

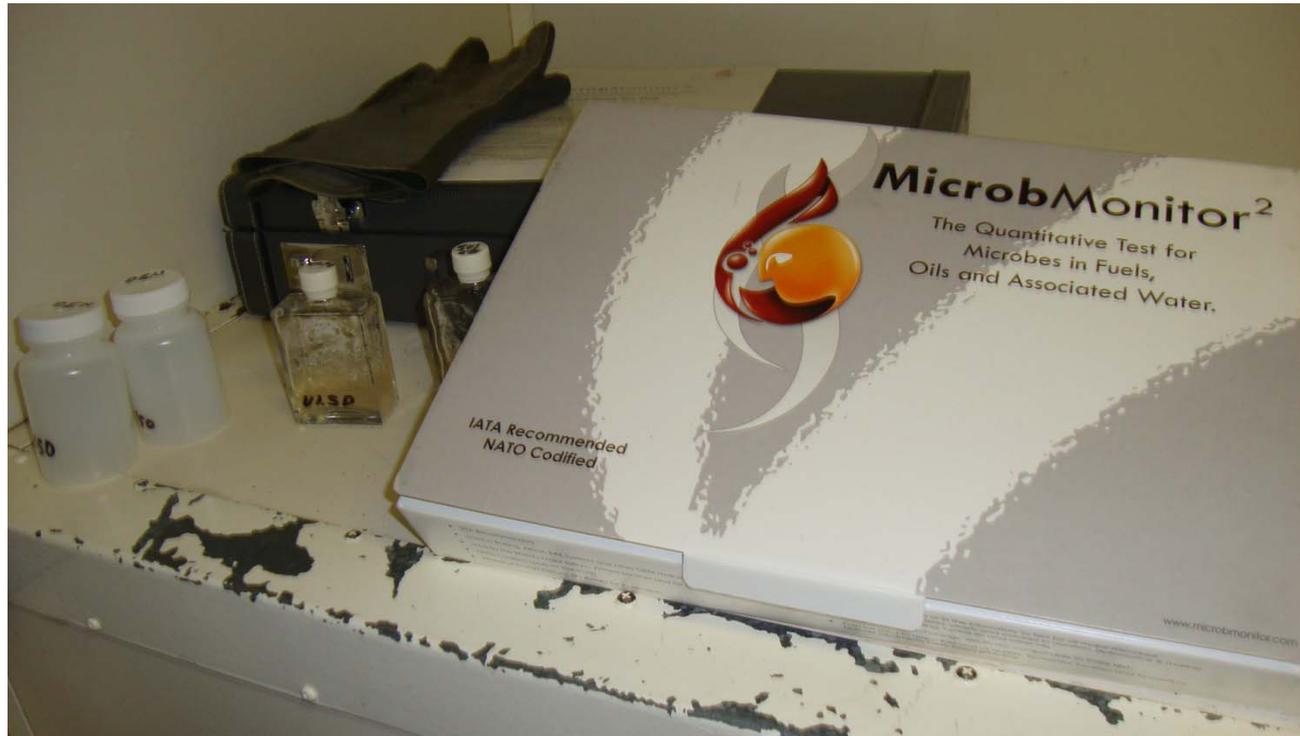
APPENDIX H

Post-Test Fluid Analysis

- Fuel Biological Contamination Assessment
- Final Fuel Certificate of Analysis
- Lube Oil Analysis Comparison

FUEL BIOLOGICAL CONTAMINATION ASSESSMENT

T/S STATE OF MICHIGAN BIOLOGICAL CONTAMINATION TEST

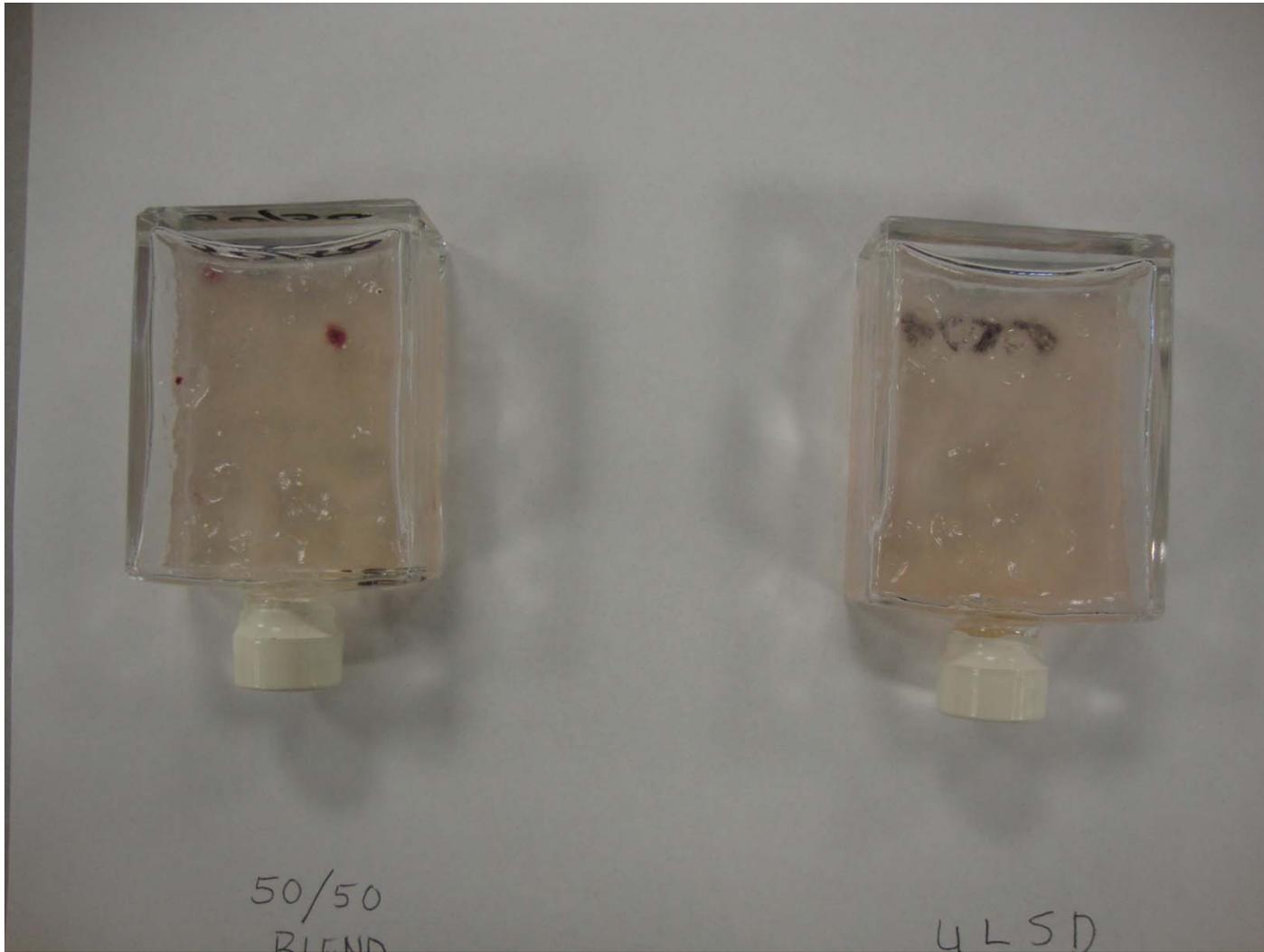


11/29/11 – 12/2/11

72 Hours

Biological Contamination Test

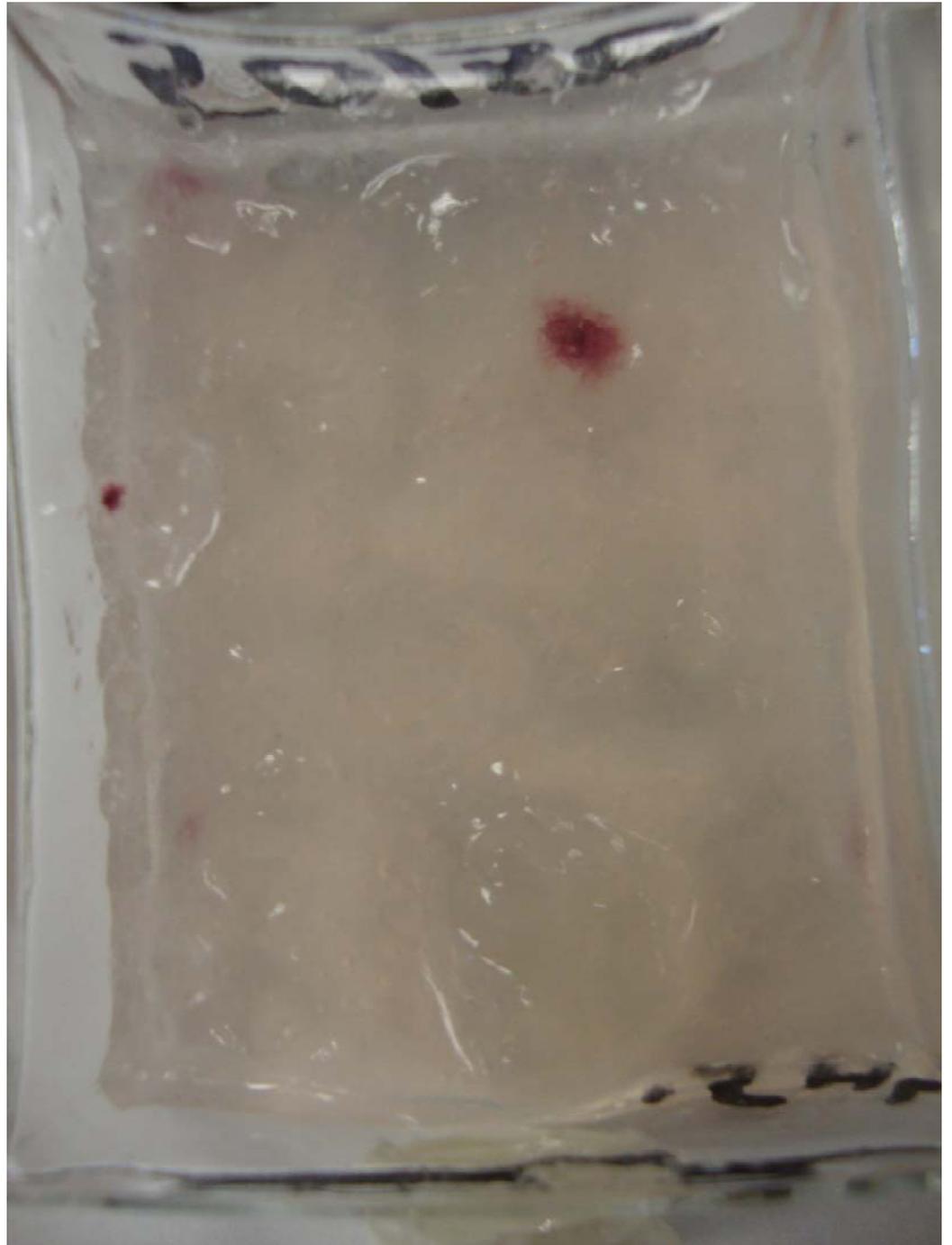
- Samples drawn from both ULSD and 50/50 blend lines as being pumped to winter storage tanks.
- ULSD showed no evidence of Bio Contamination
- 50/50 Blend test fuel showed a total of 5 colonies after 72 hours.
- Source of contamination unknown



Side-by-Side after 54 hours

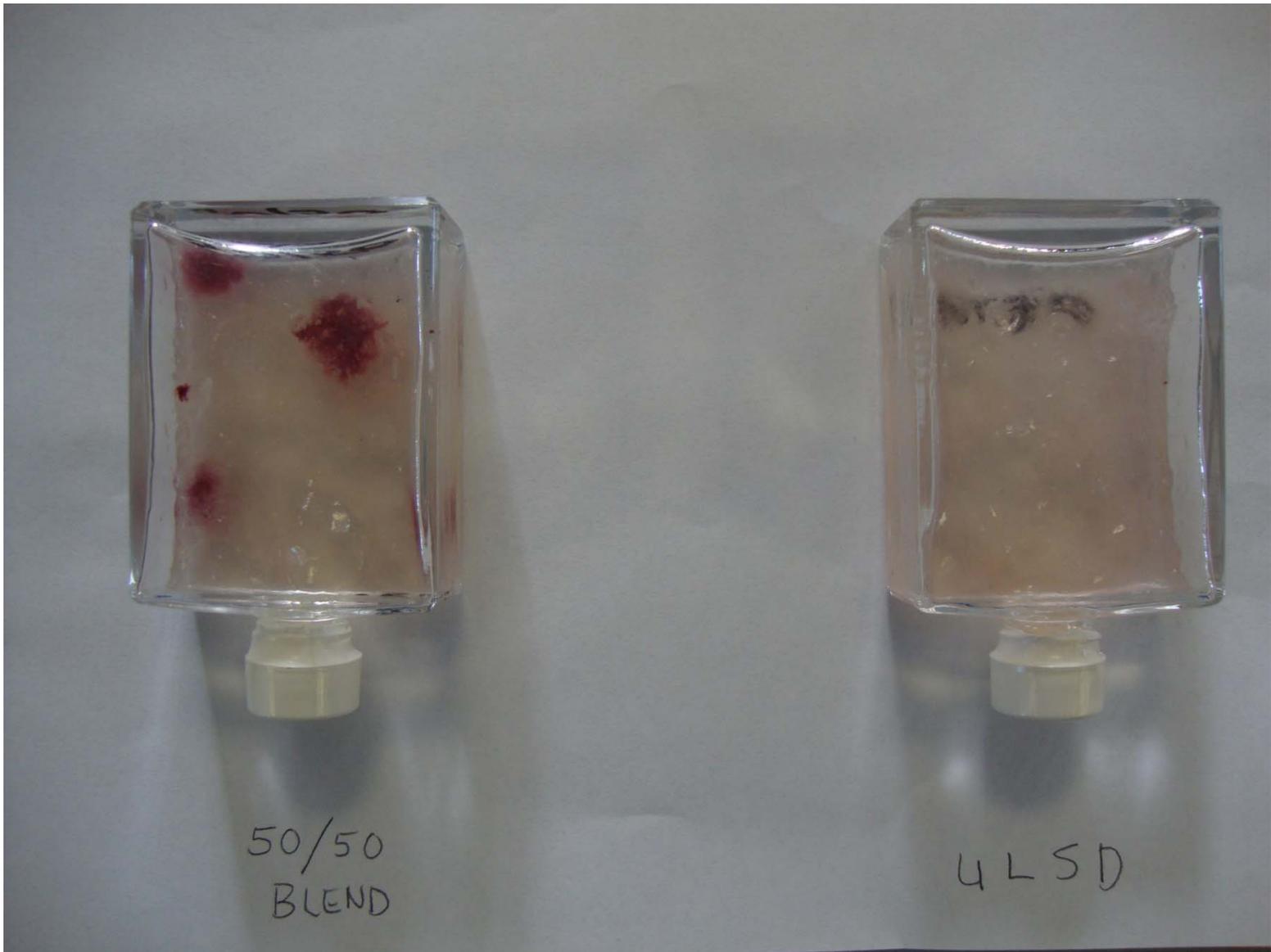


50/50 after 54 hours and close up –
observed four colonies

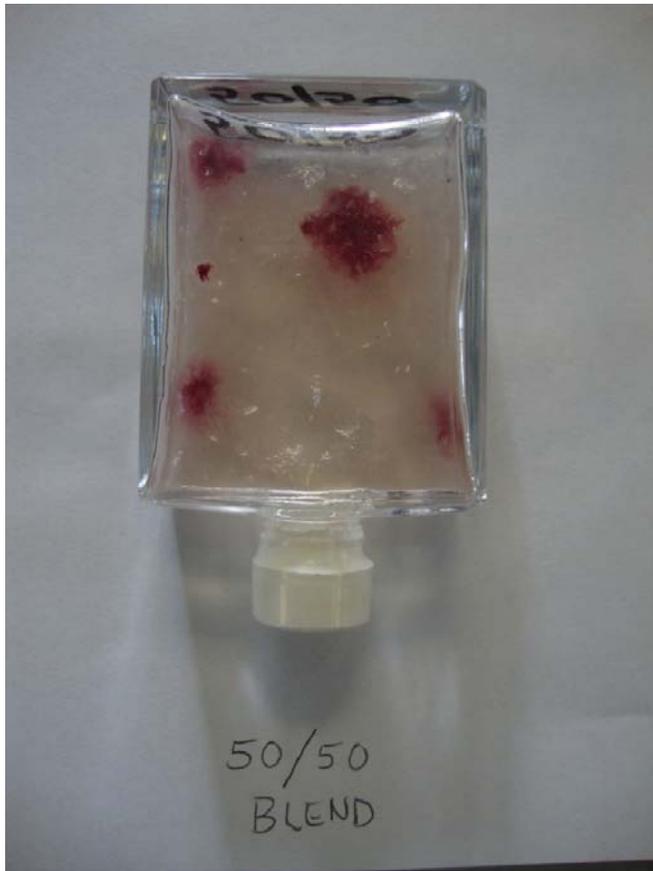




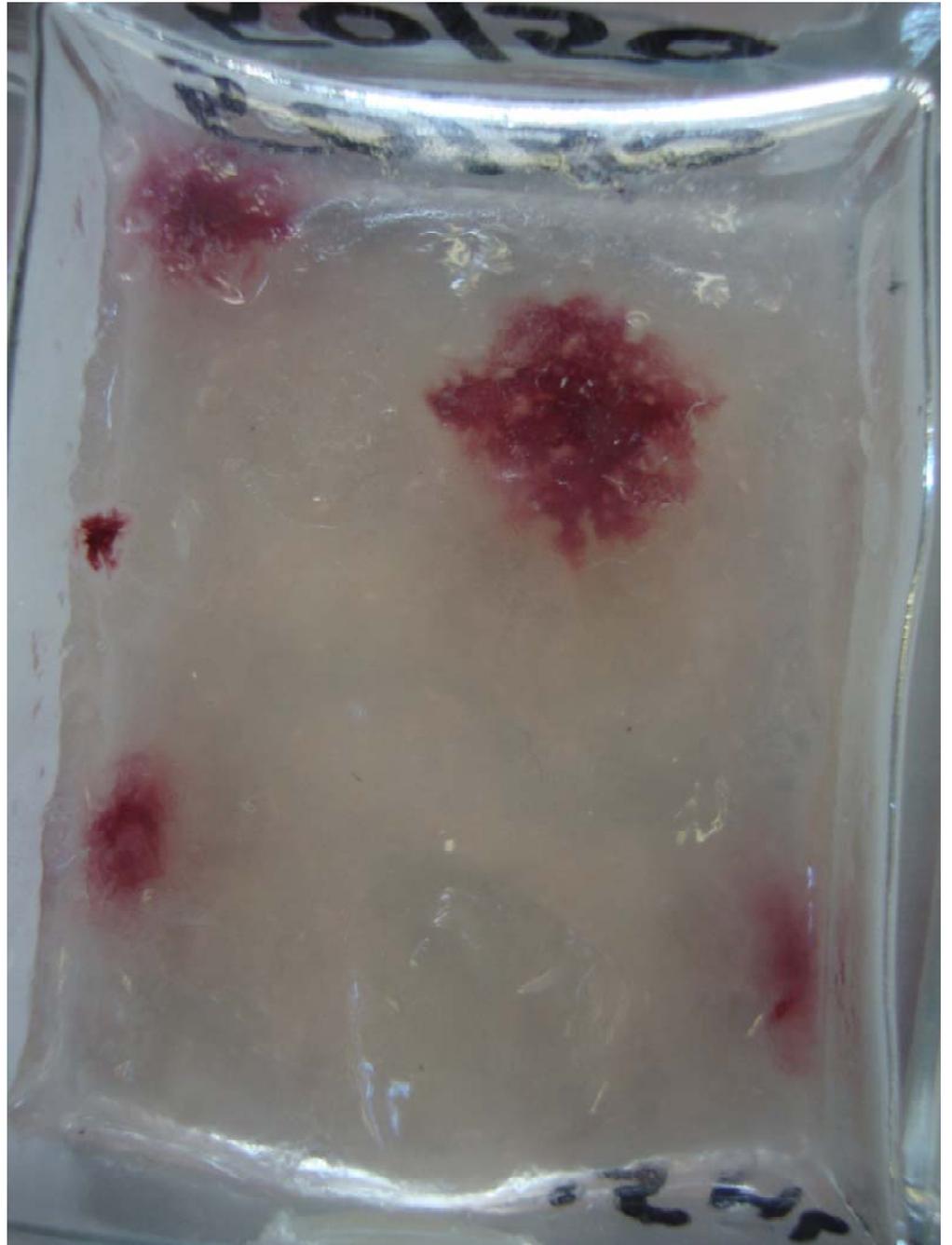
ULSD after 54 hours

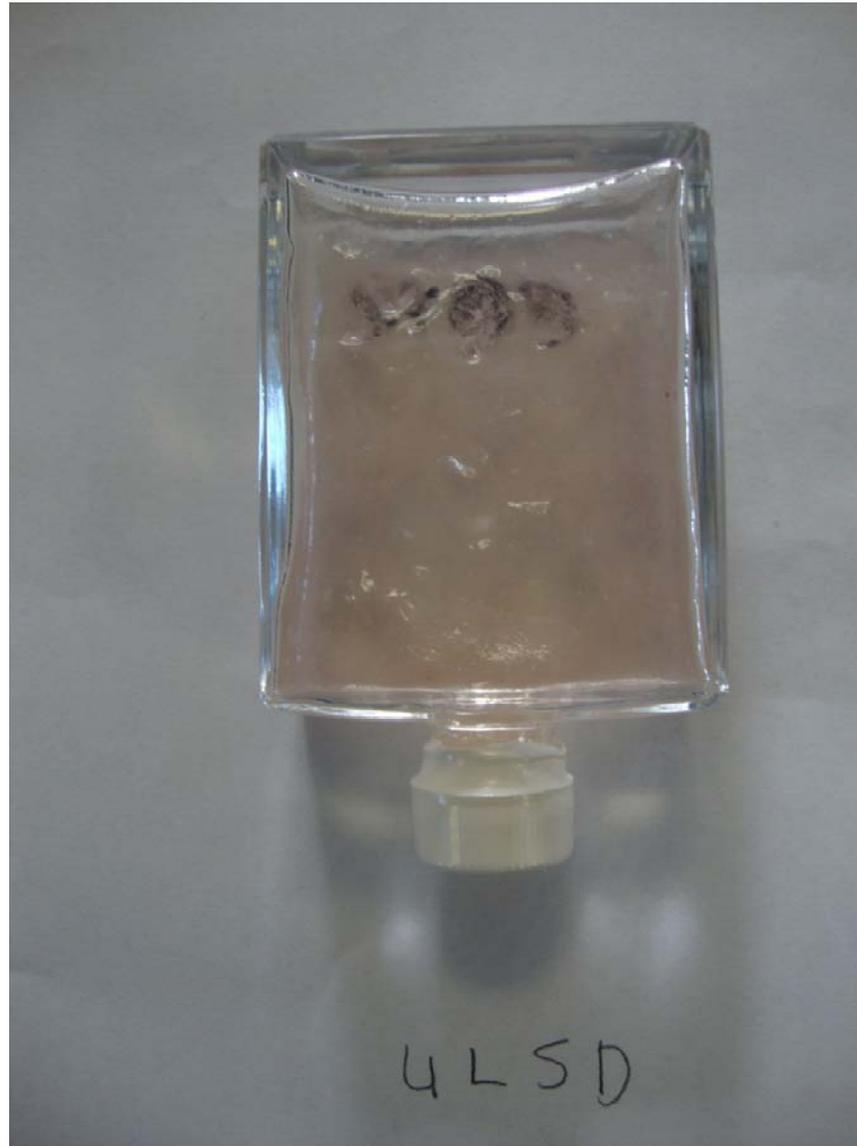


Side-by-Side after 72 hours



50/50 after 72 hours and close up –
observed five colonies





ULSD after 72 hours



MicrobMonitor

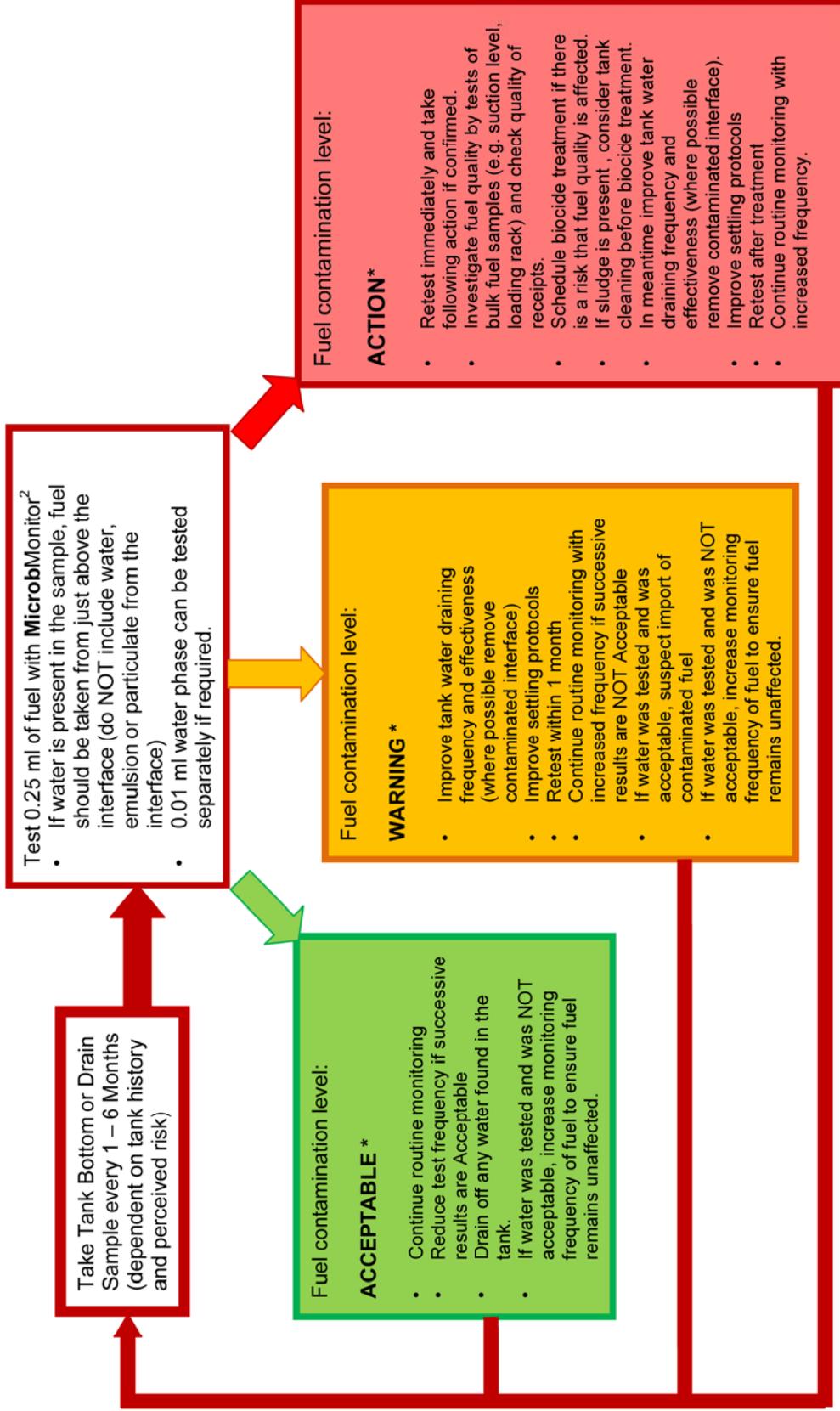
Routine Monitoring of Diesel Fuel Tanks and
Distribution Systems with **MicrobMonitor²**

Technical Guidance

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Cardiff, United Kingdom

Distributed by:

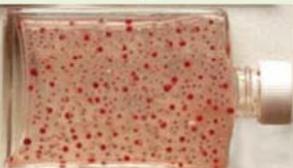
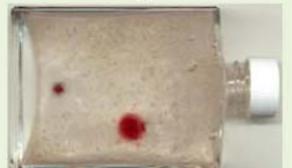
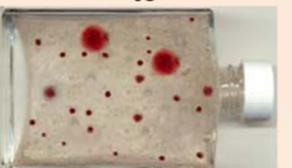
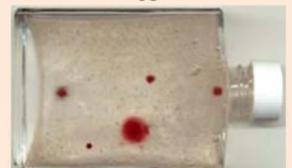
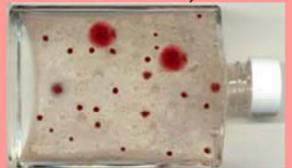
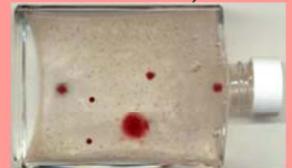
Routine Monitoring of Diesel Fuel Tanks and Distribution Systems with **MicrobMonitor**²



* See interpretation chart for more information on contamination levels in fuel and water phase in tank bottom samples and samples of bulk fuel and fuel delivered.

How to Interpret MicrobMonitor² Test Results For Diesel Samples



Interpretation	SAMPLE TYPE		
	Filter / Tank Drain or System Low Point		Bulk Fuel or Fuel Delivered (0.25 ml tested)
	Water phase (if present) (0.01 ml tested)	Fuel phase (0.25 ml tested)	
Acceptable	<p><100,000 cfu/ml (<i><1000 colonies estimated</i>)</p>  <p>to</p> 	<p>< 10,000 cfu/litre* (<i><3 colonies counted</i>)</p>  <p>to</p> 	<p><4,000 cfu/litre (<i>No colonies</i>)</p> 
	<p>100,000 - 1,000,000 cfu/ml (<i>1000 – 10,000 colonies estimated</i>)</p>  <p>to</p> 	<p>10,000 - 100,000 cfu/litre* (<i>3 - 25 colonies counted</i>)</p>  <p>to</p> 	<p>4,000 – 20,000 cfu/litre (<i>1 - 5 colonies counted</i>)</p>  <p>to</p> 
Warning (Moderate)	<p>>1,000,000 cfu/ml (<i>>10,000 colonies estimated</i>)</p> 	<p>>100,000 cfu/litre (<i>>25 colonies counted or estimated</i>)</p>  <p>to</p> 	<p>>20,000 cfu/litre (<i>>5 colonies counted or estimated</i>)</p>  <p>to</p> 

Notes on Reading Tests

*2 colonies is equivalent to 8000 cfu/litre and 3 colonies is equivalent to 12,000 cfu/litre.

The pictures shown are typical results for MicrobMonitor². The size and shape of the colonies may vary but it is the number which is important. The recommended test volume for diesel fuel is 0.25 ml. Some fuels (e.g. B100 and some marine diesels) may produce a slight uniform pink or orange discolouration in the test gel; this discolouration will not affect the test result but testing a smaller volume (e.g. 0.1 ml) can improve the ease of reading results (adjust interpretation accordingly).

Sampling

It is important when to be consistent in the procedure used for sampling and testing. Sampling equipment and sampling valves should be clean and, if possible, sterilised by rinsing or wiping with a 70% alcohol solution (ensure all residues of alcohol evaporate before taking the sample or it will affect the test result). Suitable MicrobMonitor sampling bottles and alcohol wipes are available. It is a good idea to rinse sampling equipment with fuel from the tank to be sampled before taking the sample for test. Appropriate sampling procedures are described in the Energy Institute *Guidelines for the investigation of the microbial content of petroleum fuels and for the implementation of avoidance and remedial strategies* (Energy Institute, London) and ASTM D 7464 *Standard Practice for Manual Sampling of Liquid Fuels, Associated Material, and Fuel System Components for Microbiological Testing* (ASTM International, PA, USA).

Usually, most microbial contamination will be present in the tank bottom, particularly at any fuel water interface and in water droplets suspended in the fuel. For routine monitoring, we recommend testing low point (dead bottom or drain) samples as these will provide the earliest and most consistent indication of tank contamination. Where possible, drain or bottom samples from storage tanks should be taken after any standard product settling time has been applied and immediately before tank release.

Because water phase may not always be recovered in these samples, for purposes of consistency in trend analysis, we recommend fuel phase from just above any water phase and interface is tested routinely. Ideally, the sample should be mixed gently by inverting three times and then allowed to stand for a few minutes (about 2 minutes per cm height of fuel in the sample) so that any water settles. A 0.25 ml aliquot of fuel should then be taken from half way down the fuel phase, avoiding transfer of visible interfacial particulate, water droplets or emulsion. The water phase or interface can be tested separately if required (0.01ml recommended); levels of contamination in water phase will usually be much higher than in fuel phase which is why separate guidance is given above. Note; in accordance with industry convention, water phase results are expressed per millilitre whilst fuel phase results are expressed per litre.

Once fuel samples have been taken, any microbes present will tend to slowly die and it is important to test samples as soon as possible, ideally within 48 hours. Samples will give increasingly less reliable results as they get older.

Interpretation of Test Results

There are no universally accepted standards or specification limits for microbial contamination in diesel fuel and the limit values given above are for guidance only. Variation to these limits may be appropriate in consideration of operating practice and experience and the perceived risk; in some cases more stringent standards may be appropriate for fuel in long term storage.

Low point samples will not necessarily reflect the status of bulk fuel delivered from the tank but when fuel is received into a tank it is likely to disturb any contamination on the tank bottom into the bulk fuel. Thus, heavy contamination in the tank bottom indicates a potential for contaminating bulk fuel, particularly if inadequate product settling is allowed after fuel receipts.

Increasing trends of contamination may be as important as absolute limit values. It is recommended to retest a fresh sample if moderate or heavy contamination is detected, to confirm the result before taking corrective action. In some cases contamination can be transient and corrective action is not necessary but persistent indications of moderate or heavy contamination should instigate remedial measures (seek expert advice where appropriate).

Testing bulk fuel layer samples (e.g. suction level or samples of fuel delivered to the tanker loading rack) can provide indication of status of fuel delivered from the tank and provide assurances about fuel quality. Results will be applicable to the time of sampling and it should be appreciated that microbial contamination in bulk fuel may be unevenly distributed. Contamination in bulk fuel in storage tanks may be subject to change with product settling or if tank bottoms are disturbed. Numbers of cfu/litre cannot be used alone to indicate whether fuel is fit for purpose. Where heavy contamination is indicated in bulk fuel, further investigation by a competent laboratory is recommended. Refer to the flow diagram for remedial suggestions.

This leaflet is appropriate for samples from automotive diesel, marine diesel, gas oil and heating oil systems. Other technical leaflets are available at www.microbmonitor.com

- For interpretation of results of tests of samples from **marine diesel end user tanks** please see our leaflet and EP166 *Routine Monitoring of Marine Diesel on Ships and Offshore Installations with MicrobMonitor²*.
- For interpretation of results of tests of **aviation fuel distribution system** samples please see our leaflet EP119 *How to Interpret MicrobMonitor² Test Results for Aviation Fuel Distribution System Samples*
- For interpretation of results of tests of **aviation fuel samples from aircraft** please see our leaflet and EP096 *How to Interpret MicrobMonitor² Test Results in Accordance with IATA Guidelines for Aircraft Drain Samples* .

ECHA Microbiology Ltd. does not accept any liability for any decision or assessment taken or made as a consequence of the results obtained. Please see the Instructions for Use for full conditions of use of MicrobMonitor².

FINAL FUEL CERTIFICATE OF ANALYSIS

Final Fuel Analysis

Certificate of Analysis

T/S SOM ULSD Control Fuel Sample #2

LIMS # 12041-04489

Conformance to F-76 Chemical and Physical Properties per MIL-DTL-16884L



Test	Parameter	Method	Units	Minimum	Maximum	Petroleum Diesel (F-76)
Appearance at Ambient		D4176	----	Clear & Bright		Clear & Bright
Density at 15°C		D4052	kg/m ³		876	830
Distillation	10% Recovered	D86	°C	Report		203.8
	50% Recovered		°C	Report		250.5
	90% Recovered		°C		357	309.8
	End Point		°C		385	344.5
	Residue + Loss		Volume %		3.0	1.5
Color		D1500	----		3	<5.5
Flash Point		D6450	°C	60		63.3
Particulate Contamination		D5452	mg/L		10	0.1
Carbon Residue	10% Bottoms	D524	Mass %		0.2	0.097
Hydrogen Content		D7171	Mass %	12.5		13.51
Sulfur Content, Total		D4294	Mass %		0.5	0.097
Heat of Combustion		D4809	MJ/KG			42.938

Provided by: Naval Fuels & Lubricants Cross Functional Team, AIR-4.4.5.1

POC: Emily Lim
 22229 Elmer Road, Bldg. 2360
 Patuxent River, MD 20670
 (301) 757-3426
 emily.lim@navy.mil

Certificate of Analysis

T/S SOM 50% Algae HR-76/ 50% ULSD Blend Sample #2

LIMS # 12042-04491



Conformance to F-76 Chemical and Physical Properties per ASTM D975

Test	Parameter	Method	Units	Minimum	Maximum	Petroleum Diesel (F-76)
Appearance at Ambient		D4176	----	Clear & Bright		Clear & Bright
Density at 15°C		D4052	kg/m ³		876	804
Distillation	10% Recovered	D86	°C	Report		219.5
	50% Recovered		°C	Report		270
	90% Recovered		°C		357	297.1
	End Point		°C		385	321.8
	Residue + Loss			Volume %		3.0
Color		D1500	----		3	5
Flash Point		D6450	°C	60		66.7
Particulate Contamination		D5452	mg/L		10	0.5
Carbon Residue	10% Bottom	D524	Mass %		0.2	0.064
Hydrogen Content		D7171	Mass %	12.5		14.15
Sulfur Content, Total		D4294	Mass %		0.5	0
Heat of Combustion		D4809	MJ/KG			43.4

Provided by: Naval Fuels & Lubricants Cross Functional Team, AIR-4.4.5.1

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LUBE OIL ANALYSIS COMPARISON

Lube Oil Analysis Comparison

- JOAP Lube Oil Analysis provides lube oil history
- Caterpillar sent lube oil out to their standard lab for analysis
- Caterpillar conclusion:
“Fuel Dilution indicated in engine oil – Cause: Typical Dilution for the amount of hours on the oil. Repair: Pulled another analysis and sent for testing. The sample did indicate fuel dilution though the lab suggested monitoring and not investigating. This engine has loose tolerances on the fuel system and leakage does occur. No further action Required.”

JOAP Analysis

JOINT OIL ANALYSIS PROGRAM

MARAD
SSDG CATERPILLAR 398

T/V STATE MICHIGAN
#4

Mobilgard 312

SUMMARY:
EXPERIMENTAL FUEL IN SERVICE; DROP IN VISCOSITY

Date Sampled				19-SEP-2011	26-JUN-2011	03-JUN-2011	14-JUN-2010	24-MAY-2010
Date Arrived				14-OCT-2011	18-JUL-2011	01-JUL-2011	21-JUN-2010	18-JUN-2010
Date Tested				14-OCT-2011	22-JUL-2011	07-JUL-2011		
Sample ID				10230			10J103684	10J103634
Equipment Hours				602	489	199	5205	4936
Oil Hours				602	489	198	289	63
Oil Type				Mobilgard 312				
Oil Addition				4	4	2	1	0
Temperature				Hot	Hot	Hot	Hot	Hot
		Marginal	High	Base Oil				
AES (ppm)								
Iron	Fe		76	4	7	6.6	5.4	3.6
Silver	Ag		0	0	0	0	0	0
Aluminum	Al		12	2.3	4	4.2	2.9	2.5
Chromium	Cr		9.8	0.3	0	4	3	4
Copper	Cu		39.6	0.1	2	1.9	1.4	5
Magnesium	Mg			28.1	64	69	70	51.9
Sodium	Na		168	5.6	72	14	11	4.6
Nickel	Ni			0.2	0	.1	.1	.3
Lead	Pb		21.5	0	2	1.9	1.3	.6
Silicon	Si		33	9.5	4	3.2	3.9	5.6
Tin	Sn			0	0	0	0	0
Titanium	Ti			0	0	0	0	0
Boron	B		62	2.4	1	1.4	1.4	1.1
Molybdenum	Mo			1	2	1.1	1.8	1.6
Zinc	Zn			437	458	515	493	439
Barium	Ba			1.2	0	.3	.2	1.8
Vanadium	V			0	0	2	.4	.8
Manganese	Mn			0.8	0	.4	.6	.4
Cadmium	Cd			0.1	0	.1	.4	0
FTR								
Water EP	EP			15	17	17	13	8
Antioxidant	AOX			2	1	1	1	1
Breakdown I	BRK1			1	0	0	0	0
Breakdown II	BRK2	N/A						
Water	H2O		106	34	23	17	20	15
Soot	SOOT		79	0	1	2	0	0
Oxidation	OXID		20.2	3	7	6	5	5
Nitration	NITR		20.2	5	8	7	6	6
Antwear	AWR			10	12	11	12	12
Fuel	FUEL		311	230	239	244	231	232
Sulfation	SULF		32	14	17	15	15	15
Antifreeze	GLYC		5	2	2	1	1	2
Other Fluid	OTHR	0	86	112	109	111	111	
Physical								
Chlorides	CHL	N/A						
Flashpoint (F)	FPT	N/A						
Karl Fisher (ppm)	TITR	N/A						
TAN (KOH/g)	TAN	N/A						
TBN (KOH/g)	TBN	3.25	7.5	12.9	14.1	14.3	14.5	14.6
Viscosity (cSt)	VISC	80	138	98.9	89	98	99	95
ISO								
4 microns								
6 microns								
14 microns								
Note: Parameters exceeding low reportable values will appear as blue.				Low:	N/A			
				Marginal:	N/A			
				High:				

Any questions or concerns please contact JOAP-TSC at 850.452.5627, ext 114, 103, 173, 126 or 111

Caterpillar Lube Oil Analysis Results



Equipment make: AA
 Equipment model: D 398B
 Equipment serial number: 35Z00944
 Equipment unit/fleet number: 4

Compartment: ENGINE
 Date Sample Taken:
 Date Sample Received: 12/22/11
 PSSR

Caution: Test results are informational only and carry no warranty as to a specific condition. MICHIGAN CAT provides the information without the guarantee as to the necessity for further diagnosis, repairs or other corrective action. Customer releases MICHIGAN CAT of all liability for additional diagnosis, repairs or any other subsequent expenses associated with the use of the SOS information.

MICHIGAN STATE

USA

MICHIGAN CAT
 Fluid Analysis Lab
 Toll-free assistance at:
 877-565-8561

Evaluation / Recommendation for most recent sample (lab control number: 356225)
 Resample in 50 hours or 2000 miles
 Viscosity is lower than expected
 Possible Fuel Dilution

Sample Information

Lab control number	356225	340327	340328	340329
Analysis date	12/22/11	12/06/11	12/06/11	12/06/11
Machine hours/miles	1500.0	1078.0	1550.0	1340.0
Fluid hours/miles	250.0	100.0	200.0	300.0
Quarts Make Up	0	0	0	0
Fluid Changed	No	No	No	No

Physical Analysis

Lab control number	356225	340327	340328	340329
Viscosity 40C	0.0	0.0	0.0	0.0
Viscosity 100C	10.54	11.03	10.75	11.08
Antifreeze	NEG	NEG	NEG	NEG
Fuel Oil	NEG	NEG	NEG	NEG
Total Base	0.0	0.0	0.0	0.0
Total Acid	0.0	0.0	0.0	0.0

Oil Condition

Lab control number	356225	340327	340328	340329
Percent Water	NEG	NEG	NEG	NEG
Soot	21.0	15.0	20.0	20.0
Oxidation	15.0	16.0	14.0	15.0
Nitration	41.0	33.0	39.0	39.0
Sulfur	13.0	8.0	11.0	11.0

Wear Metal

Lab control number	356225	340327	340328	340329
Molybdeum	1.0	2.0	1.0	1.0
Iron	6.0	5.0	6.0	5.0
Aluminum	1.0	1.0	2.0	3.0
Silicon	3.0	3.0	4.0	3.0
Lead	1.0	0.0	1.0	0.0
Tin	0.0	0.0	0.0	0.0
Chromium	0.0	0.0	0.0	0.0
Copper	1.0	0.0	1.0	1.0
Potassium	1.0	0.0	1.0	1.0
Sodium	4.0	6.0	3.0	2.0
Magnesium	45.0	46.0	41.0	45.0
Nickel	0.0	0.0	0.0	0.0
Phosphorus	263.0	229.0	265.0	265.0
Silver	0.0	0.0	0.0	0.0
Zinc	399.0	349.0	406.0	376.0
Calcium	4694.0	3893.0	4974.0	4809.0

Particle Count New Calibration

Lab control number	356225	340327	340328	340329
ISO 14	N/A	N/A	N/A	N/A
ISO 4	N/A	N/A	N/A	N/A
ISO 6	N/A	N/A	N/A	N/A
ISO Grade	N/A	N/A	N/A	N/A
Micron 4	N/A	N/A	N/A	N/A
Micron 6	N/A	N/A	N/A	N/A
Micron 10 New	N/A	N/A	N/A	N/A
Micron 14	N/A	N/A	N/A	N/A
Micron 18	N/A	N/A	N/A	N/A
Micron 21	N/A	N/A	N/A	N/A
Micron 38	N/A	N/A	N/A	N/A
Micron 50 New	N/A	N/A	N/A	N/A

Particle Count

Lab control number	356225	340327	340328	340329
ISO Grade	0/0	0/0	0/0	0/0
Micron 5	0.0	0.0	0.0	0.0
Micron 10	0.0	0.0	0.0	0.0
Micron 15	0.0	0.0	0.0	0.0
Micron 20	0.0	0.0	0.0	0.0
Micron 30	0.0	0.0	0.0	0.0
Micron 40	0.0	0.0	0.0	0.0
Micron 50	0.0	0.0	0.0	0.0
Micron 100	0.0	0.0	0.0	0.0