



COMMERCIAL - IN CONFIDENCE

SILSOE ODOURS Ltd
Building 42 Wrest Park, Silsoe
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REPORT
To
ARUP

Odour Emissions from Aircraft at Farnborough Airport June 2009

Date of report June 2009

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Odour Emissions from Aircraft at Farnborough Airport June 2009

1. Introduction

Farnborough Airport is the subject of odour complaints, so in order to quantify the emissions from the site and to help decide on design criteria for abatement of the odours an odour sampling survey of jet engine exhaust was proposed.

Silsoe Odours Ltd visited Farnborough Airport June 2009 to collect samples from the down wind of aircraft at the holding stand and from the engine exhaust.

Only odour concentration measurements are covered by our UKAS accreditation (Testing Laboratory No. 0609).

2. Sampling for concentration measurements

We sampled at the following places:

2.1. To assess the concentration downwind of aircraft at the F1 holding position

We collected samples from a sampling point about 45 m down wind of the F1 line near the F1 sign on both days and 100m further downwind on the first day. The sample was collected during the time aircraft stood under orders from Air Traffic Control.

2.2. To assess the odour concentration of the exhaust from aircraft on the parking apron during pre-flight testing

We collected a sample from a sampling point about 35 m behind the aircraft, in the jet stream, that was carrying out pre-flight checks on the apron. Only one sample was collected using this method because there was rarely sufficient time to position the sampling equipment before the area behind the plane became too dangerous to work.

2.3. To assess the odour concentration of the exhaust from aircraft at the F1 holding position

We collected samples from a sampling point about 45 m behind the F1 holding line in the jet stream from the engine. The sample was collected during the time aircraft stood under orders from Air Traffic Control.

3. Analysis methods

3.1. Odour concentration

Odour concentrations were measured according to EN13725 standard for olfactometry.

Air samples were analysed by dynamic olfactometry at the Silsoe Odours Ltd laboratory in Bedfordshire, a UKAS accredited laboratory using the procedures set out in the Silsoe Odours Ltd Odour Lab Procedure OL1 which incorporates BSEN13725:2003 "Air quality – Determination of odour concentration measurement by dynamic olfactometry".



Fig 1 Silsoe Odours Ltd's UKAS accredited odour laboratory

The olfactometry measurement quantifies the concentration of odour in air samples by diluting the air sample under test with known ratios of odour-free air. The diluted samples are presented to a panel of six people to determine the odour threshold value. The threshold value is the odour concentration just perceived by 50% of the panel via statistical analysis of dilution test results. Odour concentration results are expressed in European odour units per cubic metre ($\text{ou}_E \text{m}^{-3}$), which equates to the number of dilutions to the detection threshold. The odour concentration of an undiluted sample which is at threshold level is $1 \text{ou}_E \text{m}^{-3}$.

Air samples were collected through FEP sampling tubes with stainless steel fittings and collected in Nalophan-NA sample bags. The sample bags were fitted in "barrels" which were partially evacuated to provide the motive force (vacuum) to draw air from the ducts being sampled into the bags.

4. Results

4.1. The Odour concentration downwind of aircraft at the F1 holding position

Odour samples were collected from downwind of the holding position F1 of the emission from 5 planes. Concentrations ranged between 77 and $188 \text{ou}_E \text{m}^{-3}$. These low concentrations should be compared with the background sample results in sect 4.4.

4.2. To assess the odour concentration of the exhaust from aircraft on the parking apron during pre-flight testing

A sample of exhaust from one Citation 500 plane on the apron was collected from about 35m behind the engines. The odour concentration of this sample was $5524 \text{ou}_E \text{m}^{-3}$.

4.3. To assess the odour concentration of the exhaust from aircraft at the F1 holding position

As an alternative to working on the apron sampling equipment was set up at a position that was usually in the jet-stream of planes holding at F1. about 45 m from the line. Three samples were collected here. The odour concentration of the exhaust from an HS146 was $394 \text{ou}_E \text{m}^{-3}$ and the

sample collected simultaneously downwind of the aircraft was $127 \text{ ou}_{\text{EM}}^{-3}$ (compare with background sample sect 4.4)

The second sample, from in the jet-stream of a Global Express, collected from using the pump sampler had a concentration of $470 \text{ ou}_{\text{EM}}^{-3}$ and a sample from the same aircraft collected by opening the sample bag within the jet-stream had a concentration of $1,017 \text{ ou}_{\text{EM}}^{-3}$. The jet-stream of a second Global Express was sampled by opening the sample bag within the jet-stream had a concentration of $389 \text{ ou}_{\text{EM}}^{-3}$.

A sample from the smaller jet Reg. N475M had a concentration of $128 \text{ ou}_{\text{EM}}^{-3}$.

4.4. Background odour samples

Two samples were collected on 5 June when the wind was from the north, the wind fetch included an area of airport grass, rough grazing and woodland. Odour concentrations measured were $89 \text{ ou}_{\text{EM}}^{-3}$ and $123 \text{ ou}_{\text{EM}}^{-3}$.

4.5. Hydrogen Sulphide measurements

We made measurements of the odour samples with a Hydrogen Sulphide analyser not for the concentration of H_2S but because the instrument has some cross sensitivity for hydrocarbons. Thus it can be seen that the raised H_2S concentrations of the samples from the Exhaust of Citation 500 on Apron, the Exhaust of HS146 at F1, the Exhaust of Global Express at F1, and the Exhaust of Global Express at F1 sampled by opening the bag contrast with the H_2S concentrations of the other samples collected down wind of the aircraft and the background samples.

5. Conclusions

Some useful guidance on the odour emission from jet aircraft has been gathered. However the methods of collection were very dependant on the wind direction and speed. A more robust method would be to collect directly from the engine exhaust in a test area at the engine loadings experienced during holding, taxiing and takeoff then to extrapolate, using dispersion modelling, the concentration at odour receptors.

Table 1 Results of odour sampling and other sampling data sampling

Sampling Time	Sample No.	Plane type or I/D and sampling position	Comments on sampling	Wind speed, knots	Odour concentration of the sample $\text{ou}_E \text{m}^{-3}$ (including pre-dilution)	H ₂ S ppm
Wednesday 3 June 2009						
09:12	20090604 F1	MWMWM at F1	50 metres downwind	7-8	102	0.006
09:12	20090604 100-1	100 metres from F1	150 metres from plane	5	65	0.002
10:13	20090604 F2	Twin turbo at F1	50 metres downwind	7	119	0.002
10:20	20090604 F3	Lear 60 at F1	50 metres downwind	7	188	0.003
10:20	20090604 100-2	100 metres from F1	150 metres from plane	6-8	115	0.003
10:25	20090604 F4	Lear 60 at F1	50 metres downwind	6-8	188	0.002
10:44	20090604 F5	Cherokee at F1	Piston engine, 50 metres downwind	6-8	77	0.003
11:53	20090604 F6	Exhaust of Citation 500 on Apron	35metres behind aircraft	6-8	5,524	0.013
Thursday 4 June 2009						
8:56	20090605 F1	Exhaust of HS146 at F1	45m behind plane	4-6	394	0.009
8:57	20090605 F2	Downwind of HS146 at F1	At F1 sign	light	127	0.002
12:50	20090605 F3	Exhaust of Global Express at F1	Pumped sample	light	470	0.013
12:52	20090605 F5	Exhaust of Global Express at F1	Sampled by opening the bag	light	1,017	0.026
12:20	20090605 Blank1	Back ground	Wind from North	light	89	
12:25	20090605 Blank2	Back ground	Wind from North	light	123	
14:30	20090605 F6	Exhaust of Global Express at F1	Sampled by opening the bag	light	389	0.001
14:40	20090605 F7	Exhaust of N475M at F1	Pumped sample	light	128	0.001



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Olfactometric measurements for: ARUP; Farnborough on 04, 05 June 2009



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6. Appendix 1 Olfactometric measurements

Contract Report Number: CR/SO410/09/ARUP001

Customer Reference:

Measurements carried out by: L. McCartney, G. Liddle

1. Contact: M. Ireland
ARUP, 13 Fitzroy Street,
London,
W12 4BQ
Tel: 020 7755 2782
Fax: 020 7755 2451

2. Odour source: Airport

3. Sampler: * R.W. Sneath

4. Sampling date: * 03, 04 June 2009

5. Laboratory Temperature and CO₂ 23.3°C, 616 ppm

6. Measurement date: 04, 05 June 2009

7. Presentation mode: Forced choice

8. Olfactometer: Project Research n6.
Serial number OLF-N6-J-A


9. Pre-Dilution Gas Meter: Kimmon Model SK25 Ser No 0003171


10. Reference odorant/accepted reference value n-butanol. 60 ppm/ 40ppb

11. Calibration Status of Laboratory Accuracy, A_{od} 0.308

12. Method: Following Odour Lab Procedure OL1 which incorporates BSEN13725 "Air quality – Determination of odour concentration measurement by dynamic olfactometry".

13. Special remarks: None

14. Approved by

R.W. Sneath
Head of Laboratory.

Compiled by

L. McCartney
Manager of Laboratory

"This laboratory is accredited in accordance with the recognised International Standard ISO/IEC 17025:2005. This accreditation demonstrates technical competence for a defined scope and the operation of a laboratory quality management system (refer joint ISO-ILAC-IAF communiqué dated 18 June 2005)"



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**Olfactometric measurements for: ARUP;
Farnborough on 04, 05 June 2009**



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Results:

Table 1: Results of odour measurements on 4 and 5 June 2009

Analysis Time	Sample No.	Sample Source and Position	Odour Panel Threshold $\text{ou}_E \text{m}^{-3}$	Pre-dilution	Odour concentration of the sample $\text{ou}_E \text{m}^{-3}$ (including pre-dilution)	H ₂ S
09:12	20090604 100-1	100 metres from F1	65	none	65	0.002
09:30	20090604 100-2	100 metres from F1	115	none	115	0.003
09:41	20090604 F1	MWMWM at F1	102	none	102	0.006
09:56	20090604 F2	Twin turbo at F1	119	none	119	0.002
10:13	20090604 F3	Lear 60 at F1	188	none	188	0.003
10:26	20090604 F4	Lear 60 at F1	188	none	188	0.002
10:33	20090604 F5	Cherokee at F1	77	none	77	0.003
10:50	20090604 F6	Exhaust of Citation 500 on Apron	5,524	none	5,524	0.013
09:02	20090605 Blank1		89	none	89	
09:16	20090605 Blank2		123	none	123	
10:32	20090605 F1	Exhaust of HS146 at F1	394	none	394	0.009
10:22	20090605 F2	Downwind of HS146 at F1	127	none	127	0.002
10:07	20090605 F3	Exhaust of Global Express at F1	470	none	470	0.013
10:44	20090605 F5	Exhaust of Global Express at F1	1,017	none	1,017	0.026
09:51	20090605 F6	Exhaust of Global Express at F1	389	none	389	0.001
09:35	20090605 F7	Exhaust of N475M at F1	128	none	128	0.001

Deviation from the standard

None.

The following data is not covered by our UKAS Accreditation