Report for the Periodic Monitoring of Emissions to Air

Part 1. Executive summary

Permit Number:	PPC/156
Operator:	Meggit Aircraft Braking
Installation:	Coventry Plant
Monitoring Date:	23 February 2009
E.E. Report Ref.:	38279
Client Name:	Meggit Aircraft Braking
Client Address:	Holbrook Lane Coventry CV6 4AA
Monitoring Organisation:	Environmental Evaluation Ltd. (Head Office) Lawton Square Delph Oldham OL3 5DT
Date of Report:	18 March 2009
Report Written by:	D Shields
Function:	Team Leader
Report Approved By:	T Ledwith
MCERTS Registration No.:	MM 03 425
Technical Endorsements:	TE1, TE2, TE3, TE4
Signed:	[redacted]

Contents

1 Part 1: Executive Summary

1.1 Monitoring Objectives

Meggit Aircraft Braking has been authorised under the Environmental Protection Act and associated legislation to operate various processes at their Coventry Plant site, and a condition of that authorisation is that emission monitoring is undertaken on a regular basis to prove compliance or otherwise against prescribed emission limit values.

This report details the testing undertaken in: February 2009

The substance monitoring requirements for each emission point are detailed below.

Substances to be monitored	Emission Point Identification
	Main Stack
Flow	✓
Temperature	✓
Fluorides	✓
Water vapour	✓

1.2 Monitoring Results

Emission Point	Substance to be Monitored	Emission Limit Value	Periodic Monitoring Result	Uncertainty	Units	Reference Conditions	Date of Monitoring	Start and End Times	Monitoring Method Reference	Accreditation for use of Method	Operating Status
Main Stack	Fluorides	5	0.01	± 0.002	mgm^{-3}	273K and 101.3 kPa at 20.9% Oxygen Wet Basis	23/02/2009	10:07 - 12:07	BS ISO 15713:2006	None	Normal

1.3 Operating Information

Emission Point Reference	Date	Process Type	Process Duration	Feedstock	Abatement
Main Stack	23 February 2009	Batch	Batch	Brake components	Scrubber

1.4 Monitoring Deviations

Emission Point Reference	Substance Deviations	Monitoring Deviations	Other Relevant Issues
Main Stack	None	None	None

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Part 2. Supporting Information

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Signed:	[redacted]

APPENDICES

Appendix A: General Information

A1. Environmental Evaluation Limited Staff Details

Team Leader:	D Shields
MCERTS No.	MM 02 051
Certification Level:	MCERTS Level 2
Technical Endorsements:	TE1, TE2, TE3, TE4
Site Technician:	S White
MCERTS No.	MM 06 776
Certification Level:	MCERTS Level 1
Technical Endorsements:	TE1

A2. Environmental Evaluation Limited Method Details

The indicated substances were measured by the standards and in house methods specified in the table below:

Substance	Standard	EE. Reference
Flow	BS EN 13284:2001	EE/P/002 & 2a
Temperature	BS EN 13284:2001	EE/P/002 & 2a
Fluorides	BS ISO 15713:2006	EE/P/017
Water vapour	BS EN 14790:2005	EE/P/013

A3. Sub-Contract

Analysis was subcontracted to a UKAS accredited laboratory.

A4. Equipment Used in the Monitoring Campaign

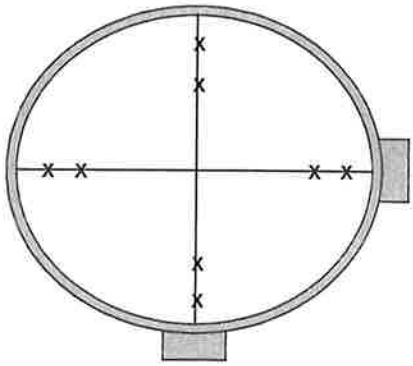
Equipment checklists appropriate to the methods were used.

Equipment Type	EE Equipment Reference Code
Unit	LCL 8, 24 and 13
Pitot	LCL 38
Manometer	LCL 26
Thermosensor	LCL 15
Thermocouple	LCL17
Tape Measure	LCL 18
Barometer	LCL 23
Probe	LCL 40, 30, 39
Nozzle	LCL 29
Vernier Callipers	LCL 14
stop watch	LCL 25

Appendix B: Emission Information

B1 - Main Stack Information

B1.1 Diagrams Showing the Dimensions and Monitoring Facilities of Main Stack

Photograph of Monitoring Point	Schematic of Sample Plane
No Photograph Available	

B1.2 Velocity and Temperature Measurement of Main Stack

Traverse Point	Sample Line A			Sample Line B			Sample Line C			Sample line D		
	Stack Temp. (°C)	ΔP (mmH_2O)	Swirl (<15°)	Stack Temp. (°C)	ΔP (mmH_2O)	Swirl (<15°)	Stack Temp. (°C)	ΔP (mmH_2O)	Swirl (<15°)	Stack Temp. (°C)	ΔP (mmH_2O)	Swirl (<15°)
1	22	5.5	Yes	22	5.5	Yes						
2	22	6	Yes	22	6	Yes						
3	23	6.5	Yes	23	6.5	Yes						
4	22	5.5	Yes	22	6.5	Yes						
5	22	6	Yes	22	5	Yes						
6	23	6	Yes	23	5.5	Yes						
7	22	5.5	Yes	22	6	Yes						
8	22	5.5	Yes	22	6.5	Yes						
9	22	5.5	Yes	22	6.5	Yes						
10	22	6	Yes	22	6	Yes						
	$\Sigma\Delta P_A$	58		$\Sigma\Delta P_B$	60		$\Sigma\Delta P_C$			$\Sigma\Delta P_D$		

Barometric Pressure (mmHg)	764	Port Depth (mm)	50
Static Pressure (mmH_2O)	1.5	Port Seal Adaptor Depth (mm)	110
Diameter (m)	1.60	Assumed CO_2 (%)	0.0
---		Assumed O_2 (%)	20.9
Stack Area (m^2)	2.011	Assumed CO (%)	0.0
Port Size (mm)	100	Assumed H_2O (%)	5.0

Appendix B1.3 - Site Measurements - Main Stack

Company	Meggit Aircraft Braking	**Test Conducted by**	D Shields & S White
Site	Coventry Plant	**Date of Test**	23/02/2009
Plant Identification	Main Stack	**Run Number**	1

Water Vapour Measurements

Impinger	Initial Wt (g)	Final Wt (g)
1	712.4	715.9
2	795.5	803.6
3	662.4	662.4
4	879.3	886.9
5		
6		
7		

Sample Reference Information

Filter Ref.	
Probe Wash Ref.	
Blank Filter Ref.	
Blank Probe Wash Ref.	
Solution A Ref.	38279/S1/230209
Solution B Ref.	38279/S2/230209
Solution C Ref.	
Blank Solution Ref.	38279/S3/230209

Leak Test Results

Initial Leak Test (%)	0.00000
Test Vacuum (mmHg)	15
Final Leak Test (%)	0.10000
Test Vacuum (mmHg)	15

Sampling Measurements

Point	Start and End Times	Duration (Min)	Vac (mmHg)	Stack Temp (°C)	Velocity Head ΔP (mmH2O)	√ΔP (√mm.H2O)	ΔP Orifice Meter (mm H_2O)	DGM (litres)	DGM Temp (°C)		Temp (°C)			
								747.7	In	Out	Probe	Filter	Impinger	Resin
1	10:07	10	7	22	5.5	2.35	24.80	905	14	14	160	160	5	---
2		10	7	22	6	2.45	27.05	1059	14	15	161	162	6	---
3		10	7	23	5.5	2.35	24.80	1221	15	15	162	162	6	----
4		10	7	23	5.5	2.35	24.80	1388	15	16	161	162	6	---
5		10	7	22	6	2.45	27.05	1478	15	15	162	162	6	---
6	12:07	10	7	23	5.5	2.35	24.80	1612.4	16	16	161	162	7	---
7														
8														
9														
10														
11														
12														
13														
14														
15														
16														
17														
18														
19														
20														
	120	60	7.00	22.50	5.67	2.38	25.55	864.70	14.83	15.17	161.17	161.67	6.00	

Appendix B1. - Gaseous Fluorides to BS ISO 15713 - Main Stack

Company	Meggit Aircraft Braking	**Test Conducted by**	D Shields & S White
Site	Coventry Plant	**Date of Test**	23 February 2009
Plant Identification	Main Stack		

Volume of Water Vapour at Standard Conditions V_{wstd}

$$V_{wstd} = (0.00124) \times V_{lc}$$

		Blank	Test 1		Units
	=	**0.0238**	**0.0238**		**m^3**

Where:

Constant	=	0.00124	0.00124		
V_{lc} is the mass of water collected	=	19.2	19.2		mg

Volume of Gas Metered, Standard Conditions V_{mstd}

$$V_{mstd} = \frac{(0.3592) \times V_m \times \left(P_b + \frac{\Delta H}{13.6}\right) \times Y_d}{(273 + T_m)}$$

		Blank	Test 1		Units
	=	**0.8855**	**0.8855**		**m^3**

Where:

Correction for standard temperature and pressure	=	0.3592	0.3592		$Kmm.Hg^{-1}$
V_m is the volume metered	=	0.8647	0.8647		m^3
P_b is the barometric pressure	=	764	764		mm.Hg
ΔH_{ave} is the average meter flow	=	25.6	25.6		$mm.H_2O$
conversion from $mm.H_2O$ to mm.Hg	=	13.6	13.6		
Y_d is the meter correction factor	=	1.0720	1.0720		
°C to K conversion constant	=	273	273		K
T_m is the meter temperature	=	15.0	15.0		°C

Moisture Content B_{wo}

$$B_{wo} = \frac{V_{wstd}}{V_{mstd} + V_{wstd}}$$

	Blank	Test 1
=	**0.026**	**0.026**

Where:

V_{wstd} is the volume of water vapour at standard conditions	=	0.0238	0.0238		m^3
V_{mstd} is the volume of gas metered, standard conditions	=	0.8855	0.8855		m^3

Velocity of Stack Gases V_s

$$V_s = K_p \times C_p \times \overline{\sqrt{\Delta P}} \times \frac{\sqrt{(\overline{T_s})} + 273}{\sqrt{M_s \times P_s}}$$

	Blank	Test 1	
=	**9.5**	**9.5**	ms^{-1}

Where:

K_p is the pitot tube velocity constant	=	34.97	34.97		
C_p is the pitot coefficient	=	0.98	0.98		
$(\sqrt{\Delta P})_{ave}$ is the average square root of velocity heads	=	2.38	2.38		$\sqrt{mm.H_2O}$
T_s is the stack temperature	=	22.5	22.5		°C
°C to K conversion constant	=	273	273		K
M_s is the molecular weight of gas	=	28.29	28.29		g/g mole
P_s is the absolute pressure of stack gas	=	764	764		mm.Hg

Appendix B1. - Gaseous Fluorides to BS ISO 15713 - Main Stack

Actual Flow Rate of Stack Gases Q_a

$$Q_a = 60 \times A_s \times V_s$$

		Blank	Test 1		
	=	**1150.3**	**1150.3**		**m^3min^{-1}**
Where:					
Second to minute conversion	=	60	60		
A_s is the cross-sectional area of stack	=	2.011	2.011		m^2
V_s is the velocity of stack gases	=	9.5	9.5		ms^{-1}

Dry Total Flow Rate of Stack Gas Q_{std}

$$Q_{std} = \frac{Q_a \times P_s \times 0.3592 \times (1 - B_{wo})}{(\overline{T_s}) + 273}$$

		Blank	Test 1		
	=	**1040.5**	**1040.5**		**m^3min^{-1}**
Where:					
Q_a is the actual flow rate of stack gases	=	1150.3	1150.3		m^3min^{-1}
P_s is the absolute pressure of stack gas	=	764	764		mm.Hg
Correction for standard temperature and pressure	=	0.3592	0.3592		$Kmm.Hg^{-1}$
B_{wo} is the moisture content	=	0.026	0.026		
T_s is the stack temperature	=	22.5	22.5		°C
°C to K conversion constant	=	273	273		K
V_s is the velocity of stack gases	=	9.5	9.5		ms^{-1}

Percent Isokineticity %I

$$\%I = \frac{(4.6398 \times 10^6) \times (\overline{T_s} + 273) \times V_{mstd}}{P_s \times V_s \times A_n \times \theta \times (1 - B_{wo})}$$

		Blank	Test 1		
	=	**99.9**	**99.9**		**%**
Where:					
Constant	=	4.6398E+06	4.6398E+06		
T_s is the stack temperature	=	22.5	22.5		°C
°C to K conversion constant	=	273	273		K
V_{mstd} is the volume of gas metered, standard conditions	=	0.8855	0.8855		m^3
P_s is the absolute pressure of stack gas	=	764	764		mm.Hg
V_s is the velocity of stack gases	=	9.5	9.5		ms^{-1}
A_n is the cross-sectional area of nozzle	=	28.56	28.56		mm^2
θ is the duration of test	=	60	60		minutes
B_{wo} is the moisture content	=	0.026	0.026		

Particulate Concentration $Cmgm^{-3}$ - Dry Basis

$$C_{mgm^{-3}} = \frac{M_n}{V_{mstd}}$$

		Blank	Test 1		
	=	**0.007**	**0.015**		**mgm^{-3}**
Where:					
Reference number		38279/S3/2 30209	38279/S1/2 30209		
Mn1 - Fluoride mass in the first impinger.	=	0.006	0.01295		mg
Reference number			38279/S2/2 30209		
Mn2 - Fluoride mass in second impinger.	=	0	<0.005		mg
V_{mstd} is the volume of gas metered, standard conditions	=	0.8855	0.8855		m^3

Appendix B1. - Gaseous Fluorides to BS ISO 15713 - Main Stack

Particulate Concentration Cmgm^{-3} - Wet Basis					
$C_{mgm-3\,(wet)} = C_{mgm-3} \times \frac{(100-Wv)}{100}$	=	Blank **0.0**	Test 1 **0.0**		**mgm^{-3}**
Where					
Concentrations at 273k and 101.3kPa Dry Basis	=	0.0	0.0		mgm^{-3}
Wv is the water vapour content %	=	2.6	2.6		%

Particulate Concentration Corrected to 20.9 % Oxygen, Wet Basis					
$C_{atx\%} = C_{mgm^{-3}} \times \frac{20.9 - O_{2ref}}{20.9 - O_{2meas}}$	=	Blank **0.0**	Test 1 **0.0**		**mgm^{-3}**
Where:					
Atmospheric oxygen concentration	=	20.9	20.9		%
O_{2ref} is the reference oxygen concentration	=	20.9	20.9		%
O_{2meas} is the measured oxygen concentration	=	*	*		%
* Oxygen Not Measured					

Particulate Emission Rate Eghr^{-1}					
$E_{ghr^{-1}} = C \times Q_{std} \times \frac{60}{1000}$	=	Blank **0**	Test 1 **1**		**ghr^{-1}**
Where:					
Cmgm-3 is theFluoride concentration, dry basis	=	0.0	0.0		mgm^{-3}
Q_{std} is the dry total flow rate of stack gas	=	1040.5	1040.5		m^{3}min^{-1}
60/1000 Conversion factor	=	0.060	0.060		

Comments on Compliance with BS ISO 15713	
Temperature maintained above 160°C	Pass
Isokinetic Rate 95% to 115%	Pass
Leak Rate <2%	Pass
Overall Blank Value <10% of the LV[a]	Pass
Duct gas flow with regard to stack axis <15°	Pass
Duct gas flow: negative velocity - not permitted	Pass
Duct gas flow: differential pressure at the pitot tube >5pa	Pass
Duct gas flow: ratio of max to min velocity <3:1	Pass

Were all of the requirements of BS ISO 15713 fulfilled during the test?

✓	
Yes	No

Appendix B1. - Gaseous Fluorides to BS ISO 15713 - Main Stack

Uncertainty Calculations

Measurement Data

Measured Quantities	Symbol	Value	Standard Uncertainty		Units
Sampled Volume	V_m	0.8855	(1%) uV_m	0.00885	m^3
Sampled Gas Temperature	T_m	288.0	uT_m	3	k
Sampled Gas Pressure	ρ_m	102.1	$u\rho_m$	0.1	kPa
Sampled Gas Humidity	H_m	2.6	uH_m	0.1	% by volume
Oxygen Content	$O_{2,m}$	*	$uO_{2,m}$	0.01	% by volume
MassFluoride	m	0.01	um_m	0.00	mg
Leak	L	2	%	0.02	%
Uncollected Mass	UCM	0			mg

Intermediate Calculation to Correct for Standardisation of Conditions

Factor for Std Conditions	fs	0.93			
Uncertainty Components	symbol	Sensitivity Coefficient		u (in units of fs)	
	ρ_m	0.009		0.001	
	H_m	0.010		0.001	
	T_m	0.003		0.010	
	ufs			0.010	
Corrected Volume	V	0.82	uV	0.012	m^3

Intermediate Calculation to Correct for Oxygen Correction

Factor for O_2 Correction	fc	1.00			
Uncertainty Components	symbol	Sensitivity Coefficient		u (in units of fc)	
	$O_{2,m}$	1.00		0.010	
Factor for O_2 Correction	ufc	1.00		0.010	%

Calculation of Expanded Uncertainty

Parameter		Value	Units	Sensitivity Coefficient	Uncertainty in Result	
Volume (Std conditions)	V	0.82	m^3	0.02	0.00	$mg.m^{-3}$
Mass	m	0.01	mg	1.10	0.00	$mg.m^{-3}$
Factor for O_2 Correction	fc	1.00		0.01	0.00	$mg.m^{-3}$
Leak	L	0.00	$mg.m^{-3}$	1.00	0.00	$mg.m^{-3}$
Uncollected mass	UCM	0.00	mg	1.10	0.00	$mg.m^{-3}$
Combined uncertainty					0.00	$mg.m^{-3}$
Expanded Uncertainty K=2					**10.88**	**%**
Expanded Uncertainty K=2					**0.002**	**$mg.m^{-3}$**

Test Certificates

RPS Laboratories

UKAS TESTING 0605

Test Certificate

Date 10/03/2009

Client	Environmental Evaluation Ltd Lawton Square Delph Oldham Lancs OL3 5DT	**Order No.**	38279
		Certificate No.	WK09-1528
		Issue No.	1
Contact	Dan Shields	**Date Received**	02/03/2009
Description	3 solutions for HF	**Technique**	Ion Chromatography

Sample No.	538479	38279/S1/230209		Method
Hydrofluoric acid		0.07 µg/ml	185 ml	C27(U)

Sample No.	538480	38279/S2/230209		Method
Hydrofluoric acid		<0.05 µg/ml	100 ml	C27(U)

Sample No.	538481	38279/S3/230209		Method
Hydrofluoric acid		<0.05 µg/ml	120 ml	C27(U)

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UKAS TESTING 0605

Test Certificate

Date 10/03/2009

Client	Environmental Evaluation Ltd	Certificate No.	WK09-1528
		Issue No.	1

Tested By Paul Robertson Date 09/03/2009

Approved By [redacted] Date 10/03/2009

Andrew Chalmers
Senior Chemist

For and on authority of RPS Laboratories Ltd.
Standard terms and conditions are applicable, a copy is available on request.

Method Symbols
(U) Analysis is UKAS Accredited
(N) Analysis is not UKAS Accredited
(S) Analysis is Subcontracted

Concentration values (mg/m3 and ppm) are provided to assist with interpretation only, they are not covered by the scope of UKAS accreditation

Analysis carried out on samples 'as received'

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End of Report