

Mack T-12 EGR Engine Oil Test

Report Packet Version No.

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 Hours:
End Of Test Date:		End Of Test Time:	
Oil Code:			
Formulation/Stand Code:			
Alternate Codes			

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

Submitted By: _____

Testing Laboratory

Signature

Typed Name

Title

**Mack T-12 EGR Engine Oil Test
Form 2**

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**Mack T-12 EGR Engine Oil Test
Form 3**

The Mack T-12 EGR Engine Oil Test is a fuel engine-dynamometer test which evaluates the ability of a lubricant to minimize piston ring wear, cylinder liner wear, lead corrosion, oil consumption, and oxidation. This test is a two-phase, steady state test (constant speed and load), run with heavy EGR. The first phase is 100 h and is run with retarded fuel injection timing to produce elevated soot levels in the oil. The second phase is 200 h and is run under heavy load conditions to induce piston ring and cylinder liner wear.

The test engine is a Mack E-TECH V-MAC III diesel engine with EGR. It is an in-line six-cylinder, four stroke, turbocharged engine. It has electronically controlled fuel injection with six individual electronic pumps. A one h break-in is conducted prior to each test since a new engine build is used for each test.

Mack T-12 Test Conditions

Parameter	Phase I	Phase II
Time, h	100	200
Injection Timing, °BTDC	Variable	21
Speed, r/min	1800	1200
Fuel Flow, kg/h	59.2	63.5
Intake CO₂, %	3.09	1.42
Exhaust CO₂, %	9.25	9.93
Inlet Manifold Temp., °C	90	80
Coolant Out Temp., °C	66	108
Fuel In Temp., °C	40	40
Oil Gallery Temp., °C	88	116
Intake Air Temp., °C	25	25
Intake Air Restriction, kPa	3.5 – 4.0	3.5 – 4.0
Inlet Manifold Pressure, kPa	Tbd	Tbd
Exhaust Back Pressure, kPa	2.7 – 3.5	2.7 – 3.5
Crankcase Pressure, kPa	0.25 – 0.75	0.25 – 0.75
Torque, Nm	Record	Record
Pre-Turbine Exhaust Temp., °C	Record	Record
Tailpipe Exhaust Temp., °C	Record	Record
Oil Sump Temp., °C	Record	Record
EGR Pre-Venturi Temp., °C	Record	Record
Inlet Air Dew Point, °C	Record	Record
EGR Pre-Venturi Press., kPa	Record	Record
Main Gallery Oil Pressure, kPa	Record	Record
Oil Filter Delta P, kPa	Not to exceed 138	Not to exceed 138

**Mack T-12 EGR Engine Oil Test
Form 4
Test Results Summary**

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

Test Results		
Date Test Started:	Start Time:	Test Length:
TMC Oil Code: ^A	Lab Oil Code:	SAE Viscosity:
Average TGA Soot % at 100 h		
Centrifugal Oil Filter Mass Gain, g		
Oil Filter Delta P, kPa (138 maximum)		
EOT TBN		

	Delta Pb@ EOT (ppm)	Avg Liner Wear (µm)	Avg Top Ring Weight Loss (mg)	Oil Consumption (g/h)	Delta Pb 250-300h (ppm)
Original Result					
Transformed Result ^B					
Correction Factor ^B					
Corrected Transformed Result ^B					
Severity Adjustment ^B					
Final Transformed Result ^B					
Final Original Unit Result					
Mack Merits ^C					
Total Mack Merits ^C					

Last Stand Reference Results					
Test Number:					
Oil Code:					
Test Length:			TMC Oil Code:		
EOT Date:			EOT Time:		
Stand Calibration Expiration Date:					
Average TGA Soot % at 100 h					
	Delta Pb@ EOT (ppm)	Avg Liner Wear (µm)	Avg Top Ring Weight Loss (mg)	Oil Consumption (g/h)	Delta Pb 250-300h (ppm)
Final Original Unit Result					

^A Reference Tests only.

^B Transformed Units for Delta Pb only.

^C Non-reference Tests only.

**Mack T-12 EGR Engine Oil Test
Form 5
Operational Summary**

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

Parameter	Units	Threshold	EOT QI ^A	Target		Average	Samples ^B	BQD ^C	Over/Under Range ^D
				1800	1200				
Speed	r/min	0.000		1800	1200				
Fuel Flow	kg/h	0.000		59.2	63.5				
Inlet Manifold Temp.	°C	0.000		90	80				
Coolant Out Temp.	°C	0.000		66	108				
Fuel In Temp.	°C	0.000		40					
Oil Gallery Temp.	°C	0.000		88	116				
Inlet Air Temp.	°C	0.000		25					
Inlet Air Restriction	kPa			3.5 – 4.0					
Inlet Man. Pressure	kPa			tbd	Tbd				
Exh. Back Pressure	kPa			2.7 – 3.5					
Crankcase Pressure	kPa			0.25 – 0.75					
Intake CO₂	%			3.09±0.05	1.42±0.05				
Exhaust CO₂	%			9.25±0.15	9.93±0.15				
Parameter	Units	Threshold	EOT QI^A	Target		Average	Samples^B	BQD^C	Over/Under Range^D
Torque	Nm	tbd	tbd						
Brake Specific Fuel Cons.	g/kW-h	tbd	tbd						
Pre-Turbine Temp. (L)	°C	tbd	tbd						
Pre-Turbine Temp. (R)	°C	tbd	tbd						
Tailpipe Temp.	°C	tbd	tbd						
Oil Sump Temp.	°C	tbd	tbd						
EGR Pre-Venturi Temp.	°C	tbd	tbd						
Blowby	L/min	tbd	tbd						
Inlet Air Dew Point	°C	tbd	tbd						
EGR Pre-Venturi Pressure	kPa	tbd	tbd						
Main Gallery Oil Pressure	kPa	tbd	tbd						

^A QI values above the threshold are acceptable by the Mack Surveillance Panel. QI values below the threshold may not be considered acceptable based on an engineering review. Refer to Annex A5
^B Total number of data points taken. Minimum acceptable value is 3000
^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

**Mack T-12 EGR Engine Oil Test
Form 6
Rod Bearing Weight Loss**

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

Cylinder #	Location	SOT Weight, g	EOT Weight, g	Weight Change, mg
1	Upper			
2	Upper			
3	Upper			
4	Upper			
5	Upper			
6	Upper			

Summary	As Measured	Outlier Screened
Upper Bearing Average Weight Loss, mg		
Upper Bearing Weight Loss Std. Dev., mg		
Upper Bearing Minimum Weight Loss, mg		
Upper Bearing Maximum Weight Loss, mg		
Outlier Upper Rod Bearing ^A		

^A Cylinder number

Cylinder #	Location	SOT Weight, g	EOT Weight, g	Weight Change, mg
1	Lower			
2	Lower			
3	Lower			
4	Lower			
5	Lower			
6	Lower			
Lower Bearing Average Weight Loss, mg				
Lower Bearing Weight Loss Std. Dev., mg				
Lower Bearing Minimum Weight Loss, mg				
Lower Bearing Maximum Weight Loss, mg				

Conrod Bearing Batch ID	
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**Mack T-12 EGR Engine Oil Test
Form 7
Ring Weight Loss**

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

Cylinder No.	Top Ring SOT Weight, g	Top Ring EOT Weight, g	Weight Loss, mg
1			
2			
3			
4			
5			
6			

Summary	As Measured	Outlier Screened
Top Ring Average Weight Loss, mg		
Top Ring Weight Loss Std. Dev., mg		
Top Ring Minimum Weight Loss, mg		
Top Ring Maximum Weight Loss, mg		
Outlier Ring^B		

^A Results calculated without rings with plasma flanking.

^B Ring number wear results are not currently outlier screened.

Cylinder No.	2nd Ring SOT Weight, g	2 nd Ring EOT Weight, g	Weight Loss, mg
1			
2			
3			
4			
5			
6			
2nd Ring Average Weight Loss, mg			
2nd Ring Weight Loss Std. Dev., mg			
2nd Ring Min. Weight Loss, mg			
2nd Ring Max. Weight Loss, mg			

Cylinder No.	Oil Ring SOT Weight, g	Oil Ring EOT Weight, g	Weight Loss, mg
1			
2			
3			
4			
5			
6			
Oil Ring Average Weight Loss, mg			
Oil Ring Weight Loss Std. Dev., mg			
Oil Ring Minimum Weight Loss, mg			
Oil Ring Maximum Weight Loss, mg			

MACK T-12 EGR Engine Oil Test

Form 8

Oil Analysis Summary

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

Hours	Soot Wt. % TGA	Viscosity At 100°C cSt	Viscosity Increase cSt	TBN	TAN	Integrated IR Oxidation	Metal Elements (ppm)										
							Fe	Pb	Cu	Cr	Al	Si	Sn	Na	Ni		
100 (2nd)																	
100 Avg.																	

Summary	
Delta Pb @ EOT, ppm	Outlier Bearing Adjusted
Delta Pb @ 250-300h, ppm	

**Mack T-12 EGR Engine Oil Test
Form 9
Liner Surface Roughness & Bore Diameter**

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

Liner No.	Location	Ra (µm)	Bore Diameter (mm)	Avg.	Std. Dev.	Dia. (mm)
1	Top Ring Travel @ 0°C			Avg.		
	Top Ring Travel @ 90°C			Std. Dev.		
	Top Ring Travel @ 180°C			Min.		
	Top Ring Travel @ 270°C			Max.		
2	Top Ring Travel @ 0°C			Avg.		
	Top Ring Travel @ 90°C			Std.Dev.		
	Top Ring Travel @ 180°C			Min.		
	Top Ring Travel @ 270°C			Max.		
3	Top Ring Travel @ 0°C			Avg.		
	Top Ring Travel @ 90°C			Std. Dev.		
	Top Ring Travel @ 180°C			Min.		
	Top Ring Travel @ 270°C			Max.		
4	Top Ring Travel @ 0°C			Avg.		
	Top Ring Travel @ 90°C			Std.Dev.		
	Top Ring Travel @ 180°C			Min.		
	Top Ring Travel @ 270°C			Max.		
5	Top Ring Travel @ 0°C			Avg.		
	Top Ring Travel @ 90°C			Std. Dev.		
	Top Ring Travel @ 180°C			Min.		
	Top Ring Travel @ 270°C			Max.		
6	Top Ring Travel @ 0°C			Avg.		
	Top Ring Travel @ 90°C			Std. Dev.		
	Top Ring Travel @ 180°C			Min.		
	Top Ring Travel @ 270°C			Max.		

	Ra (µm)	Bore Diameter (mm)
Average Surface Roughness & Bore Diameter		
Standard Deviation Surface Roughness & Bore Diameter		
Minimum Surface Roughness & Bore Diameter		
Maximum Surface Roughness & Bore Diameter		

**Mack T-12 EGR Engine Oil Test
Form 10
Liner Wear Summary**

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

Position	Wear Step (µm)					
	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 (Anti-Thrust)						
10:00						
11:00						
12:00 (Front)						
Average						

Summary	As Measured	Outlier Screened
Average, µm		
Std. Dev., µm		
Minimum, µm		
Maximum, µm		
Outlier Liners^A		

^A Cylinder Number.

**Mack T-12 EGR Engine Oil Test
Form 12
Test Fuel Analysis (Last Batch)**

Laboratory:	EOT Date:	EOT Time:
Test Number:		
Oil Code:		
Formulation/Stand Code:		
Supplier:		Batch Identifiers:

Measurement	Specs.	Analysis		Test Method
		New	EOT	
Total Sulfur, ppm	7 - 15			D 5453
Gravity, °API	34 - 37			D 4052
Hydrocarbon Composition				
Aromatics % Wt.	26 - 31.5			D 5186
Olefins % Vol.	Report			D 1319
Cetane Index	Report			D 976
Cetane No.	43 - 47			D 613
Copper Strip Corrosion	1 Maximum			D 130
Flash Point, °C	54 Minimum			D 93
Pour Point, °C	-18 Maximum			D 97
Carbon Residue on 10% Residuum, %	0.35 Maximum			D 524 (10% Bottoms)
Water & Sediment, % Vol.	0.05 Maximum			D 2709
Viscosity, cSt @ 40°C	2.0 - 2.6			D 445
Total Acid Number	0.05 Maximum			D 664
Strong Acid Number	0.00 Maximum			D 664
Accelerated Stability	1.5 max			D 2274
Ash, % Wt.	0.005 max			D 482
SLBOCLE, g	3100 min^A			D 6078^A
90% Distillation, °C	293 - 332			D 86

^AMay be altered to be consistent with CARB or ASTM diesel fuel specifications.

**Mack T-12 EGR Engine Oil Test
Form 13
Characteristics of the Data Acquisition System**

Laboratory:	EOT Date:	EOT Time:
Test Number:		
Oil Code:		
Formulation/Stand 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							
Other							
Fuel Flow							
Engine RPM							
Load							
Inlet Restr.							
Exh. Press.							
Oil Gal. Press.							

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**
 LG - Handlog Sheet
 DL - Automatic Data Logger
 SC - Strip Chart Recorder
 C/M - Computer, Using Manual Data Entry
 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 for the output to reach 63.2% of final value for step change at input**

**Mack T-12 EGR Engine Oil Test
Form 14
Build-up and Hardware Information**

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

Injection Timing

Timing Hours	Timing (Deg)
Total Timing Changes	

Hardware

Part	Part Number	Serial Number
Primary Turbocharger		
Secondary Charger		
Cylinder Head (front)		
Cylinder Head (rear)		
Pistons		
Injection Nozzles		
Rod Bearings		
Liners		
Ring Set		

Cylinder Kit Location	CPD ID Number
Cylinder 1	
Cylinder 2	
Cylinder 3	
Cylinder 4	
Cylinder 5	
Cylinder 6	

**Mack T-12 EGR Engine Oil Test
Form 16
Rating Summary: Piston #2**

Laboratory:	EOT Date:	EOT Time:
Test Number:		
Oil Code:		
Formulation/Stand Code:		
Date Rated:	Rater Initials:	Verified By:

Total Piston Ratings Summary																		
Dep. Factor	Grooves				Dep. Factor	Lands				Groove		Lands		Oil Cooling		Under Crown		
	A, %	Dem.	No. 1	No. 2		A, %	Dem.	No. 1	No. 2	A, %	Dem.	A, %	Dem.	A, %	Dem.	A, %	Dem.	
Carbocation																		
8-9					7.5													
7-7.9																		
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																		
Clean	0	0	0	0	Clean	0	0	0	0	0	0	0	0	0	0	0	0	0
Total																		
Rating																		
Location Factor	2	3	1	3					20	20	20	60			0.5			1
Ind Rating																		
WDP																		
TLC																		
TGC																		
Unweighted Deposits																		
T. L. Flaked Carbon %																		

**Mack T-12 EGR Engine Oil Test
Form 17
Rating Summary: Piston #3**

Laboratory:	EOT Date:	EOT Time:
Test Number:		
Oil Code:		
Formulation/Stand Code:		
Date Rated:	Rater Initials:	Verified By:

Total Piston Ratings Summary																				
Dep. Factor	Grooves				Dep. Factor	Lands				Groove		Lands		Oil Cooling		Under Crown				
	A, %	Dem.	No. 1	No. 2		A, %	Dem.	No. 1	No. 2	A, %	Dem.	No. 3	Dem.	A, %	Dem.	A, %	Dem.	A, %	Dem.	
Carbocation																				
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					Clean															
Clean	0	0	0	0					0	0	0	0	0	0	0	0	0	0	0	0
Total																				
Rating																				
Location Factor	2	3	1	3					20	20	20	60	0.5	0.5	0.5	1				
Ind Rating																				
WDP																				
TLC																				
TGC																				
Unweighted Deposits																				
T. L. Flaked Carbon %																				

**Mack T-12 EGR Engine Oil Test
Form 18
Rating Summary: Piston #4**

Laboratory:	EOT Date:	EOT Time:
Test Number:		
Oil Code:		
Formulation/Stand Code:		
Date Rated:	Rater Initials:	Verified By:

Total Piston Ratings Summary																		
Dep. Factor	Grooves				Dep. Factor	Lands				Groove		Lands		Oil Cooling		Under Crown		
	A, %	Dem.	No. 1	No. 2		A, %	Dem.	No. 1	No. 2	A, %	Dem.	A, %	Dem.	A, %	Dem.	A, %	Dem.	
Carbocation																		
8-9					7.5													
7-7.9																		
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																		
Clean	0	0	0	0	Clean	0	0	0	0	0	0	0	0	0	0	0	0	0
Total																		
Rating																		
Location Factor	2	3	1	3					20	20	60	60					0.5	1
Ind Rating																		
WDP																		
TLC																		
TGC																		
Unweighted Deposits																		
T. L. Flaked Carbon %																		

**Mack T-12 EGR Engine Oil Test
Form 19
Rating Summary: Piston #5**

Laboratory:	EOT Date:	EOT Time:
Test Number:		
Oil Code:		
Formulation/Stand Code:		
Date Rated:	Rater Initials:	Verified By:

Total Piston Ratings Summary																		
Dep. Factor	Grooves				Dep. Factor	Lands				Groove		Lands		Oil Cooling		Under Crown		
	A, %	Dem.	No. 1	No. 2		A, %	Dem.	No. 1	No. 2	A, %	Dem.	A, %	Dem.	A, %	Dem.	A, %	Dem.	
Carbocation																		
8-9					7.5													
7-7.9																		
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																		
Clean	0	0	0	0	Clean	0	0	0	0	0	0	0	0	0	0	0	0	0
Total																		
Rating																		
Location Factor	2	3	1	3					20	20	20	60					0.5	1
Ind Rating																		
WDP																		
TLC																		
TGC																		
Unweighted Deposits																		
T. L. Flaked Carbon %																		

**Mack T-12 EGR Engine Oil Test
Form 21
Main Bearing Weight Loss**

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

Position No.	Location	SOT Weight, g	EOT Weight, g	Weight Change, mg
1	Upper			
2	Upper			
3	Upper			
4	Upper			
5	Upper			
6	Upper			
7	Upper			
Upper Bearing Average Weight Loss, mg				
Upper Bearing Weight Loss Std. Dev., mg				
Upper Bearing Minimum Weight Loss, mg				
Upper Bearing Maximum Weight Loss, mg				

Position No.	Location	SOT Weight, g	EOT Weight, g	Weight Change, mg
1	Lower			
2	Lower			
3	Lower			
4	Lower			
5	Lower			
6	Lower			
7	Lower			
Lower Bearing Average Weight Loss, mg				
Lower Bearing Weight Loss Std. Dev., mg				
Lower Bearing Minimum Weight Loss, mg				
Lower Bearing Maximum Weight Loss, mg				

Main Bearing Batch ID	
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**Mack T-12 EGR Engine Oil Test
Form 22
Ring Gap Measurements**

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

Cylinder No.	Top Ring Gap, mm		
	SOT	EOT	Delta (EOT-SOT)
1			
2			
3			
4			
5			
6			
Average			

Cylinder No.	2 nd Ring Gap, mm		
	SOT	EOT	Delta (EOT-SOT)
1			
2			
3			
4			
5			
6			
Average			

Cylinder No.	Oil Ring Gap, mm		
	SOT	EOT	Delta (EOT-SOT)
1			
2			
3			
4			
5			
6			
Average			

**Mack T-12 EGR Engine Oil Test
Form 23
American Chemistry Council Code of Practice
Test Laboratory Conformance Statement**

Test Laboratory					
Test Sponsor					
Formulation / Stand Code					
Test Number					
Start Date		Start Time		Time Zone	

Declarations

No. 1 All requirements of the ACC Code of Practice for which the test laboratory is responsible were met in the conduct of this test. Yes _____ No _____*

No. 2 The laboratory ran this test for the full duration following all procedural requirements; and all operational validity requirements of the latest version of the applicable test procedure (ASTM or other) including all updates issued by the organization responsible for the test, were met.
Yes _____ No _____*

If the response to this Declaration is “No”, does the test engineer consider the deviations from operational validity requirements that occurred to be beyond the control of the laboratory?
Yes _____* No _____

No. 3 A deviation occurred for one of the test parameters identified by the organization responsible for the test as being a special case. Yes _____* No _____ *(This currently applies only to specific deviations identified in the ASTM Information Letter System)*

Check The Appropriate Conclusion

	Operational review of this test indicates that the results should be included in the Multiple Test Acceptance Criteria calculations.
	*Operational review of this test indicates that the results should not be included in the Multiple Test Acceptance Criteria calculations.

Note: *Supporting comments are required for all responses identified with an asterisk.*

Comments	

Signature

Date

Typed Name

Title