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FLUORINE FREE FOAM (F3)




FIRE TESTS

FALCK NUTEC TRAINING CENTRE

ESBJERG, DENMARK

MAY 2012

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ABBREVIATIONS

AFFF	Aqueous Film Forming Foam
ARFF	Airport Rescue and Fire Fighting
DFL	Denmark Fire Laboratories
DNA	Did Not Achieve
F	Fluorine
F3	Fluorine Free Foam
ICAO	International Civil Aviation Organisation
IPA	Isopropanol (IsoPropyl Alcohol)
MMS	Modified Military Specification Nozzle (Mil-F-24385)
PFC	PerFluoroChemical
PFOA	PerFluoroOctanoic Acid
PFOS	PerFluoroOctaneSulphonate
RPI	Resource Protection International

1.0 INTRODUCTION AND SCOPE OF WORK

Resource Protection International (RPI) was commissioned to witness this series of Fluorine Free Foam (F3) fire tests in May 2012 at the Falck Nutec Training Centre in Esbjerg, Denmark. The tests were sponsored by Dynax Corporation, a member of the Fire Fighting Foam Coalition (FFFC), with logistical support from Dafo-Fomtec and Denmark Fire Laboratories (DFL). The tests were undertaken during the week 7 to 11 May 2012. Those present from the three organisations were:

Mr Mitch Hubert	Dynax Corporation;
Dr Jan-Erik Jönsson	Dafo Fomtec AB;
Dr Barbara Chisholm	Resource Protection International.

RPI is uniquely positioned, as LASTFIRE coordinators, to provide third party witnessing services for this series of tests. Dr Barbara Chisholm is a nominated member of the LASTFIRE foam test team, and members of RPI also sit on the NFPA and EN foam committees and the LASTFIRE Steering Panel.

A full support team from Fomtec and DFL were also present to set-up each of the tests and clean up between. In addition a technician from the Falck training centre was on hand at all times to provide additional support. The hard work of each member in helping to achieve so many fire tests in a short period was invaluable.

The tests were being independently conducted to compare the fire performance of different fluorine free foam concentrates. The intention was that these tests would be conducted using the same equipment, personnel and site conditions to provide a good comparison. In addition to performing the tests using the standard UNI 86 nozzle, a modification to air aspirating foam test nozzle as described in Mil-F-24385 (US Military Specification for AFFF) was employed. This Modified Military Specification (MMS) nozzle had been developed to simulate the type of foam quality potentially encountered by some Airport Rescue and Fire Fighting (ARFF) Services and Municipal Fire Brigades around the world.

This report is provided to present a record of the tests undertaken and the results. As an independent witness of these tests it is not within RPI's scope, on this occasion, to provide any interpretation or draw any conclusions from the results of this limited series of tests using fluorine free foam concentrates. Consequently this report should not be regarded as an endorsement of any of the foam concentrates by RPI or the LASTFIRE group.

It should be noted that this series of fire tests were carried out on manufacturers' batches. As with all foam concentrate testing, RPI recommend that to obtain a true indication of performance a randomly selected sample of each batch to be delivered to a particular facility shall be tested to the appropriate standard to confirm that the concentrate provided meets the specific performance based requirements of a procurement specification.

2.0 TEST EQUIPMENT

2.1 Apparatus

The test apparatus used was as specified in the various standards.

Table 1: Standards Referenced

Document Number	Document Title
EN 1568-3:2008	Fixed Extinguishing Media – Foam Concentrates – Part 4: Specification for low expansion foam concentrates for surface application to water-immiscible liquids
EN 1568-4:2008	Fixed Extinguishing Media – Foam Concentrates – Part 4: Specification for low expansion foam concentrates for surface application to water-miscible liquids
ICAO Level B Fire Test	Airport Services Manual Part 1 Rescue and Fire Fighting 3 rd Edition: 1990 Chapter 8, Fire Test Method

For the EN 1568-3 and ICAO B tests a 2.44 m diameter test pan was used with a surface area of approximately 4.5 m². The pan depth was 200 mm. For the EN 1568-4 tests a 1.48 m diameter test pan was used with a depth of 150 mm. This pan provides a surface area of approximately 1.73 m².

All tests used a burnback pot of 300 mm diameter and 250 mm high.

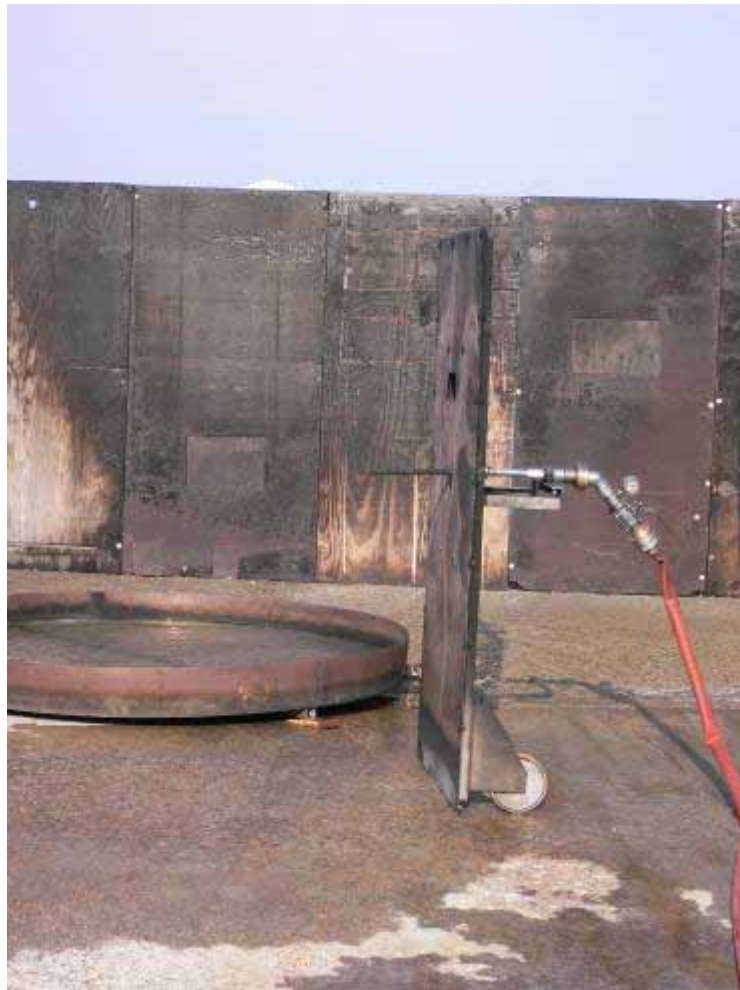
The test area was protected on three sides by plywood panels to demarcate the fire test area and provide a shield to minimise any wind effects.



Photograph 1: Fire Test Area

The nozzle was mounted horizontally in the test stand. The stand was positioned during each test and moved only to ensure that the foam stream was applied as appropriate for the test procedure. That is:

- EN 1568-3:
 - Forceful application 1 m from the tray edge furthest from the nozzle;
 - Gentle application central on the backboard 0.5 m above the fuel level;
- EN 1568-4:
 - Central on the backboard 0.5 m above the fuel level;
- ICAO Level B:
 - Centre of test pan.



Photograph 2: Foam Nozzle Support Stand



Photograph 3: 1.44 m Diameter Pan With Backboard



Photograph 4: Pre-Mix Vessels and Pump Skid

The pump skid, shown in the photograph above, had an integral electronic flow meter and pressure gauge. The calibration of the pump was checked each day using

a graduated container and stop watch. This indicated that the flow meter was accurate at the required flow rate – 11.4 lpm.

Foam concentrate was weighed using electronic scales to ensure accurate proportioning – no account of specific gravity was taken. The pre-mix was then mixed using the electric pump to recirculate within the vessel. In each case potable water was provided by Falck Nutec in the IBC above the premix vessel. This was removed and re-filled as necessary.

2.2 Foam Concentrate

This series of tests was undertaken using five different F3 concentrates provided by four foam manufacturers for these tests. The table below identifies the details taken from the containers provided. Photographs of each container are provided in Appendix B.

Table 2: Fluorine Free Foam Concentrates Provided For Fire Tests

MANUFACTURER	FOAM	BATCH	DATE OF MANUFACTURE
Solberg	Re-healing Foam RF6	110930	30-09-2011
Dr Sthamer	Moussol F-F 3/6	73727	10-2011
Solberg	Re-healing Foam RF3	110906	06-09-2011
Fomtec	Enviro 3x3 Plus	For Tests	02-05-2012
Bioex	Ecopol	00309	03-2012

A 0.5 litre sample of each fluorine free foam concentrate used was taken from the container by RPI. These samples were then sealed by RPI and taken to UK for forwarding for laboratory analysis. Photographs of the sealed samples are provided in Appendix B of this report.

Data taken from the manufacturers datasheets – provided in Appendix C – regarding foam quality and approvals is identified in Table 3 and 4 below.

Table 3: Fluorine Free Foam Quality – Manufacturers Data

MANUFACTURER	FOAM	EXPANSION	25% DRAINAGE TIME (minutes)
Solberg	Re-healing Foam RF6	8 to 20	5 to 15
Dr Sthamer	Moussol F-F 3/6	6 to 15	6 to 15 (50%)
Solberg	Re-healing Foam RF3	8 to 20	5 to 15
Fomtec	Enviro 3x3 Plus		
Bioex	Ecopol	8 @ 3% 9 @ 6%	15 @ 3% 30 @ 6%

Table 4: Fluorine Free Foam Concentrate Approvals – Manufacturers Data

MANUFACTURER	FOAM	EN 1568	ICAO
Solberg	Re-healing Foam RF6	Part 3 approval	Meets ICAO level B
Dr Sthamer	Moussol F-F 3/6	Part 3 – IIIB / IIID Part 4 – IA / IB	Meets ICAO level B
Solberg	Re-healing Foam RF3	Part 3 approval	Meets ICAO – B
Fomtec	Enviro 3x3 Plus		
Bioex	Ecopol	Complies with Part 3 – IIIB Part 4 - IA	

The Fomtec Enviro 3x3 Plus foam concentrate is currently under further development and thus no published data was available at the time of the tests.

2.3 Nozzles

Two nozzle types were used for these tests. The first set of each test was undertaken using the foam making nozzle identified in EN 1568-3 & 4: G.1.3 and in figures G3 & G4. This nozzle, commonly called the UNI 86 nozzle as specified in BS-ISO 7203-1 and ICAO Doc. 9137-AN/898, is a straight stream, air aspirating nozzle. This is designed to provide a flow rate of 11.4 lpm at a nozzle pressure of 6.3 bar. This flow rate represents an application rate of approximately:

- 2.53 lpm/m² for the 2.44 m diameter pan; and
- 6.59 lpm/m² for the 1.48 m diameter pan.

The second set of tests were carried out using a modification of the nozzle described in Mil-F-24385. Mil –F-24385 is the standard used by the US Military to qualify AFFF for use by both US and NATO Armed Forces. This air aspirated nozzle is designed to provide a foam flow rate of 2 US gpm (7.57 lpm) at an inlet pressure of 100 psi (6.9 bar). The modification made to this standard nozzle was to change the internal orifice plates and tip fittings to provide 11.4 lpm at an inlet pressure of approximately 40 psi (2.76 bar). The intention of the use of this nozzle was to replicate more closely the type of foam quality thought to be achieved by the most typically used Fire Brigade equipment around the world. A photograph of this nozzle is provided below.



Photograph 5: MMS Nozzle In Stand

It should be noted that whilst this nozzle did produce a foam of approximately half the expansion as that produced by the standard UNI 86 nozzle (as intended), the MMS nozzle is not to any official specification having been modified specifically for this series of tests.

3.0 FIRE TESTS

A full list of the fire tests carried out during the week of 7 to 11 May 2012 is provided in Table 5 below.

Table 5: Full List of Tests Undertaken

TEST NO	%	FUEL	APPLICATION	NOZZLE
Solberg - Re-healing foam – RF6				
1	6%	Heptane	Forceful	UNI 86
2		Heptane	Gentle	UNI 86
3		Jet A1	Forceful	UNI 86
4		Jet A1	Forceful	MMS
5		Heptane	Forceful	MMS
6		Heptane	Gentle	MMS
Dr Sthamer - Moussol FF 3/6				
7	3%	Heptane	Forceful	UNI 86
8		Heptane	Gentle	UNI 86
9		Jet A1	Forceful	UNI 86
10		Jet A1	Forceful	MMS
11		Heptane	Forceful	MMS
12		Heptane	Gentle	MMS
13	6%	IPA	Gentle	UNI 86
14		Acetone	Gentle	UNI 86
Solberg - Re-healing foam – RF3				
15	3%	Heptane	Forceful	UNI 86
16		Heptane	Gentle	UNI 86
17		Heptane	Forceful	MMS
18		Heptane	Gentle	MMS
Fomtec - Enviro 3x3 Plus				
19	3%	Heptane	Forceful	UNI 86
20		Heptane	Gentle	UNI 86
21		Heptane	Forceful	MMS
22		Heptane	Gentle	MMS
23		IPA	Gentle	UNI 86
24		Acetone	Gentle	UNI 86
25		IPA	Gentle	MMS
Bioex - Ecopol				
26	3%	Heptane	Gentle	UNI 86
27		Heptane	Gentle	MMS

TEST NO	%	FUEL	APPLICATION	NOZZLE
28	6%	IPA	Gentle	UNI 86
29		Acetone	Gentle	UNI 86
30		IPA	Gentle	MMS
Solberg - Re-healing foam RF6				
31	6%	Heptane	Forceful	UNI 86
32		Heptane	Gentle	UNI 86
33		Heptane	Forceful	MMS
34		Heptane	Gentle	MMS
Solberg - Re-healing foam RF3				
35	3%	Jet A1	Forceful	UNI 86
36		Jet A1	Forceful	MMS
Bioex - Ecopol				
37	3%	Jet A1	Forceful	UNI 86
Fomtec – Enviro 3x3 Plus				
38	3%	Jet A1	Forceful	UNI 86

Of these tests:

- Tests 1 to 14 inclusive were undertaken on 8 May 2012;
 - Sunny intervals, dry, gusty wind at times;
- Tests 15 to 30 inclusive were undertaken on 9 May 2012;
 - Overcast, still, slight drizzle in morning;
- Tests 31 to 38 inclusive were undertaken on 10 May 2012 (afternoon);
 - Overcast, rain spells, light wind; becoming dry with gusty wind.

Table 6 provides the temperatures recorded for each test: - air, fuel and premix.

Table 6: Test Temperatures

TEST NO	DATE	AIR TEMP. °C	FUEL TEMP. °C	PREMIX TEMP. °C
1	8-May	12.5	7.6	9.9
2		12.5	7.6	9.9
3		14.7	8.7	10.5
4		12.6	10.2	8.9
5		11.4	12.1	11.2
6		11.4	12.1	11.2
7	8-May	10.5	11.5	12.2
8		10.5	11.5	12.2
9		10.6	13.5	14.2
10		12.1	14.4	13.7
11		14.7	11.1	12.4
12		14.7	11.1	12.4
13		15.1	14.2	11.9
14		15.1	14.2	11.9
15	9-May	12.3	11.3	11.4
16		12.3	11.3	11.4
17		14.8	11.5	12.3
18		14.9	11.5	12.3
19	9-May	14.6	11.5	12.6
20		14.6	11.5	12.6
21		16.5	14.8	14.3
22		16.5	14.8	14.3
23		14.7	14.5	14.7
24		14.7	14.5	14.7
25		16.4	14.6	14.7
26	9-May	14.8	14.6	14.2
27		14.2	14.3	14.1
28		13.9	13.7	14.0
29		13.9	13.7	14.0
30		13.2	13.3	12.9
31	10-May	14.9	11.8	12.5
32		14.9	11.8	12.5
33		14.5	11.5	12.9
34		14.5	11.5	12.9
35	10-May	14.5	12.9	11.4
36		14.5	12.9	11.4
37	10-May	14.4	12.9	11.4
38	10-May	14.4	12.9	11.4

All tests were fully documented and recorded on video. One video camera ran for the full length of each test providing an overview of the full test. A second video camera was then used to focus on the foam blanket after the pre-burn period and specifically for the burnback period.

Test numbers 31 to 34 inclusive were essentially repeats of tests 1, 2, 5 and 6. These were repeated to see if it was possible to identify if the weather conditions on the Tuesday (dry with sunny spells and gusty winds at times) had substantially affected the tests.

3.1 Fire Tests To EN 1568-3

These tests were performed following the test methodology provided in Appendix H of EN 1568-3: Fire extinguishing media – Foam concentrates; Part 3: Specification for low expansion foam concentrates for surface application to water-immiscible liquids. In each case the foam solution was prepared using potable water with heptane as the fuel.

In line with the recommendations of Annex H, screens had been erected around the test area. Additional wind-screens were provided, as required, during the burnback period.

For each test sheet the following parameters were recorded:

- Location;
- Foam concentrate;
- Air temperature;
- Fuel temperature;
- Foam solution temperature.

As this series of tests was intended to provide a comparison of fluorine free foam concentrates rather than to provide a formal classification of each product, only two tests were undertaken for each. For each foam concentrate a forceful application fire test was done followed by a gentle application; this was undertaken for the UNI 86 nozzle and the MMS nozzle. The table below identifies the test procedures followed in each case.

Table 7: Fire Test Procedure – EN 1568-3

Fire Test Procedure	Forceful Application (seconds / minutes)	Gentle Application (seconds / minutes)
Pre-burn Time	60 / 1	60 / 1
Foam Application	180 / 3	300 / 5
Burnback Wait Period	300 / 5	300 / 5

For each test the following times were recorded:

- 90% control;
- 99% control;
- extinction; and
- 25% burnback.

For each pair of tests the foam quality was also tested to record expansion and 25% drainage time. In each case foam samples were collected by RPI, with assistance from Dynax, with RPI carrying out the calculations as verification of foam quality.

Table 8: Foam Quality Analysis For Fire Tests to EN 1568-3

TEST NO	NOZZLE	EXPANSION	25% DRAINAGE	PREMIX CONC.
SOLBERG RF6				
1	UNI 86	9.25	25' 16"	6%
5	MMS	4.6	10' 25"	6%
31	UNI 86	8.8	18' 25"	6%
33	MMS	5.03	9' 33"	6%
DR STHAMER – MOUSSOL FF 3/6				
7	UNI 86	9.3	16' 57"	3%
11	MMS	4.5	6' 04"	3%
SOLBERG - RF3				
15	UNI 86	8.5	21' 32"	3%
17	MMS	4.2	18' 28"	3%
FOMTEC - ENVIRO 3x3 PLUS				
19	UNI 86	8.7	19' 11"	3%
21	MMS	5.1	15' 34"	3%
BIOEX - ECOPOL				
26	UNI 86	8.7	18' 04"	3%
27	MMS	4.4	5' 58"	3%

The results of these tests are recorded in Table 9 below. The results have been normalised so that control and extinction times relate to the start of foam application and 25% burnback times relate to the lighting of the burnback pot.

It should also be noted here that whilst Fomtec scored the majority of these tests in agreement with RPI and under their supervision, tests 19 and 21 (Fomtec foam) and tests 31 and 33 were scored directly by RPI.

Table 9: Results From Fire Tests To EN 1568-3

TEST NO	NOZZLE	90% CONTROL	99% CONTROL	EXTINCTION	25% BURNBACK	CLASS
SOLBERG - RF6						
1-F	UNI 86	0' 45"	1' 25"	None	N/A	Fail
2-G	UNI 86	0' 35"	1' 00"	None	N/A	Fail
5-F	MMS	0' 45"	1' 20"	None	N/A	Fail
6-G	MMS	1' 00"	1' 40"	None	N/A	Fail
DR STHAMER - MOUSSOL FF 3/6						
7-F	UNI 86	0' 50"	1' 10"	None	N/A	Fail
8-G	UNI 86	0' 40"	1' 20"	None	N/A	Fail
11-F	MMS	0' 55"	DNA	None	N/A	Fail
12-G	MMS	1' 00"	1' 45"	None	N/A	Fail
SOLBERG - RF3						
15-F	UNI 86	0' 45"	1' 20"	1' 49"	6' 00"	*
16-G	UNI 86	0' 35"	1' 20"	2' 17"	24' 30"	IB
17-F	MMS	0' 40"	3' 00"	None	N/A	*
18-G	MMS	0' 45"	1' 55"	4' 05"	23' 30"	IIIB
FOMTEC - ENVIRO 3x3 PLUS						
19-F	UNI 86	0' 40"	1' 15"	2' 09"	5' 55"	*
20-G	UNI 86	0' 35"	1' 05"	1' 40"	21' 50"	IB
21-F	MMS	0' 50"	DNA	None	N/A	*
22-G	MMS	0' 45"	1' 30"	2' 50"	12' 45"	IIIC
BIOEX - ECOPOL						
26-G	UNI 86	0' 45"	1' 25"	2' 08"	17' 00"	IIIB
27-G	MMS	1' 25"	2' 10"	None	(10' 40")	Fail
SOLBERG - RF6						
31-F	UNI 86	0' 25"	1' 00"	None	N/A	Fail
32-G	UNI 86	0' 35"	1' 00"	None	N/A	Fail
33-F	MMS	0' 40"	2' 50"	None	N/A	*
34-G	MMS	0' 55"	1' 15"	3' 40"	13' 00"	IIIC

In Table 9,;

- F = forceful application;
- G = gentle application;
- DNA = did not achieve;
- DNE = did not extinguish;
- * = test continued with gentle application to determine burnback resistance performance level.

Whilst it was not the intention of this series of tests to formally classify the foam concentrates used, where possible a potential classification has been identified from

these results. This classification is based on the requirements of EN 1568-3 as summarised in the table below.

Table 10: Classification of Foam Concentrates To EN 1568-3

Extinguishing Performance Class	Burnback Resistance Level	Gentle Application		Forceful Application	
		Extinction Time ≤	Burnback Time ≤	Extinction Time ≤	Burnback Time ≤
I	A	Not Applicable		3	10
	B	5	15	3	Not Applicable
	C	5	10	3	
	D	5	5	3	
II	A	Not Applicable		4	10
	B	5	15	4	Not Applicable
	C	5	10	4	
	D	5	5	4	
III	B	5	15	Not Applicable	
	C	5	10		
	D	5	5		

3.2 Fire Tests To EN 1568-4

These tests were performed following the test methodology provided in Appendix H of EN 1568-4: Fire extinguishing media – Foam concentrates; Part 4: Specification for low expansion foam concentrates for surface application to water-miscible liquids. In each case the foam solution was prepared using potable water with isopropanol (IPA) or acetone as the fuel. The fuel used for each test is identified in Table 12.

In line with the recommendations of Annex H, screens had been erected around the test area. Additional wind-screens were provided, as required, during the burnback period.

For each test sheet the following parameters were recorded:

- Location;
- Foam concentrate;
- Air temperature;
- Fuel temperature;
- Foam solution temperature.

As this series of tests was intended to provide a comparison of fluorine free foam concentrates rather than to provide a formal classification of each product, only two tests were undertaken for each. For each foam concentrate a forceful application fire test was done followed by a gentle application; this was undertaken for the UNI 86 nozzle and the MMS nozzle. The table below identifies the test procedures followed in each case.

Table 11: Fire Test Procedure – EN 1568-4

Fire Test Procedure	Gentle Application Class I (seconds / minutes)	Gentle Application Class II (seconds / minutes)
Pre-burn Time	120 / 2	
Foam Application	180 / 3	300 / 5
Wait After Foam Application	300 / 5	

For each test the following times were recorded:

- 90% control;
- 99% control;
- extinction; and
- 25% burnback.

For each pair of tests the foam quality was also tested to record expansion and 25% drainage time. In each case foam samples were collected by RPI, with assistance from Dynax, with RPI carrying out the calculations as verification of foam quality.

Table 12: Foam Quality Analysis For Fire Tests to EN 1568-4

TEST NO	NOZZLE	EXPANSION	25% DRAINAGE	PREMIX CONC.
SOLBERG RF6 – not applicable				
DR STHAMER – MOUSSOL FF 3/6				
13	UNI 86	9.1	45' 30"	6%
SOLBERG – RF3 – not applicable				
FOMTEC – ENVIRO 3x3 PLUS				
23	UNI 86	8.2	19' 22"	3%
25	MMS	5.0	16' 15"	3%
BIOEX - ECOPOL				
28	UNI 86	8.1	44' 27"	6%
30	MMS	4.9	21' 57"	6%

The results of these tests are recorded in Table 13 below. The results have been normalised so that control and extinction times relate to the start of foam application and 25% burnback times relate to the lighting of the burnback pot.

It should also be noted here that whilst Fomtec scored the majority of these tests in agreement with RPI and under their supervision, tests 23, 24 and 25 (Fomtec foam) were scored directly by RPI.

Table 13: Results From Fire Tests To EN 1568-4

TEST NO	NOZZLE	90% CONTROL	99% CONTROL	EXTINCTION	25% BURNBACK	CLASS
SOLBERG - RF6 – not applicable						
DR STHAMER - MOUSSOL FF 3/6 @ 6%						
13-IPA	UNI 86	DNA	DNA	None	N/A	Fail
14-ACETONE	UNI 86	1' 15"	1' 35"	2' 15"	12' 15"	IB
SOLBERG - RF3 – not applicable						
FOMTEC - ENVIRO 3x3 PLUS						
23-IPA	UNI 86	1' 25"	1' 55"	2' 06"	15' 15"	IA
24-ACETONE	UNI 86	0' 25"	0' 45"	1' 04"	16' 55"	IA
25-IPA	MMS	1' 45"	2' 10"	2' 57"	15' 30"	IA
BIOEX - ECOPOL – 6%						
28-IPA	UNI 86	1' 50"	2' 25"	3' 00"	8' 45"	IC
29-ACETONE	UNI 86	0' 30"	0' 45"	1' 12"	19' 00"	IA
30-IPA	MMS	DNA	DNA	None	N/A	Fail

In Table 13.:

- F = forceful application;
- G = gentle application;
- DNA = did not achieve;
- DNE = did not extinguish;

Whilst it was not the intention of this series of tests to formally classify the foam concentrates used, where possible a potential classification has been identified from these results. This classification is based on the requirements of EN 1568-4 as summarised in the table below.

Table 14: Classification of Foam Concentrates To EN 1568-4

Extinguishing Performance Class	Burnback Resistance Level	Gentle Application	
		Extinction Time ≤	Burnback Time ≤
I	A	3	15
	B	3	10
	C	3	5
II	A	5	15
	B	5	10
	C	5	5

3.3 Fire Tests To ICAO Level B

These tests were performed following the test methodology provided in ICAO Airport Services Manual Part 1 Rescue and Fire Fighting 3rd Edition: 190 Chapter 8, Fire Test Method. In each case the foam solution was prepared using potable water with Jet A-1 (Gropasol D40) as the fuel.

In line with the EN tests undertaken, screens had been erected around the test area. Additional wind-screens were provided, as required, during the burnback period.

For each test sheet the following parameters were recorded:

- Location;
- Foam concentrate;
- Air temperature;
- Fuel temperature;
- Foam solution temperature.

As this series of tests was intended to provide a comparison of fluorine free foam concentrates rather than to provide a formal classification of each product, two tests were undertaken for each. For each foam concentrate a fire test was carried out using the UNI 86 nozzle. The MMS nozzle was also used with the Solberg foams and Dr Sthamer. The table below identifies the test procedure followed in each case.

Table 15: Fire Test Procedure – ICAO Level B

Fire Test Procedure	Forceful Application (seconds / minutes)
Pre-burn Time	60 / 1
Foam Application	120 / 2
Wait After Foam Application	120 / 2

For each test the following times were recorded:

- 90% control;
- 99% control;
- extinction; and
- 25% burnback.

For each test the foam quality was also tested to record expansion and 25% drainage time. In each case foam samples were collected by RPI, with assistance from Dynax, with RPI carrying out the calculations as verification of foam quality.

Table 16: Foam Quality Analysis For Fire Tests To ICAO B

TEST NO	NOZZLE	EXPANSION	25% DRAINAGE	PREMIX CONC.
SOLBERG - RF6				
3	UNI 86	9.64	18' 26"	6%
4	MMS	4.8	10' 56"	6%
DR STHAMER - MOUSSOL FF 3/6				
9	UNI 86	10.2	15' 07"	3%
10	MMS	4.93	5' 35"	3%
SOLBERG - RF3				
35	UNI 86	9.6	16' 16"	3%
36	MMS	4.5	18' 38"	3%
FOMTEC - ENVIRO 3x3 PLUS				
38	UNI 86	8.5	22' 57"	3%
BIOEX - ECOPOL				
37	UNI 86	7.4	17' 00"	3%

The results of these tests are recorded in Table 17 below. The results have been normalised so that control and extinction time relate to the start of the foam application and 25% burnback times relate to the lighting of the burnback pot.

It should be noted here that the Solberg RF6 and Dr Sthamer Moussol FF 3/6 tests were scored by Fomtec in agreement with RPI and under their supervision, the remainder of the tests were scored directly by RPI.

Whilst it was not the intention of this series of tests to formally classify the foam concentrates used, where possible a potential classification has been identified from these results. This classification is based on the requirements for ICAO Level B performance, summarised as:

- Extinguishing time ≤ 60 seconds and
- 25% burnback time ≥ 5 minutes

Table 17: Results From Fire Tests To ICAO Level B

TEST NO	NOZZLE	90% CONTROL	99% CONTROL	EXTINCTION	25% BURNBACK	PASS / FAIL
SOLBERG - RF6						
3	UNI 86	0' 35"	0' 45"	None	N/A	Fail
4	MMS	0' 30"	0' 45"	1' 58"	(6' 45")	Fail
DR STHAMER - MOUSSOL FF 3/6						
9	UNI 86	0' 40"	0' 45"	1' 24"	(7' 50)	Fail
10	MMS	0' 35"	0' 55"	None	N/A	Fail
SOLBERG - RF3						
35	UNI 86	0' 50"	1' 05"	2' 00"	(8' 30")	Fail
36	MMS	0' 50"	1' 45"	None	N/A	Fail
FOMTEC - ENVIRO 3x3 PLUS						
38	UNI 86	0' 55"	1' 05"	1' 40"	(9' 50")	Fail
BIOEX - ECOPOL						
37	UNI 86	0' 40"	0' 55"	1' 50"	(8' 05")	Fail

4.0 LABORATORY ANALYSIS OF FOAM CONCENTRATE SAMPLES

4.1 F3 SAMPLE ANALYSES

On return to the UK the sealed 0.5 l F3 samples were each split into two by RPI.

One set of samples was sent to:

Intertek USA, Inc. d/b/a QTI
291 Route 22 East
Salem Industrial Park, Bldg #5
Whitehouse, NJ 08888

This set was for %F analyses. The test methodology for this suite of tests is provided in Appendix D.

The second set of samples was sent to:

AXYS Analytical Services Ltd.
2045 Mills Road West
Sidney, British Columbia
Canada V8L 5X2

This set was for perfluorochemical (PFC) analyses by MLA-060. This suite of tests looks for perfluorooctanesulphonate (PFOS) and perfluorooctanoic acid (PFOA), amongst other PFCs.

4.2 F3 ANALYSES RESULTS

The results of these analyses are provided within Appendix D. These results confirm that the five foam concentrates used for this series of tests were fluorine free to the detectable limits of the analyses.

APPENDIX A
PHOTOGRAPHS:
FIRE TESTS



Typical Fire at 90% Control



Typical Fire at 99% Control



Typical Fire at 25% Burnback Re-Involvement

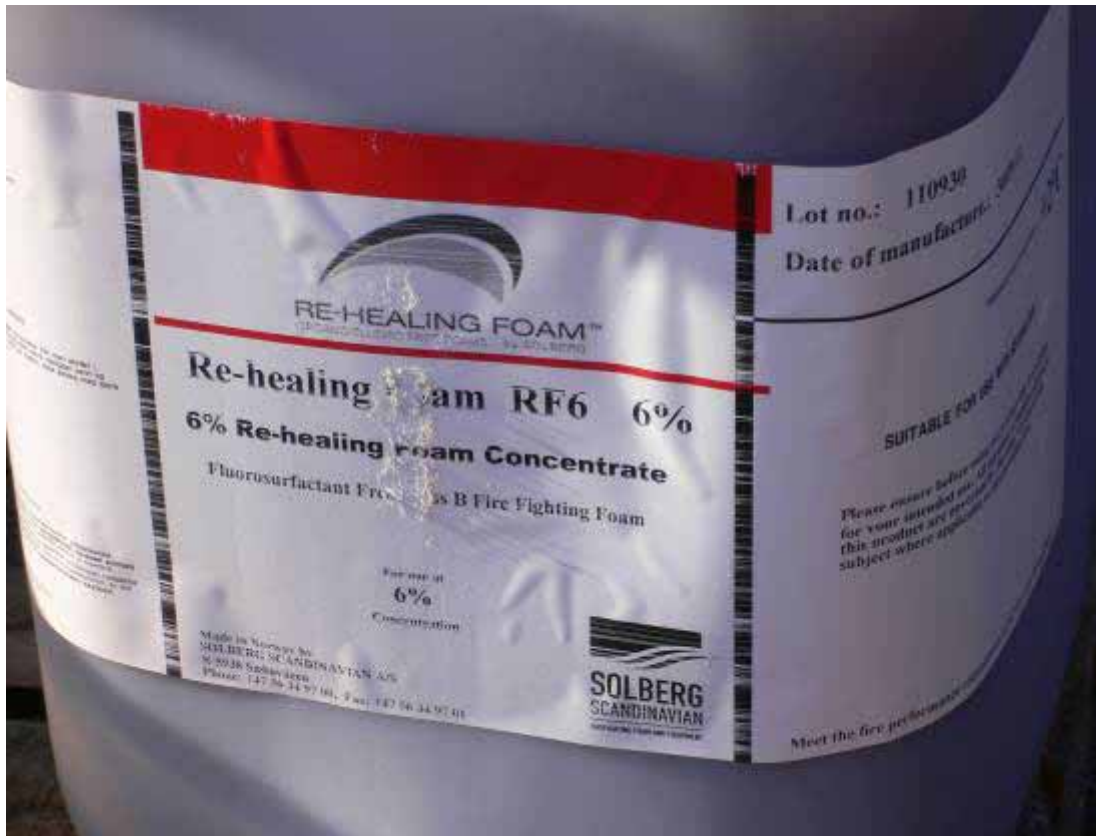


Typical Example of Persistent Edge Flickers

APPENDIX B

PHOTOGRAPHS:

FOAM CONCENTRATE CONTAINERS







Sealed Foam Concentrate Samples

APPENDIX C
FOAM CONCENTRATE DATASHEETS

The following foam concentrate datasheets have been taken from the manufacturers web site, printed and then scanned. Thus it is assumed that these will provide the most current information available at the time of the tests.

Note that as the Fomtec Enviro 3x3 Plus foam concentrate was still being developed at the time of these tests no datasheet was available to include at this point.



RE-HEALING FOAM™ RF6 6% -5°C



PRODUCT SHEET

RE-HEALING FOAM™ RF6 6%

RE-HEALING FOAM™ RF6 is a new environmentally benign, synthetic foam concentrate used to effectively extinguish hydrocarbon fires at 6%. It is a real FFFP, AFFF, FFFP-AR and AR-AFFF alternative without fluorosurfactants or organohalogen ingredients.

For maximum security of fire fighters the product possesses excellent burn-back characteristics due to its re-healing capabilities of a rapidly resealing foam blanket.

Most commonly available foam aspirating equipment as well as non aspirating equipment, including standard sprinkler heads, can be used to obtain maximum

results. The compatibility with most powders provides the possibility to attack 3 Dimensional fires. Not only can it be used in case of fire fighting but also for covering of a liquid spill to prevent re-ignition and it can also be used to minimise smell inconvenience, due to the excellent vapour suppressing capabilities.

On Class 'A' fires it will improve extinguishment in case of deep seated fires.

Quality security and environmental care.

All products manufactured at Solberg Scandinavian are thoroughly quality controlled before release. Both with

respect to laboratory control of physical parameters as well as the finished foam's fire performance. A *Certificate of Analysis (CoA)* is issued with every batch.

For questions about mixing of other foam concentrates with **RE-HEALING FOAM™ RF6** our technical staff are at your disposal. Generally when applied to a fire the product can be mixed with other similar foam types but not in medium or long term storage.

Together with the fast extinguishment this product gives the maximum protection to the environment as possible.

PROPERTIES

<i>Visual:</i>	Brown non-newtonian liquid
<i>Specific gravity (25° C):</i>	1,055 kg/l
<i>pH (25° C):</i>	8,0
<i>Viscosity:</i>	Pseudoplastic liquid
<i>Frost resistance:</i>	Product has a freezing stretch starting at -2° C
<i>Minimum use temp:</i>	2° C
<i>Maximum storage temp:</i>	< 50° C
<i>Sediments:</i>	none

Foam expansion depending on water pressure and type of equipment:

<i>very low expansion:</i>	between 1.5 and 4
<i>low expansion:</i>	between 8 and 20
<i>medium expansion:</i>	between 20 and 50
<i>high expansion:</i>	up to 500
<i>25% drainage time:</i>	> 5 min till 15 min (depending on water pressure and type of equipment used)
<i>Product guarantee:</i>	10 years when stored in original package
<i>Salt, fresh and brackish water can be used.</i>	

RE-HEALING FOAM™ RF6 has *EN 1568 part 3 approval* and meets *ICAO level 'B' regulations* and can be shipped in 20 litre pails, 200 litre drums or 1000 litre containers. For large amounts bulk delivery is also possible.

SOLBERG SCANDINAVIAN AS
Ølsvollstranda, N-5938 Sæbøvågen NORWAY

Phone: +47 56 34 97 00
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E-mail: Info@solbergfoams.com
Internet: www.solbergfoams.com



PIENG, RF6-1 issue date 21-1-2010

MOUSSOL-FF 3/6

Universal alcohol resistant fluorine free fire extinguishing foam concentrate

Description

MOUSSOL-FF 3/6 is an alcohol-resistant fluorine free fire extinguishing foam concentrate. It is based on special surface active agents, polymer film formers, co-surfactants as well as foam stabilisers and antifreezing compounds which are partially made of re-growing raw materials.

MOUSSOL-FF 3/6 has very good foaming properties and can be used as medium expansion foam as well. On polar hydrocarbons, the polymer film formed effectively prevents destruction of the foam.

Properties

MOUSSOL-FF 3/6 is a pseudoplastic product which is stable against both polar (water-miscible) and non-polar hydrocarbons as well as mixtures of the two.

Recommended induction rate	3 % on non-polar hydrocarbons 6 % on polar and highly polar products
Foam expansion	depending on foam equipment, water pressure and induction rate low expansion foam 6 to 15 times medium expansion foam to 100 times
Foam stability	50 % water drainage time depending on foam equipment, water pressure and induction rate low expansion foam ≥ 20 minutes medium expansion foam 5 - 10 minutes
Density	1.04 ± 0.02 kg/l
Frost resistance	-5 °C
pH value	6.5 to 7.5
Sediment content	none
Viscosity	Thixotrope liquid
Environmental acceptability	MOUSSOL-FF 3/6 is physiologically harmless and easily biodegradable.
Special notes	MOUSSOL-FF 3/6 is not detrimental to health, provided it is used for the intended purpose. Fire extinguishing exercises and tests may have to be coordinated with the local authorities. When persons are sprayed with foam, please bear in mind that they will not be able to breathe while covered with foam. For further information users are asked to refer to the safety data sheet.

Physical properties and technical data

07.08

Product information

MOUSSOL-FF 3/6

Universal alcohol resistant fluorine free fire extinguishing foam concentrate

Application

MOUSSOL-FF 3/6 is used with all mobile equipment and fixed foam systems for generating low and medium expansion foam, especially for fighting fires of foam-destroying products, e.g. alcohols, ketones, esters, etc. The induction rate is 3% for fires of non-polar and 6% for fires of polar, foam-destroying hydrocarbons.

Spilled chemicals should be covered by foam to prevent emissions. The foam blanket suppresses the evaporation of the liquid and prevents a possible ignition.

To achieve an optimal extinguishing success, fires of polar liquids should be extinguished by using gentle application methods, e.g. goose necks.

A pump supported induction may be advisable. Besides tap water **MOUSSOL-FF 3/6** can also be used with sea and brackish water as well as with treated industrial water.

Compatibility

with other foaming agents

For immediate usage **MOUSSOL-FF 3/6** can be mixed with other equivalent foaming agents, independent of the mixing ratio. Existing stocks of **MOUSSOL-FF 3/6** must not be mixed with other products.

Compatibility with

other fire extinguishing foams

MOUSSOL-FF 3/6 foams are compatible with all other readily expanded fire extinguishing foams.

Compatibility with powder

MOUSSOL-FF 3/6 is suitable for the combined use with foam compatible powders.

Storage

MOUSSOL-FF 3/6 can be stored for long periods of time in the sealed original containers and in corrosion-resistant plastic or stainless steel tanks. High temperatures up to +50°C do not affect the quality; neither does temporary freezing at temperatures below the specified frost resistance limit.

Approval

MOUSSOL-FF 3/6 is officially approved for class A + B fires including low and medium expansion foam applications for polar and non-polar solvent fires according to DIN EN 1568 Parts 1, 3, and 4.

Approval No.:	SP-32/08	
Performance class:	IIIB/IIID	EN1568-3
	IA/IB	EN1568-4

Subject to alterations



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 g.boessert@sthamer.com



Hamburg - April 2004



RE-HEALING FOAM™ RF3 3% -5°C



PRODUCT SHEET

RE-HEALING FOAM™ RF3 3%

RE-HEALING FOAM™ RF3 is a new environmentally benign, synthetic foam concentrate used to effectively extinguish hydrocarbon fires at 3%. It is a real FFFP, AFFF, FFFP-AR and AR-AFFF alternative without fluorosurfactants or organohalogen ingredients.

For maximum security of fire fighters the product possesses excellent burn-back characteristics due to its re-healing capabilities of a rapidly resealing foam blanket.

Most commonly available foam aspirating equipment as well as non aspirating equipment, including standard sprinkler heads, can be used to obtain maximum

results. The compatibility with most powders provides the possibility to attack 3 Dimensional fires. Not only can it be used in case of fire fighting but also for covering of a liquid spill to prevent re-ignition and it can also be used to minimise smell inconvenience, due to the excellent vapour suppressing capabilities. On Class 'A' fires it will improve extinguishment in case of deep seated fires.

Quality security and environmental care.

All products manufactured at Solberg Scandinavian are thoroughly quality controlled before release. Both with respect to laboratory control of physi-

cal parameters as well as the finished foam's fire performance.

A *Certificate of Analysis (CoA)* is issued with every batch. For questions about mixing of other foam concentrates with **RE-HEALING FOAM™ RF3** our technical staff are at your disposal. Generally when applied to a fire the product can be mixed with other similar foam types. However the foam concentrate should not be mixed with other brands of concentrate. Together with the fast extinguishment this product gives the maximum protection to the environment as possible.

PROPERTIES

<i>Visual:</i>	Brown non-newtonian liquid
<i>Specific gravity (25° C):</i>	1,05 kg/l
<i>pH (25° C):</i>	8,0
<i>Viscosity:</i>	Pseudoplastic liquid
<i>Frost resistance:</i>	Product has a freezing stretch starting at -2° C
<i>Minimum use temp:</i>	2° C
<i>Maximum storage temp:</i>	< 50° C
<i>Sediments:</i>	none
<i>Spreading coefficient:</i>	> 3 mN/m

Foam expansion depending on water pressure and type of equipment:

<i>very low expansion:</i>	between 1.5 and 4
<i>low expansion:</i>	between 8 and 20
<i>medium expansion:</i>	between 20 and 50
<i>high expansion:</i>	up to 500
<i>25% drainage time:</i>	> 5 min till 15 min (depending on water pressure and type of equipment used)
<i>Product guarantee:</i>	10 years when stored in original package

Salt, fresh and brackish water can be used.

RE-HEALING FOAM™ RF3 has *EN 1568 part 3 approval* and meets *ICAO-B regulations* and can be shipped in 20 litre pails, 200 litre drums or 1000 litre containers. For large amounts bulk delivery is also possible.

SOLBERG SCANDINAVIAN AS
Ølsvollstranda, N-5038 Seibevågen NORWAY

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E-mail: info@solbergfoams.com
Internet: www.solbergfoams.com



PICMG, RF3-1 issue date 21-1-2010



ECOPOL

FLUOROCOMPOUND FREE FOAM AR CONCENTRATE

DESCRIPTION

Environment-friendly, ECOPOL is the real alternative to traditional foam concentrates. This synthetic FFF (Fluorocompound-Free Foam) AR foam concentrate, of new generation, is based on the combination of hydrophilic natural polymers and surfactants resistant to contamination.

ECOPOL is pseudoplastic : its viscosity decreases when it is agitated. This property authorizes its use even at low temperature and low pressure.

➤ **Foaming power** : ECOPOL is usable at Low, Medium and High Expansion.

The foaming base of ECOPOL is exclusively made from copra fatty acids, a natural re-growing resource.

➤ **Fuel fires** : ECOPOL is efficient on hydrocarbon fires and polar solvents fires. ECOPOL is approved as a 3X3 and a 3X6, enabling to select the concentration of use at 3% or 6% depending on the proportioning system chosen.

ECOPOL has been successfully tested on numerous fires, such as acetone, methanol, isopropanol, THF, diethylether, toluene, ethylacetate...

ECOPOL can keep its water for a very long period. This outstanding property makes it highly efficient on polar solvents fires.

➤ **Environment** : ECOPOL is harmless for environment and totally biodegradable.

ECOPOL is totally fluorine-free.

PHYSICAL DATA

Appearance	green gel
Specific gravity at 20°C	1.06 ± 0.02 Kg/dm ³
pH at 20°C	7.0 ± 1.0
Viscosity* at 20°C	1300 mPa.s
Viscosity* at -10°C	1600 mPa.s
Sediments	< 0.1 %
Surface tension at 3 %	25 ± 2 mN/m
Freezing point	- 16°C
Temperature of use	- 10°C / + 50°C

* Viscometer Brookfield, spindle #4 ; 60 rpm

FOAM QUALITY

Concentration of use at 3 %

Low Expansion	8*
Drainage time 25 %	15 minutes
Medium Expansion	60*
High Expansion	800*

Concentration of use at 6 %

Low Expansion	9*
Drainage time 25 %	30 minutes
Medium Expansion	130*

* Foam expansion values depend on the equipment



PERFORMANCES & APPLICATIONS

ECOPOL complies with standards :

- EN 1568-1 • EN 1568-2 • EN 1568-3 : class III B • EN 1568-4 : class IA
- Oil Industry : Lastfire certificate
- Navy : Bureau Veritas certificate

ECOPOL can be used with tap water, sea water and brackish water at 3% on hydrocarbon fires and of 3 at 6% on polar solvents fires.

It is suitable with all kind of known equipment.

WARRANTY & SERVICES

ECOPOL has a 10 years warranty in its original packaging and at storage temperatures -30°C/+60°C.

Our Quality Control Laboratory offers its analytical expertise BIO-LAB.

Safety Data and Environment Data are available upon request ; contact@bio-ex.fr

bio-ex S.R.L.

www.bio-ex.com

Z.I. La Petite Olivière
69770 MONTROTIER France • TEL : +33 (0)4 74 70 23 81

TECHNICAL DATA
Date : 23/04/09 #3

APPENDIX D
F3 ANALYSIS AND RESULTS

ELEMENTAL ANALYSIS METHODOLOGY BY INTERTEK

Analysis: Fluorine

Turn Around Time: 1 Day

Sample Requirements:

Theoretical Range (%)	Sample Size (mg)
.1-5	10-20
5-15	3-5
>15	1-3

Note: This analysis is suitable for samples containing >0.05% fluorine. Samples requiring lower limits of detection must use ion chromatography.

Accuracy: $\pm 0.3\%$ Absolute

Compatible Sample Types: Solids, Liquids, Oils

Incompatible Samples Types: Gases

Interferences: This method alleviates most of the common interferences found in classical techniques such as colorimetric titrations. However, the presence of anions of aluminum, boron, silicon, and iron in concentrations of more than 5 times the concentration of fluoride may result in low fluorine values due to complexation.

Analysis Technique: Ion Specific Electrode

Sample Preparation: The sample is accurately weighed and transferred to a bed of mannitol wrapped in an ashless filter paper. The sample is combusted in an oxygen combustion flask containing 100 ml of TISAB II where the covalently bound fluorine is converted to fluoride. The sample is set aside for 20 minutes.

Method Summary: Fluorine in organic materials is determined by transferring the quench solution to a sample beaker which is then analyzed potentiometrically by an ion specific electrode using a single known addition technique. The system must be checked with an NIST traceable organic standard, which contains fluorine, prior to sample analysis. The standard must check to within $\pm 0.3\%$ absolute. %F is calculated based on the sample weight, solution volume and fluoride concentration.

RESULTS FROM TOTAL %F ANALYSES BY INTERTEK



P.O. Box 470, Salem Industrial Park - Bldg. #5
Whitehouse, New Jersey 08888
(908) 534-4445 FAX (908) 534-1054
QTI.AnalyticalReports@intertek.com

Analytical Report
Report Number: 62202
Report Status: *Final*

Barbara Chisholm
Resource Protection International
Walker House, George St.
Aylesbury,, Bucks HP20 2HU

Sample: BIOEX ECOPOL 3%

F

< 0.05

< 0.05

Sample: DR STHAMER-.MOUSSOL F-F 3/6

F

< 0.05

< 0.05

Sample: FOMTEC ENVIRO-3X3 PLUS

F

< 0.05

< 0.05

Sample: SOLBERG-RF3 3%

F

< 0.05

< 0.05

Sample: SOLBERT-RF6 6%

F

< 0.05

< 0.05

Sample analysis performed by ion specific electrode.
Limit of detection by this procedure is 0.05%.

REPORT FROM PERFLUORINATED ORGANICS ANALYSES BY AXYS

www.axysanalytical.com



AXYS

Axys Analytical
Services Ltd

2045 Mills Road West
SIDNEY, BRITISH COLUMBIA, CANADA V8L 5K2

TEL 250-655-5800 FAX 250-655-5811
www.axysanalytical.com

AXYS Client No.: 4711

Client Address: Dynax Corporation
79 Westchester Ave.
Pound Ridge, NY, US, 10576

The AXYS contact for these data is Kirsten Anderson.



Page 1 of 9

BATCH SUMMARY

Batch ID:	WG40317	Date:	28-Jun-2012
Analysis Type:	Perfluorinated Organic	Matrix Type:	AQ surfactant
BATCH MAKEUP			
Contract:	4711	Blank:	WG40317-101
Samples:			
L18058-1	SOLBERG- RF6 6%		
L18058-2	DR STHAMER- MOUSSOL F-F 3/6		
L18058-3	SOLBERG- RF3 3%		
L18058-4	FOMTEC ENVIRO 3X3 PLUS		
L18058-5	BIOEX ECOPOL 3%		
		Reference or Spike:	WG40317-102
		Duplicate:	
Comments:			
Resubmission, July 3rd 2012:			
The PDF report has been revised to omit Form 2s, QA report forms, and accreditation information. No other changes to the reports have been made.			
<ol style="list-style-type: none"> 1. Data are not blank corrected. 2. The recovery of some ¹³C-labelled quantification standards in samples did not meet the method criteria; these compounds are flagged with a 'V'. As the isotope dilution method of quantification produces data that are recovery corrected, the slight variances from the method acceptance criteria are deemed not to affect the quantification of these analytes. Percent surrogate recoveries are used as general method performance indicator only. 			

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February 1993

FQA-006 Rev. 2. 18-Jul-1994



FLUORINE FREE FOAM (F3) FIRE TESTS, ESBJERG, DENMARK

www.axysanalytical.com

AXYS METHOD MLA-060 Rev 10

Form 1A

CLIENT SAMPLE NO.
SOLBERG- RF8 6%
Sample Collection:
08-May-2012

PERFLUORINATED ORGANICS ANALYSIS REPORT

AXYS ANALYTICAL SERVICES

2045 MILLS RD. SIDNEY, B.C., CANADA
V8L 5X2 TEL (250) 655-5800 FAX (250) 655-5811

Contract No.: 4711

Lab Sample I.D.: L18058-1

Matrix: AQ SURFACTANT

Sample Size: 0.0224 g

Sample Receipt Date: 11-Jun-2012

Initial Calibration Date: 19-Jun-2012

Extraction Date: 19-Jun-2012

Instrument ID: LC MS/MS

Analysis Date: 20-Jun-2012 Time: 05:53:22

Column ID: C18MS

Extract Volume (uL): 4000

Sample Data Filename: FC2G_220 S: 52

Injection Volume (uL): 15

Blank Data Filename: FC2G_220 S: 50

Dilution Factor: N/A

Cal. Ver. Data Filename: FC2G_220 S: 43

Concentration Units: ng/g

This page is part of a total report that contains information necessary for accreditation compliance.
Results are compliant with NELAP accreditation described in the total report. Sample results relate only to the sample tested.

COMPOUND	LAB FLAG ¹	CONC. FOUND	REPORTING LIMIT (RL) ²	RETENTION TIME
PFBA	U		22.3 (L)	
PFPeA	U		22.3 (L)	
PFHxA	U		22.3 (L)	
PFHpA	U		22.3 (L)	
PFOA	U		22.3 (L)	
PFNA	U		22.3 (L)	
PFDA	U		22.3 (L)	
PFUnA	U		22.3 (L)	
PFDoA	U		22.3 (L)	
PFBS	U		44.7 (L)	
PFHxS	U		44.7 (L)	
PFOS	U		44.7 (L)	
PFOSA	U		22.3 (L)	

(1) Where applicable, custom lab flags have been used on this report, U = not detected at RL.

(2) Reporting Limit (Code): S = sample detection limit, M = method detection limit, L = lowest calibration level equivalent; Q = contract defined limit.

These data are validated and reported as accurate and in accord with AXYS Analytical Services Ltd. ISO17025 compliant quality assurance processes.

Signed: _____ Jason MacKenzie _____

For Axys Internal Use Only [XSL Template: FC-Form1A.xsl; Created: 28-Jun-2012 16:20:36; Application: XMLTransformer-1.12.17; Report Filename: PFC_FC_LC_PFOA_L18058-1_Form1A_FC2G_220S52_SJ1472750.html; Workgroup: WG40317; Design ID: 1849]



Page 3 of 9

Page 1 of 1 (WG40317 - PFC_FC_LC_PFOA_L18058-1_Form1A_FC2G_220S52_SJ1472750.html)

FLUORINE FREE FOAM (F3) FIRE TESTS, ESBJERG, DENMARK

www.axysanalytical.com

AXYS METHOD MLA-060 Rev 10

Form 1A

CLIENT SAMPLE NO.
DR STHAMER- MOUSSOL F-F
3/6
Sample Collection:
08-May-2012

PERFLUORINATED ORGANICS ANALYSIS REPORT

AXYS ANALYTICAL SERVICES
2045 MILLS RD., SIDNEY, B.C., CANADA
V8L 5X2 TEL (250) 655-5800 FAX (250) 655-5811

Contract No.: 4711

Lab Sample I.D.: L18058-2

Matrix: AQ SURFACTANT

Sample Size: 0.0218 g

Sample Receipt Date: 11-Jun-2012

Initial Calibration Date: 19-Jun-2012

Extraction Date: 19-Jun-2012

Instrument ID: LC MS/MS

Analysis Date: 20-Jun-2012 Time: 06:10:08

Column ID: C18MS

Extract Volume (uL): 4000

Sample Data Filename: FC2G_220 S: 53

Injection Volume (uL): 15

Blank Data Filename: FC2G_220 S: 50

Dilution Factor: N/A

Cal. Ver. Data Filename: FC2G_220 S: 43

Concentration Units: ng/g

This page is part of a total report that contains information necessary for accreditation compliance.
Results are compliant with NELAP accreditation described in the total report. Sample results relate only to the sample tested.

COMPOUND	LAB FLAG ¹	CONC. FOUND	REPORTING LIMIT (RL) ²	RETENTION TIME
PFBA	U		22.9 (L)	
PFPeA	U		22.9 (L)	
PFHxA	U		22.9 (L)	
PFHpA	U		22.9 (L)	
PFOA	U		22.9 (L)	
PFNA	U		22.9 (L)	
PFDA	U		30.4 (S)	
PFUnA	U		22.9 (L)	
PFDoA	U		22.9 (L)	
PFBS	U		45.9 (L)	
PFHxS	U		45.9 (L)	
PFOS	U		45.9 (L)	
PFOSA	U		22.9 (L)	

(1) Where applicable, custom lab flags have been used on this report, U = not detected at RL.

(2) Reporting Limit (Code): S = sample detection limit, M = method detection limit, L = lowest calibration level equivalent; Q = contract defined limit.

These data are validated and reported as accurate and in accord with AXYS Analytical Services Ltd. ISO17025 compliant quality assurance processes.

Signed: Jason MacKenzie

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FLUORINE FREE FOAM (F3) FIRE TESTS, ESBJERG, DENMARK

www.axysanalytical.com

AXYS METHOD MLA-060 Rev 10

Form 1A

CLIENT SAMPLE NO.
SOLBERG- RF3 3%
Sample Collection:
09-May-2012

PERFLUORINATED ORGANICS ANALYSIS REPORT

AXYS ANALYTICAL SERVICES

2045 MILLS RD. SIDNEY, B.C., CANADA
V8L 5X2 TEL (250) 655-5800 FAX (250) 655-5811

Contract No.: 4711

Lab Sample I.D.: L18058-3

Matrix: AQ SURFACTANT

Sample Size: 0.0206 g

Sample Receipt Date: 11-Jun-2012

Initial Calibration Date: 19-Jun-2012

Extraction Date: 19-Jun-2012

Instrument ID: LC MS/MS

Analysis Date: 20-Jun-2012 Time: 06:26:53

Column ID: C18MS

Extract Volume (uL): 4000

Sample Data Filename: FC2G_220 S: 54

Injection Volume (uL): 15

Blank Data Filename: FC2G_220 S: 50

Dilution Factor: N/A

Cal. Ver. Data Filename: FC2G_220 S: 43

Concentration Units: ng/g

This page is part of a total report that contains information necessary for accreditation compliance.
Results are compliant with NELAP accreditation described in the total report. Sample results relate only to the sample tested.

COMPOUND	LAB FLAG ¹	CONC. FOUND	REPORTING LIMIT (RL) ²	RETENTION TIME
PFBA	U		24.0 (L)	
PFPeA	U		24.0 (L)	
PFHxA	U		24.0 (L)	
PFHpA	U		24.0 (L)	
PFOA	U		24.0 (L)	
PFNA	U		24.0 (L)	
PFDA	U		24.0 (L)	
PFUnA	U		24.0 (L)	
PFDoA	U		24.0 (L)	
PFBS	U		48.1 (L)	
PFHxS	U		48.1 (L)	
PFOS	U		48.1 (L)	
PFOSA	U		24.0 (L)	

(1) Where applicable, custom lab flags have been used on this report, U = not detected at RL.

(2) Reporting Limit (Code): S = sample detection limit, M = method detection limit, L = lowest calibration level equivalent; Q = contract defined limit.

These data are validated and reported as accurate and in accord with AXYS Analytical Services Ltd. ISO17025 compliant quality assurance processes.

Signed: _____ Jason MacKenzie _____

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FLUORINE FREE FOAM (F3) FIRE TESTS, ESBJERG, DENMARK

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AXYS METHOD MLA-060 Rev 10

Form 1A

CLIENT SAMPLE NO.
FOMTEC ENVIRO 3X3 PLUS
Sample Collection:
09-May-2012

PERFLUORINATED ORGANICS ANALYSIS REPORT

AXYS ANALYTICAL SERVICES

2045 MILLS RD. SIDNEY, B.C., CANADA
V8L 5X2 TEL (250) 655-5800 FAX (250) 655-5811

Contract No.: 4711

Lab Sample I.D.: L18058-4

Matrix: AQ SURFACTANT

Sample Size: 0.0209 g

Sample Receipt Date: 11-Jun-2012

Initial Calibration Date: 19-Jun-2012

Extraction Date: 19-Jun-2012

Instrument ID: LC MS/MS

Analysis Date: 20-Jun-2012 Time: 06:43:38

Column ID: C18MS

Extract Volume (uL): 4000

Sample Data Filename: FC2G_220 S: 55

Injection Volume (uL): 15

Blank Data Filename: FC2G_220 S: 50

Dilution Factor: N/A

Cal. Ver. Data Filename: FC2G_220 S: 43

Concentration Units: ng/g

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COMPOUND	LAB FLAG ¹	CONC. FOUND	REPORTING LIMIT (RL) ²	RETENTION TIME
PFBA	U		23.9 (L)	
PFPeA	U		23.9 (L)	
PFHxA	U		23.9 (L)	
PFHpA	U		23.9 (L)	
PFOA	U		23.9 (L)	
PFNA	U		23.9 (L)	
PFDA	U		23.9 (L)	
PFUnA	U		23.9 (L)	
PFDoA	U		23.9 (L)	
PFBS	U		47.9 (L)	
PFHxS	U		47.9 (L)	
PFOS	U		47.9 (L)	
PFOSA	U		23.9 (L)	

(1) Where applicable, custom lab flags have been used on this report, U = not detected at RL.

(2) Reporting Limit (Code): S = sample detection limit, M = method detection limit, L = lowest calibration level equivalent; Q = contract defined limit.

These data are validated and reported as accurate and in accord with AXYS Analytical Services Ltd. ISO17025 compliant quality assurance processes.

Signed: _____ Jason MacKenzie _____

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FLUORINE FREE FOAM (F3) FIRE TESTS, ESBJERG, DENMARK

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AXYS METHOD MLA-060 Rev 10

Form 1A

CLIENT SAMPLE NO.
BIOEX ECOPOL 3%
Sample Collection:
09-May-2012

PERFLUORINATED ORGANICS ANALYSIS REPORT

AXYS ANALYTICAL SERVICES

2045 MILLS RD. SIDNEY, B.C., CANADA
V8L 5X2 TEL (250) 655-5800 FAX (250) 655-5811

Contract No.: 4711

Lab Sample I.D.: L18058-5

Matrix: AQ SURFACTANT

Sample Size: 0.0222 g

Sample Receipt Date: 11-Jun-2012

Initial Calibration Date: 19-Jun-2012

Extraction Date: 19-Jun-2012

Instrument ID: LC MS/MS

Analysis Date: 20-Jun-2012 Time: 07:00:33

Column ID: C18MS

Extract Volume (uL): 4000

Sample Data Filename: FC2G_220 S: 56

Injection Volume (uL): 15

Blank Data Filename: FC2G_220 S: 50

Dilution Factor: N/A

Cal. Ver. Data Filename: FC2G_220 S: 43

Concentration Units: ng/g

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COMPOUND	LAB FLAG ¹	CONC. FOUND	REPORTING LIMIT (RL) ²	RETENTION TIME
PFBA	U		22.6 (L)	
PFFeA	U		22.6 (L)	
PFHxA	U		22.6 (L)	
PFHpA	U		22.6 (L)	
PFOA	U		22.6 (L)	
PFNA	U		22.6 (L)	
PFDA	U		22.6 (L)	
PFUnA	U		22.6 (L)	
PFDoA	U		22.6 (L)	
PFBS	U		45.1 (L)	
PFHxS	U		45.1 (L)	
PFOS	U		45.1 (L)	
PFOSA	U		22.6 (L)	

(1) Where applicable, custom lab flags have been used on this report, U = not detected at RL.

(2) Reporting Limit (Code): S = sample detection limit, M = method detection limit, L = lowest calibration level equivalent; Q = contract defined limit.

These data are validated and reported as accurate and in accord with AXYS Analytical Services Ltd. ISO17025 compliant quality assurance processes.

Signed: _____ Jason MacKenzie _____

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FLUORINE FREE FOAM (F3) FIRE TESTS, ESBJERG, DENMARK

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AXYS METHOD MLA-060 Rev 10

Form 1A

CLIENT SAMPLE NO.

PERFLUORINATED ORGANICS ANALYSIS REPORT

Lab Blank
Sample Collection:
N/A

AXYS ANALYTICAL SERVICES

2045 MILLS RD. SIDNEY, B.C., CANADA
V8L 5X2 TEL (250) 655-5800 FAX (250) 655-5811
Contract No.: 4711

Project No.

N/A

Lab Sample I.D.:

WG40317-101

Matrix: AQUEOUS

Sample Size:

0.0200 g

Sample Receipt Date: N/A

Initial Calibration Date:

19-Jun-2012

Extraction Date: 19-Jun-2012

Instrument ID:

LC MS/MS

Analysis Date: 20-Jun-2012 Time: 05:19:42

Column ID:

C18MS

Extract Volume (uL): 4000

Sample Data Filename:

FC2G_220 S: 50

Injection Volume (uL): 15

Blank Data Filename:

FC2G_220 S: 50

Dilution Factor: N/A

Cal. Ver. Data Filename:

FC2G_220 S: 43

Concentration Units: ng/g

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COMPOUND	LAB FLAG ¹	CONC. FOUND	REPORTING LIMIT (RL) ²	RETENTION TIME
PFBA	U		25.0 (L)	
PFPeA	U		25.0 (L)	
PFHxA	U		25.0 (L)	
PFHpA	U		25.0 (L)	
PFOA	U		25.0 (L)	
PFNA	U		25.0 (L)	
PFDA	U		25.0 (L)	
PFUnA	U		25.0 (L)	
PFDoA	U		25.0 (L)	
PFBS	U		50.0 (L)	
PFHxS	U		50.0 (L)	
PFOS	U		50.0 (L)	
PFOSA	U		25.0 (L)	

(1) Where applicable, custom lab flags have been used on this report, U = not detected at RL.

(2) Reporting Limit (Code): S = sample detection limit, M = method detection limit, L = lowest calibration level equivalent; Q = contract defined limit.

These data are validated and reported as accurate and in accord with AXYS Analytical Services Ltd. ISO17025 compliant quality assurance processes.

Signed: _____ Jason MacKenzie _____

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Report Filename: PFC_FC_LC_PFOA_WG40317-101_Form1A_FC2G_220S50_SJ1472746.html; Workgroup: WG40317; Design ID: 1849]



FLUORINE FREE FOAM (F3) FIRE TESTS, ESBJERG, DENMARK

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AXYS METHOD MLA-060 Rev 10

Form 8A

PERFLUORINATED ORGANICS ONGOING PRECISION AND RECOVERY (OPR)

AXYS ANALYTICAL SERVICES

2045 MILLS RD., SIDNEY, B.C., CANADA
V8L 5X2 TEL (250) 655-5800 FAX (250) 655-5811

Contract No.: 4711

Lab Sample I.D.: WG40317-102

Matrix: AQUEOUS

Initial Calibration Date: 19-Jun-2012

Extraction Date: 19-Jun-2012

Instrument ID: LC MSMS

Analysis Date: 20-Jun-2012 Time: 04:12:26

Column ID: C18MS

Extract Volume (uL): 4000

OPR Data Filename: FC2G_220 S: 46

Injection Volume (uL): 15

Blank Data Filename: FC2G_220 S: 50

Dilution Factor: N/A

Cal. Ver. Data Filename: FC2G_220 S: 43

ALL CONCENTRATIONS REPORTED ON THIS FORM ARE CONCENTRATIONS IN EXTRACT, BASED ON A 1 mL EXTRACT VOLUME.

COMPOUND	LAB FLAG 1	SPIKE CONC. (ng/mL)	CONC. FOUND (ng/mL)	% RECOVERY	RETENTION TIME
PFBA		20.0	20.3	101	5:14
PFPeA		20.0	19.6	98.0	5:58
PFHxA		20.0	19.7	98.6	6:23
PFHpA		20.0	17.7	88.3	6:45
PFOA		20.0	20.4	102	7:09
PFNA		20.0	20.4	102	7:33
PFDA		20.0	20.9	105	8:03
PFUnA		20.0	20.4	102	8:37
PFDoA		20.0	20.8	104	9:15
PFBS		40.0	38.2	95.5	6:30
PFHxS		40.0	35.1	87.7	7:21
PFOS		40.0	40.2	100	8:21
PFOSA		20.0	19.6	98.1	9:56

(1) Where applicable, custom lab flags have been used on this report.

These data are validated and reported as accurate and in accord with AXYS Analytical Services Ltd. ISO17025 compliant quality assurance processes.

Signed: _____ Jason MacKenzie _____

These pages are part of a larger report that may contain information necessary for full data evaluation. Results reported relate only to the sample tested.

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