

Volvo T-13 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

	Lab Is Currently Operating Under An LTMS Precision Alarm*
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* Check box only if YES

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

In my opinion this test _____ been conducted in a valid manner in accordance with the Test Method D8048 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

**Volvo T-13 Engine Oil Test
Form 2**

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**Volvo T-13 EGR Engine Oil Test
Form 3
Summary of Test Method**

The Volvo T-13 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, oxidation and nitration. This test is a single phase, steady state test (constant speed and load), run with heavy EGR.

The test engine is an in-line six-cylinder, four stroke Volvo D13 diesel engine with EGR and VGT. It has electronically controlled fuel injection with six individual electronic pumps. A break-in is conducted prior to each test according to the procedure since a new engine build is used for each test.

Volvo T-13 Test Conditions

Parameter	
Time, h	360
Speed, r/min	1500
Fuel flow kg/h	68
Coolant Out Temp., °C	110
Oil Gallery Temp., °C	130
Inlet Air Temp., °C	30
Inlet Manifold Temp., °C	78
EGR Gas Out Temp., °C	120
Fuel In Temp., °C	35
Inlet Air Pressure, kPaA	94
Inlet Manifold Pressure, kPaG	232 ± 5
Intake CO2	2.01 to 2.11
Engine Coolant Blanket Pressure, kPaG	99 to 107
EGR Coolant Blanket Pressure, kPaG	99 to 140
Crankcase Pressure, kPa	-0.3 to 0.3
Load, N-m	2200
Exhaust CO2, %	Record
Coolant In Temp., °C	Record
Crankcase Pressure, kPa	Record
Pre-Turbine Temp. (F), °C	Record
Pre-Turbine Temp. (R), °C	Record
Tailpipe Temp., °C	Record
Main Gallery Oil Pressure, kPa	Record
Oil Sump Temp., °C	Record
Oil Jet Temp., °C	Record
Oil Jet Pressure, kPa	Record
Fuel Gallery Temp., °C	Record
Fuel Gallery Pressure, kPa	Record
Intercooler Out Temp., °C	Record
Intercooler Out Pressure, kPa	Record
Compressor Out Temp., °C	Record
Compressor Out Pressure, kPa	Record
Room Temp., °C	Record
EGR Position, %	Record
VGT Position, %	Record
Throttle Position, %	Record
Blowby, L/min	Record
Inlet Air Dew Point, °C	Record

**Volvo T-13 EGR Engine Oil Test
Form 4
Test Results Summary**

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

Lab Oil Code		TMC Oil Code ^A	
SAE Viscosity		Number of Tests Since Stand Calibration ^B	

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			

	IR Peak Height @ 360 Hrs	Viscosity Increase @ 40° C (%)
Original Result		
Transformed Result ^C		
Correction Factor ^C		
Corrected Transformed Result ^C		
Severity Adjustment ^C		
Final Transformed Result ^C		
Final Original Unit Result		

Additional Results	
360 HR TBN	

Last Stand Reference Results^D		
Test Number:		
Oil Code:		
Test Length:	TMC Oil Code:	
EOT Date:	EOT Time:	
Stand Calibration Expiration Date		
	IR Peak Height @ 360 Hrs	Viscosity Increase @ 40° C (%)
Final Original Unit Result		

^A Reference Tests only.

^B Transformed Units apply to Viscosity Increase @ 40° C only.

^C Operationally valid tests only, including current test.

^D Non-reference Tests only.

**Volvo T-13 EGR Engine Oil Test
Form 5
Operational Summary
Controlled Parameters**

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

Controlled Parameters	Parameter	Units	QI Threshold	EOT QI ^A	Target	Average	Samples ^B	BQD ^C	Over/Under Range ^D
	Speed	RPM	0.000		1500				
	Torque	Nm	0.000		2200				
	Fuel Flow	kg/h	0.000		68				
	Coolant Out Temp.	°C	0.000		110				
	Oil Gallery Temp.	°C	0.000		130				
	Inlet Air Temp.	°C	0.000		30				
	Inlet Manifold Temp.	°C	0.000		78				
	EGR Gas Out Temp	°C	0.000		120				
	Fuel In Temp.	°C	0.000		35				
	Inlet Air Pressure	kPaA	0.000		94				
	Exh. Back Pressure	kPaA	0.000		115.3				
Inlet Air Moisture Content	g/kg	0.000		11.4					
Inlet Man. Pressure	kPaG	0.000		232±5					
Intake CO2	%	0.000		2.06±0.05					

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.

**Volvo T-13 EGR Engine Oil Test
Form 6
Operational Summary
Non-Controlled Parameters**

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

	Parameter	Units	Typical Values ^A	Test Average	48-192 Hr Average
Non-Controlled Parameters	Exhaust CO2	%	11		
	Coolant In Temp	°C	105		
	Crankcase Pressure	kPa	-0.10		
	Pre-Turbine Temp. (F)	°C	TBD		
	Pre-Turbine Temp. (R)	°C	TBD		
	Tailpipe Temp.	°C	427		
	Main Gallery Oil Pressure	kPa	266		
	Oil Sump Temp.	°C	138		
	Oil Jet Temp.	°C	130		
	Oil Jet Pressure	kPa	130		
	Fuel Gallery Temp	°C	87		
	Fuel Gallery Pressure	kPa	445		
	Intercooler Out Temp	°C	64		
	Intercooler Out Pressure	kPa	235		
	Compressor Out Temp	°C	212		
	Compressor Out Pressure	kPa	238		
	Room Temp	°C	34		
	EGR Position	%	78		
	VGT Position	%	55		
	Throttle Position	%	85		
Blowby	L/min	109			
Inlet Air Dew Point	°C	15			
Moisture Content Location Pressure	kPaA				

^A Typical values determined from reference oil test database

**Volvo T-13 EGR Engine Oil Test
Form 7
Rod Bearing Weight Loss**

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

Extended Test Length	
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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				

Rod Bearings ID - Upper	
Rod Bearings ID - Lower	

Volvo T-13 EGR Engine Oil Test

Form 8

Main Bearing Weight Loss

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

Extended Test Length	
----------------------	--

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 Bearings ID - Upper	
Main Bearings ID - Lower	

**Volvo T-13 EGR Engine Oil Test
Form 9
Ring Weight Loss**

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

Extended Test Length	
----------------------	--

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			
2 nd Ring Average Weight Loss, mg			
2 nd Ring Weight Loss Std. Dev., mg			
2 nd Ring Min. Weight Loss, mg			
2 nd 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			

**Volvo T-13 EGR Engine Oil Test
Form 10
Ring Gap Measurements**

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

Extended Test Length	
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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			

Top Ring ID	
2 nd Ring ID	
Oil Ring ID	

**VOLVO T-13 EGR Engine Oil Test
Form 13
Oil Consumption Calculation**

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

Hours	Average Oil Consumption (g/h)
0-24	
24-48	
48-72	
72-96	
96-120	
120-144	
144-168	
168-192	
192-216	
216-240	
240-264	
264-288	
288-312	
312-336	
336-360	
Average (48 – 192 HRS)	

**Volvo T-13 EGR Engine Oil Test
Form 14
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.	Min.	Max.
1	Top Ring Travel @ 0°			Avg.			
	Top Ring Travel @ 90°			Std. Dev.			
	Top Ring Travel @ 180°			Min.			
	Top Ring Travel @ 270°			Max.			
2	Top Ring Travel @ 0°			Avg.			
	Top Ring Travel @ 90°			Std.Dev.			
	Top Ring Travel @ 180°			Min.			
	Top Ring Travel @ 270°			Max.			
3	Top Ring Travel @ 0°			Avg.			
	Top Ring Travel @ 90°			Std. Dev.			
	Top Ring Travel @ 180°			Min.			
	Top Ring Travel @ 270°			Max.			
4	Top Ring Travel @ 0°			Avg.			
	Top Ring Travel @ 90°			Std.Dev.			
	Top Ring Travel @ 180°			Min.			
	Top Ring Travel @ 270°			Max.			
5	Top Ring Travel @ 0°			Avg.			
	Top Ring Travel @ 90°			Std. Dev.			
	Top Ring Travel @ 180°			Min.			
	Top Ring Travel @ 270°			Max.			
6	Top Ring Travel @ 0°			Avg.			
	Top Ring Travel @ 90°			Std. Dev.			
	Top Ring Travel @ 180°			Min.			
	Top Ring Travel @ 270°			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		

NOTE: Reporting of this information is NOT mandatory for T-13 Tests.

**Volvo T-13 EGR Engine Oil Test
Form 15
Liner Wear Summary**

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

Extended Test Length	
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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 [^]		

[^] Cylinder Number.

Liner ID	
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**Volvo T-13 EGR Engine Oil Test
Form 18
Rating Summary
ASTM Deposit Ratings ^A**

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

NOTE: Reporting of this information is NOT mandatory for T-13 Tests.

Piston No.	WDP	TGC	TLC	Unweighted Deposits	T. L. Flaked Carbon %
1					
2					
3					
4					
5					
6					

^A Rating values determined per ASTM Deposit Rating Manual 20

**Volvo T-13 EGR Engine Oil Test
Form 19
Rating Summary: Piston #1**

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

NOTE: Reporting of this information is NOT mandatory for T-13 Tests.

Total Piston Ratings Summary																				
C a r b o n	Dep. Factor	Grooves				Lands				Dep. Factor	Groove		Lands				Oil Cooling		Under Crown	
		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.						
	HC-1.0																			
	MC-0.5																			
	LC-.25																			
	Total																			
V a r i s h	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	
	Total																			
	Rating																			
	Location Factor		2		3		1		3			20		20		60		0.5		1
	Ind Rating																			
	WDP		TGC				TLC				Unweighted Deposits				T. L. Flaked Carbon %					

**Volvo T-13 EGR Engine Oil Test
Form 20
Rating Summary: Piston #2**

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

NOTE: Reporting of this information is NOT mandatory for T-13 Tests.

Total Piston Ratings Summary																				
C a r b o n	Dep. Factor	Grooves				Lands				Dep. Factor	Groove		Lands				Oil Cooling		Under Crown	
		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.				
	HC-1.0																			
	MC-0.5																			
	LC-.25																			
	Total																			
V a r i s h	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
	Total																			
Rating																				
Location Factor		2		3		1		3			20		20		60		0.5		1	
Ind Rating																				
WDP		TGC				TLC				Unweighted Deposits				T. L. Flaked Carbon %						

**Volvo T-13 EGR Engine Oil Test
Form 23
Rating Summary: Piston #5**

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

NOTE: Reporting of this information is NOT mandatory for T-13 Tests.

Total Piston Ratings Summary																				
C a r b o n	Dep. Factor	Grooves				Lands				Dep. Factor	Groove		Lands				Oil Cooling		Under Crown	
		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.				
	HC-1.0																			
	MC-0.5																			
	LC-.25																			
	Total																			
V a r i s h	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	
	Total																			
	Rating																			
	Location Factor	2		3		1		3			20		20		60		0.5		1	
	Ind Rating																			
	WDP					TGC				TLC		Unweighted Deposits				T. L. Flaked Carbon %				

**Volvo T-13 EGR Engine Oil Test
Form 24
Rating Summary: Piston #6**

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

NOTE: Reporting of this information is NOT mandatory for T-13 Tests.

Total Piston Ratings Summary																				
C a r b o n	Dep. Factor	Grooves				Lands				Dep. Factor	Groove		Lands				Oil Cooling		Under Crown	
		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.						
	HC-1.0																			
	MC-0.5																			
	LC-.25																			
	Total																			
V a r i s h	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	
	Total																			
	Rating																			
	Location Factor		2		3		1		3			20		20		60		0.5		1
	Ind Rating																			
	WDP						TGC							TLC				Unweighted Deposits		T. L. Flaked Carbon %

**Volvo T-13 EGR Engine Oil Test
Form 25
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 or equivalent
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% Residuam, %	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
HFRR	0.460 µm			D 6079 ^A
90% Distillation, °C	293 - 332			D 86

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

**Volvo T-13 EGR Engine Oil Test
Form 26
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

Typed Name

Date

Title