L38 Engine Evaluation of Engine Oils

Version 19990621

Title / Validity Declaration Page
Form 1

Conducted for

MICROLON CORPORATION

V	V = Valid
	I = Invalid

Test Number			
Test Stand	**Power Section**	**#of Runs on Power Section Since Last Ref Test**	**Total Runs on Power Section**
52	105	3	348
Date Completed: 20040915		**Completion Time:** 16:47	
Oil Code: GF-3 5W-30			
Formulation / Stand Code:[A]			
Alternate Codes:[B]			

In my opinion this test has been conducted in a valid manner in accordance with Test Method D5119 and the appropriate amendments through the information letter system.The remarks included in this report describe the anomalies associated with this test.

[A] *ACC-Registered Tests Only*

[B] *When Provided or Required by Client*

Submitted by:

Southwest Research Institute (R)
Testing Laboratory

Fred W. Gerhart
Signature

Fred W. Gerhart
Typed Name

Research Technologist
Title

L-38 Engine Evaluation of Engine Oils

Table of Contents

Laboratory:	SR	**Oil Code:**	GF-3 5W-30
Date Completed:	20040915		
Test Number:	52-105-3-348		
Formulation / Stand:			

[A] *ACC-Registered Tests Only*

[B] *When Requested*

[C] *Form 2 is included if run with a reference oil. Form 3 is included if run with a non-reference oil.*

L-38 Engine Evaluation of Engine Oils

Summary of Test Method

Laboratory:	SR	**Oil Code:**	GF-3 5W-30
Date Completed:	20040915		
Test Number:	52-105-3-348		
Formulation / Stand:			

Labeco L-38 Test Method, D 5119, is designed to evaluate crankcase lubricating oils for oxidation stability and resistance to corrosion, sludge and varnish when subjected to high temperature operation. When Multi Grades are tested, it also evaluates shear stability of the test oil.

This procedure involves the continuous operation of the single cylinder CLR oil evaluation engine under constant speed, air-fuel ratio and fuel flow conditions for a total of 40 hours, subsequent to a break-in period of 4 1/2 hours. Prior to each run, the engine is thoroughly cleaned, pertinent measurements of engine parts are taken, and a new piston, piston rings and new copper lead connecting rod bearing inserts are installed.

The key operating conditions of the engine of this evaluation are as follows:

Duration	40 Hours
Speed	3150 ± 25 rpm
Load	Adjusted to provide proper fuel flow at specified air : fuel ratio
Fuel Flow	4.75 ± 0.25 lbs./hr.
Air : Fuel Ratio	14.0 ± 0.5
Jacket Out Temperature	200 ± 2°F
Difference Between Jacket In and Jacket Out Temperatures	10 ± 2°F
Gallery Oil Temperature	SAE 20, 30, 50 and Multi Grades: 290 ± 2°F
	SAE 10: 275 ± 2°F

At the conclusion of the run, the engine is disassembled and the performance of the oil is judged by the following:

1) a visual examination of the engine for deposits
2) by the weight loss of the copper-lead bearing
3) by comparing the periodic oil sample analysis with the new oil analysis

These data are tabulated on the following pages. Also included are photographs of the piston and copper-lead bearing, if required.

L38 Engine Evaluation of Engine Oils

Ratings and Measurements Summary

Form 3

Test Purchaser 1:	MICROLON
Test Purchaser 2:	
Test Sponsor Oil Code:	GF-3 5W-30

Testing Lab:	SR	Test Oil Temp. (275 or 290 °F):	290
Viscosity Grade:	5W-30	Lab Internal Oil Code:	LO-194070
Test Stand No.:	52	Date Started:	20040913
Power Section No.:	105	Date Completed:	20040915
No. Runs Since Ref.:	3	Completion Time:	16:47
Runs on Power Section:	348	Test Bearing Part No.:	100034-1
Test Fuel Type:	Soltrol 10 + TEL	Bearing Batch No.:	11-93
Test Fuel Lot:	GA-469	Bearing Lot No.:	10
Test Length:	40		
Formulation / Stand Code:			

Bearing Weight Loss, mg	
Hours	40
Top	6.6
Bottom	5.3
Total	11.9
Corrected H-24 Total	26.8
Severity Adjustment	0.0
Adjusted Total	26.8

Test Stand / Power Section Reference History					
Stand No.: 52		Power Section No.: 105		Runs on Power Section:	
Bearing Batch No.: 11-93				Bearing Lot No.: 10	
Industry Ref. Oil Code	**Completion Test Date**	**Completion Time (hour)**	**Total Brg. weight loss, mg**	**Corrected H-24 Total**	**Oil Code**

Power Section Deposit Inspection Rating			
Varnish Deposits		**Sludge Deposits**	
Piston Skirt	9.80	Rocker Arms	9.90
Rocker Arm Cover	9.90	Rocker Arm Cover	9.90
Push Rod Cover	9.90	Push Rod Cover	9.90
Cylinder Wall, BRT[A]	9.90	Oil Screen	9.90
Oil Pan	9.90	Oil Pan	9.90
Crankcase Cover Plate	9.90	Crankcase Cover Plate	9.90
Total Varnish	59.30	Total Sludge	59.40

[A] *BRT-Below Ring Travel*

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Operational Summary
Form 4

Laboratory:	SR	**Oil Code:**	GF-3 5W-30
Date Completed:	20040915		
Test Number:	52-105-3-348		
Formulation / Stand:			

Operating Parameters				
Miscellaneous	**Minimum**	**Maximum**	**Average**	**Specification**
Speed, r/min	3146.0	3156.0	3150.0	(3150 ± 25)
Air/Fuel Ratio	13.9	14.2	14.0	(14.0 ± 0.5:1)
Fuel Flow, kg/h	2.09	2.26	2.19	(4.75 ± 0.25)(2.25 ±0.11kg/h)
Output, W	4.8	5.6	5.3	(Record)(bhp = 0.7456999 kW)
Oil Heater Input, W	1839.0	2089.0	1935.0	(Record)
Crankcase Off-Gas, sl/h	843.4	854.1	849.1	(30 ± 1)(850 ± 28 L/h)
Temperatures, °C				
Sump Oil	139.3	140.7	139.8	(Record)
Gallery Oil[A]	143.4	143.6	143.5	(290 or 275±2)(143.5 or 135.0±1°C)
Coolant - In	87.6	88.2	87.9	(Record)
Coolant - Out	93.2	93.8	93.5	(200 ± 2)(93.5 ± 1°C)
Delta T Coolant	5.5	5.8	5.6	(10 ± 2)(5.6 ± 1°C)
Intake Air	26.9	35.5	29.5	(Record)
Pressures				
Oil, kPa	270.0	284.0	277.0	(40 ± 2)(276 ± 14 kPa)
Intake Man. Vac., kPa	9.4	11.1	10.5	(Record)
Exhaust, kPa	-0.5	0.4	0.4	(0 to 1)(0 to 3.4 kPa)
Crankcase Vac., kPa	476.0	520.0	500.0	(2.0 ± 0.5)(500 ± 120 kPa)
Spark Advance, °BTDC	35	35	35	(35 ± 1)
Blowby, sl/h	153.0	184.0	174.0	(Record)

Oil Consumption, lb/h (lb/h = 0.4535924 kg/h)		
0 - 10 h	0.001	(Record)
10 - 20 h	0.009	(Record)
20 - 30 h	0.004	(Record)
30 - 40 h	0.009	(Record)
0 - 40 h	0.006	(Record)
Maximum Oil Consumption	0.009	(Record)

[A] *See Table 6 for Viscosity-Related Temperature*

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Power Section Measurements / Critical Parts
Form 5

Laboratory:	SR	**Oil Code:**	GF-3 5W-30
Date Completed:	20040915		
Test Number:	52-105-3-348		
Formulation / Stand:			

Power Section Measurements, inches[A]				
	Minimum	**Maximum**	**Average**	**Specification**
Valve Stem Clearance in Guide				
Inlet	0.0021	0.0025	0.0023	(0.002 - 0.004 in)
Exhaust	0.0030	0.0032	0.0030	(0.003 - 0.005 in)
Connecting Rod Bearing Clearance	0.0025	0.0028	0.0026	(0.0024 - 0.003 in)
Main Bearing Clearance				
Front	0.0020	0.0020	0.0020	(0.002 - 0.003 in.)
Rear	0.0020	0.0024	0.0022	(0.002 - 0.003 in.)
Connecting Rod Journal Out-of-Round		0.0002		(0.001 in. Max.)

Runs on Liner	13	Liner may be used as long as the piston to liner clearance is in the specified range
Piston to Liner Clearance	0.0020	0.0012 to 0.0025 in.

Oil Analysis					
Hours	**New Oil**	**10**	**20**	**30**	**40**
Acid Number	1.33	1.41	1.44	1.94	1.86
Viscosity[B] cSt @ 40°C	59.94	52.28	50.70	50.06	50.19
Viscosity[B] cSt @ 100°C	10.27	9.06	8.81	8.72	8.69
Stripped Viscosity cSt 100°C (for multiviscosity-graded oils only: see MIL-L-2104)		9.12			
% Viscosity[B] Increase, cSt @ 40°C		-12.78	-15.42	-16.48	-16.27
% Viscosity[B] Increase, cSt @ 100°C		-11.78	-14.22	-15.09	-15.38

Critical Parts Listing		
	I.D. Code	**Received Date**
Crankshaft	759	N/Avail
Camshaft	105	N/Avail
Rod Bearings		19931101
Main Bearings	8252	19931101
Camshaft Bearings	8231A	19931101
Connecting Rod	104	N/Avail
Piston	2405	19970801
Cylinder Liner	100030-1	19921001

[A] 1 in. = 25.4 mm.

[B] {°C = (°F - 32)/1.8}

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Downtime Occurrences and Other Comments

Form 6

Laboratory:	SR	**Oil Code:**	GF-3 5W-30
Date Completed:	20040915		
Test Number:	52-105-3-348		
Formulation / Stand:			

Number of Downtime Occurrences: 1

Test Hours	Date	Downtime	Reasons
01 BI	20040913	00:33	Shutdown to replace crankcase vacuum control valve.
Total Downtime			

Other Comments

Number of Comment Lines: 17

1) The test oil was a commerically available API SL 5W-30 automotive oil.

2) The 4 hour Run in and 1/2 hour Flush were conducted without MICROLON product.

3) Prior to starting the engine for the start of the 40 hour test, the engine sump was charged with 3.15 lbs of the lubricant noted in (1) above. The engine was then prelubed as per standard test protocol. After completion of the prelube, 16 fluid ounces of MICROLON metal treatment was added to the crankcase. The engine was then prelubed a second time before starting. MICROLON treatment was also added to the test fuel at this time.

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Downtime Occurrences and Other Comments

Form 6

Laboratory:	SR	**Oil Code:**	GF-3 5W-30
Date Completed:	20040915		
Test Number:	52-105-3-348		
Formulation / Stand:			

Number of Downtime Occurrences: 1

Test Hours	Date	Downtime	Reasons
Total Downtime			

Other Comments

Number of Comment Lines: 17

(4) The pass limit for the H24 corrected total bearing weight loss is
40 mg maximum. The H24 corrected bearing weight loss result for
this test provided a passing result of 26.8 mg.

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Operational Outlier Occurrences
Form 7

Laboratory:	SR	**Oil Code:**	GF-3 5W-30
Date Completed:	20040915		
Test Number:	52-105-3-348		
Formulation / Stand:			

Number of Operational Outlier Occurrences: 4

Test Hours	Parameter	Parameter Range	Reading	Time Out	Deviation Percentage
01:00	Fuel Flow	2.14 to 2.36	2.10	1:00	0.9
02:00	Fuel Flow	2.14 to 2.36	2.09	1:00	1.1
03:00	Fuel Flow	2.14 to 2.36	2.11	1:00	0.7
04:00	Fuel Flow	2.14 to 2.36	2.10	0:27	0.4

L-38 Engine Evaluation of Engine Oils

Deviations of Operational Parameters

Form 8

Laboratory:	SR	**Oil Code:**	GF-3 5W-30
Date Completed:	20040915		
Test Number:	52-105-3-348		
Formulation / Stand:			

Primary Parameter	Maximum Permitted Deviation Percentage	Calculated Total Deviation Percentage
Engine Oil Gallery Temperature	2.5%	0.0
Engine Coolant Outlet Temperature	2.5%	0.0
Engine Coolant Delta Temperature	2.5%	0.0
Fuel Flow	2.5%	3.1
Crankcase Off Gas	2.5%	0.0
Oil Pressure	2.5%	0.0
Secondary Parameters		
Engine Speed	5.0%	0.0
AFR	5.0%	0.0
Spark Advance	5.0%	0.0
Exhaust	5.0%	0.0
Crankcase Vacuum	5.0%	0.0

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Data Acqusition System Details
Form 9

Laboratory:	SR	**Oil Code:**	GF-3 5W-30
Date Completed:	20040915		
Test Number:	52-105-3-348		
Formulation / Stand:			

Parameter (1)	Sensing Device (2)	Calibration Frequency (3)	Record Device (4)	Observation Frequency (5)	Record Frequency (6)	Log Frequency (7)	System Response (8,9)
Temperatures							
Oil In	Type J TC	6 mos	C/D	4	---	SS-Hourly	<1 Sec
Coolant Out	Type J TC	6 Months	C/C	4	---	SS-Hourly	<1 Sec
Coolant Delta	Type J TC	6 Months	C/D	4	---	SS-Hourly	<1 Sec
Other							
Fuel Flow	Micro-Motion	6 Months	C/D	4	---	SS Hourly	2.4 Sec
Engine Speed	MAG Pick-up	6 Months	C/D	4	---	SS-Hourly	<1 Sec
AFR	Exh Analysis	---	C/D	4	---	SS-Hourly	2.4 Sec
Exhaust Pressure	Transducer	6 Months	C/D	4	---	SS-Hourly	<1 Sec
Crankcase Off Gas	Gas Meter	6 Months	C/D	4	---	SS-Hourly	45.6 Sec
Oil Pressure	Transducer	6 Months	C/D	4	----	SS-Hourly	2.4 Sec
Crankcase Vacuum	Transducer	6 Months	C/D	4	---	SS-Hourly	<1 Sec

Legend:

(1) Operating Parameter
(2) The Type of Device Used to Measure Temperature, Pressure or Flow:
TC - Thermocouple
(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 Recorded if 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
(9) See Annex A14 for Procedure to Determine System Response of the Characteristics of the Acquisition System

Appendix
Photographs

1. Piston Thrust & Anti-thrust
2. Connecting Rod Bearing

L-38 Engine Evaluation of Engine Oils

Laboratory:	SR	**Oil Code:**	GF-3 5W-30
Test Stand No.:	52	**Test No.:**	52-105-3-348
Laboratory Oil Code:	LO-194070	**Test Hours:**	40
Formulation / Stand Code:			

Thrust

Anti Thrust

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L-38 Engine Evaluation of Engine Oils

Laboratory:	SR	**Oil Code:**	GF-3 5W-30
Test Stand No.:	52	**Test No.:**	52-105-3-348
Laboratory Oil Code:	LO-194070	**Test Hours:**	40
Formulation / Stand Code:			

Connecting Rod Bearing