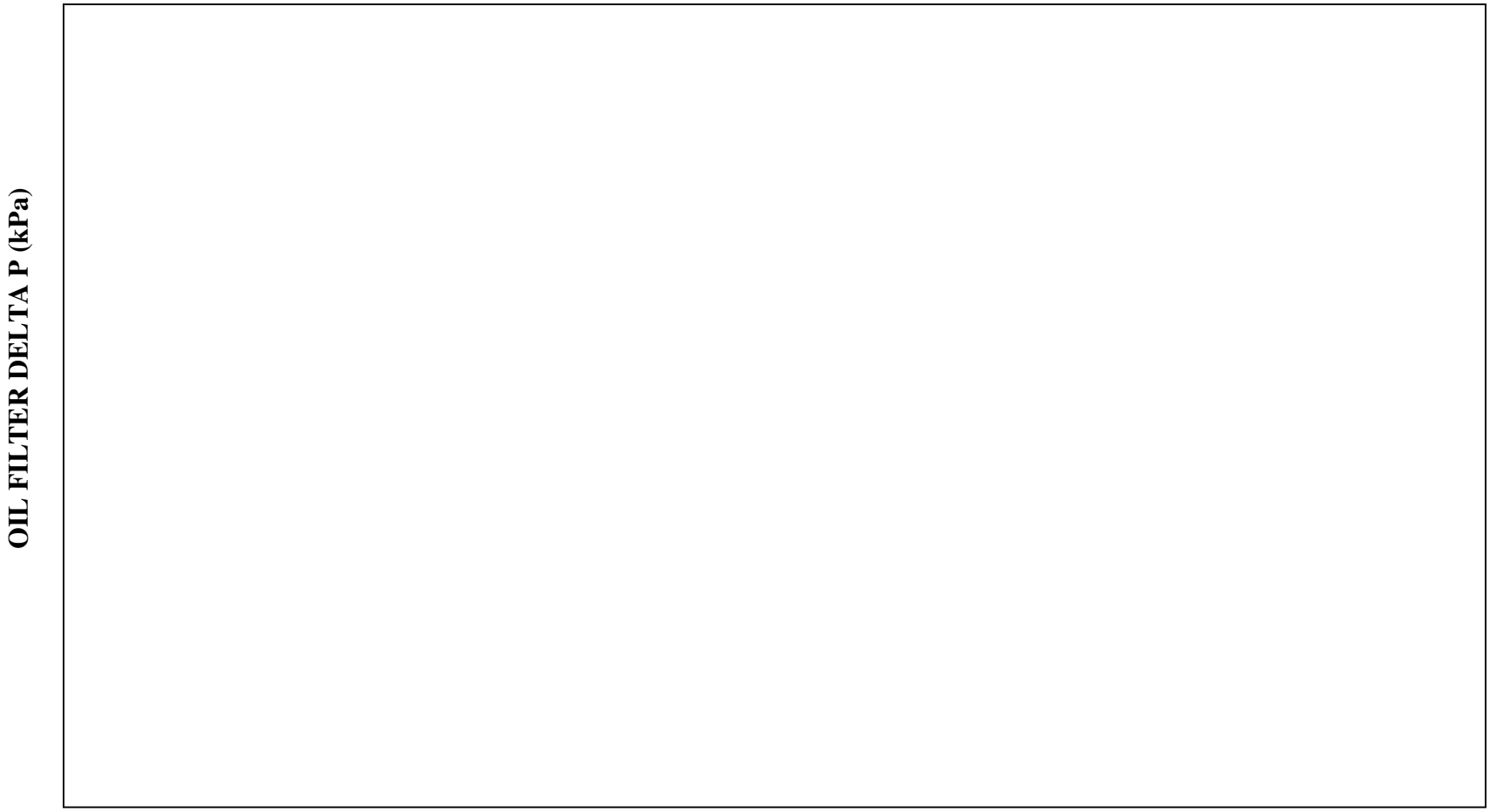
[A] Location Designation. Example: 3E

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

M11 EGR 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



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 % 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:		

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

Laboratory	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:		

	GROOVES				LANDS				DEP FACTOR	GROOVES		LANDS				OIL COOLING GALLERY (2)		UNDER CROWN (1)	
DEP.	NO. 1		NO. 2		NO. 1		NO. 2			NO. 3		NO. 3		NO. 4					
FACTOR	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:		

	GROOVES				LANDS				DEP FACTOR	GROOVES		LANDS				OIL COOLING GALLERY (2)		UNDER CROWN (1)	
DEP. FACTOR	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.
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 13
PISTON 3 DEPOSIT RATINGS

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

	GROOVES				LANDS				DEP FACTOR	GROOVES		LANDS				OIL COOLING GALLERY (2)		UNDER CROWN (1)	
DEP. FACTOR	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.
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 14
PISTON 4 DEPOSIT RATINGS

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

	GROOVES				LANDS				DEP FACTOR	GROOVES		LANDS				OIL COOLING GALLERY (2)		UNDER CROWN (1)	
DEP. FACTOR	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.
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:		

	GROOVES				LANDS				DEP FACTOR	GROOVES		LANDS				OIL COOLING GALLERY (2)		UNDER CROWN (1)	
DEP. FACTOR	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.
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:		

	GROOVES				LANDS				DEP FACTOR	GROOVES		GROOVES				OIL COOLING GALLERY (2)		UNDER CROWN (1)	
DEP. FACTOR	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.
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 17
RING MASS LOSS SUMMARY

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

	TOP RING			**SECOND RING**			**OIL RING**		
	MASS (g)		MASS LOSS (mg)	MASS (g)		MASS LOSS (mg)	MASS (g)		MASS LOSS (mg)
CYLINDER	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 18
OIL ANALYSIS SUMMARY

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

Test Hours	VISCOSITY @ 100˚C, cSt	TGA % SOOT	TBN D4739	TAN D664	COPPER (ppm)	IRON (ppm)	LEAD (ppm)	ALUMINUM (ppm)	CHROMIUM (ppm)
NEW									

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

Laboratory	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
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

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

Laboratory	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

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

Number of Downtime Occurrences			
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 (1)	SENSING DEVICE (2)	CALIBRATION FREQUENCY (3)	RECORD DEVICE (4)	OBSERVATION FREQUENCY (5)	RECORD FREQUENCY (6)	LOG FREQUENCY (7)	SYSTEM RESPONSE (8)
Temperature							
Oil Gallery							
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
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