



environmental consultants

Union Street
Hetton-le-Hole
Tyne & Wear
DH5 9HU

Tel: 01915208211
Fax: 01915208209

Email: info@epa-services.co.uk

REPORT FOR THE MONITORING OF EMISSIONS TO AIR FROM BAE SYSTEMS MARITIME - SUBMARINES, BARROW-IN-FURNESS, CUMBRIA, LA14 1AF

Part 1: Executive Summary

Permit /Authorisation Number: PGN 6/23

Operator: BAE Systems

Installation: Maritime – Submarines, Barrow-In-Furness

Monitoring Dates: 30th June – 4th July & 8th August 2014

Project Number: EPA/JBN/14/515

For The Attention of: Mr Terry Hughes

Client: Leck Construction

Client Address: Site Engineering Services Dept.,
Central Area,
Barrow-In-Furness,
Cumbria,
LA14 1AF

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Report Author: T Dodds

Report Approved By: T Dodds

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MCERTS Qualifications: Level 2 TE1, TE2, TE3 & TE4

Position: Director

Signature:



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Contents Page

Part 1: Executive Summary	1
1.1 Monitoring Objectives	4
Table 1: Determinants to be Monitored From Varying Facilities.....	4
1.2 Monitoring Results.....	5
1.3 Operating Information	7
1.4 Monitoring Deviations	8
Part 2: Supporting Information	9
2.1 Appendix 1: General Information	9
2.1.1 Emissions Monitoring Team.....	9
2.1.2 Substances Monitored.....	9
2.1.3 Site Equipment Log	10
2.2 Appendix 2: RIF Hand Paint Enclosure.....	11
2.2.1 Sampling Location	11
2.2.2 Flow Criteria Measurements	12
2.2.3 Gas Measurements	12
2.2.4 Manual Method Calculations	13
2.2.5 Sampling Measurements	15
2.2.6 Instrumental Gas Analyser Site Calibration Measurements	16
2.2.7 Instrumental Gas Analyser Results	16
2.2.8 Uncertainty Calculations.....	19
2.3 Appendix 3: RIF Spray Paint Enclosure	20
2.3.1 Sampling Location	20
2.3.2 Flow Criteria Measurements	21
2.3.3 Gas Measurements	21
2.3.4 Manual Method Calculations	22
2.3.5 Sampling Measurements	24
2.3.6 Instrumental Gas Analyser Site Calibration Measurements	25
2.3.7 Instrumental Gas Analyser Results	25
2.3.8 Uncertainty Calculations.....	28
2.4 Appendix 4: Paint Shop Oven Vent	29
2.4.1 Sampling Location	29
2.4.2 Flow Criteria Measurements	30
2.3.3 Gas Measurements	30
2.4.4 Manual Method Calculations	31
2.4.5 Sampling Measurements	33
2.4.6 Instrumental Gas Analyser Site Calibration Measurements	34
2.4.7 Instrumental Gas Analyser Results	34
2.4.8 Uncertainty Calculations.....	37
2.5 Appendix 5: Paint Shop Spray Area	38
2.5.1 Sampling Location	38
2.5.2 Flow Criteria Measurements	39
2.5.3 Gas Measurements	39
2.5.4 Manual Method Calculations	40
2.5.5 Sampling Measurements	42
2.5.6 Instrumental Gas Analyser Site Calibration Measurements	43
2.5.7 Instrumental Gas Analyser Results	43
2.5.8 Uncertainty Calculations.....	47
2.6 Appendix 6: Paint Shop Shot Blast.....	48
2.6.1 Sampling Location	48
2.6.2 Flow Criteria Measurements	49

2.6.3 Gas Measurements	49
2.6.4 Manual Method Calculations	50
2.6.5 Sampling Measurements	52
2.6.6 Uncertainty Calculations	53
2.7 Appendix 7: DDH Hall Paint Extract	54
2.7.1 Sampling Location	54
2.7.2 Flow Criteria Measurements	55
2.7.3 Gas Measurements	55
2.7.4 Manual Method Calculations	56
2.7.5 Sampling Measurements	58
2.7.6 Instrumental Gas Analyser Site Calibration Measurements	59
2.7.7 Instrumental Gas Analyser Results	59
2.7.8 Uncertainty Calculations	62
2.8 Appendix 8: NAS Annex	63
2.8.1 Sampling Location	63
2.8.3 Gas Measurements	64
2.8.4 Manual Method Calculations	65
2.8.5 Sampling Measurements	67
2.8.6 Instrumental Gas Analyser Site Calibration Measurements	68
2.8.7 Instrumental Gas Analyser Results	68
2.8.8 Uncertainty Calculations	72
2.9 Appendix 9: DDH Tile Cutting Facility	73
2.9.1 Sampling Location	73
2.9.2 Flow Criteria Measurements	74
2.9.3 Gas Measurements	74
2.9.4 Manual Method Calculations	75
2.9.5 Sampling Measurements	77
2.9.6 Uncertainty Calculations	78
2.10 Appendix 10: Contractors Paint Mixing Facility	79
2.10.1 Sampling Location	79
2.10.2 Flow Criteria Measurements	80
2.10.3 Gas Measurements	80
2.10.4 Manual Method Calculations	81
2.10.5 Sampling Measurements	83
2.10.6 Instrumental Gas Analyser Site Calibration Measurements	84
2.10.7 Instrumental Gas Analyser Results	84
2.10.8 Uncertainty Calculations	87
2.11 Certificates of Analysis	88
2.12 Calibration Certificates	95

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1.1 Monitoring Objectives

EPA Limited were commissioned by Leck Construction to carry out emissions monitoring to determine the release of prescribed pollutants from varying release points (refer to Table 1) under normal operating conditions.

Table 1: Determinants to be Monitored From Varying Facilities

Emission Point Identification	Substances to be Monitored	
	Particulates	Total VOC's
RIF Hand Paint Enclosure Area D16	✓	✓
RIF Spray Paint Enclosure Area D16	✓	✓
Paint Shop Oven Vent Area D13	✓	✓
Paint Shop Spray Area D13	✓	✓
Paint Shop Shot Blast Area D13	✓	-
DDH Paint Extraction Area D34	✓	✓
NAS Annex Area A69	✓	✓
Tile Cutting Facility	✓	-
Contractors Paint Mixing Facility Area D00	✓	✓

1.2 Monitoring Results

Emission Point Reference	Substance to be Monitored	Emission Limit Value (30 min mean)	Periodic Monitoring Result (30 min mean)	Uncertainty	Units	Reference Conditions	Date of Sampling	Start and Stop Time	Monitoring Method Reference	Accreditation for use of Method	Operating Status
RIF Hand Paint Enclosure Area D16	Particulates	50mg/Nm ³	1.5	± 0.3	mgm ⁻³	STP (101.3kPa, 273K)	30.06.14	12:54 – 13:24	BS EN 13284-1	UKAS/MCERTS	Normal
	Total VOC's	N/A	11.5	± 3.56	mgm ⁻³	STP (101.3kPa, 273K)			BS EN 12619	UKAS/MCERTS	Normal
RIF Spray Paint Enclosure Area D16	Particulates	50mg/Nm ³	16.9	± 0.7	mgm ⁻³	STP (101.3kPa, 273K)	02.07.14	13:50 – 14:20	BS EN 13284-1	UKAS/MCERTS	Normal
	Total VOC's	N/A	12293.8	± 33.7	mgm ⁻³	STP (101.3kPa, 273K)			BS EN 13526	UKAS/MCERTS	Normal
Paint Shop Oven Vent Area D13	Particulates	50mg/Nm ³	0.9	± 0.3	mgm ⁻³	STP (101.3kPa, 273K)	01.07.14	10:53 – 11:23	BS EN 13284-1	UKAS/MCERTS	Normal
	Total VOC's	N/A	19.6	± 3.5	mgm ⁻³	STP (101.3kPa, 273K)			BS EN 13526	UKAS/MCERTS	Normal
Paint Shop Spray Area D13	Particulates	50mg/Nm ³	1.7	± 0.5	mgm ⁻³	STP (101.3kPa, 273K)	01.07.14	12:48 – 13:20	BS EN 13284-1	UKAS/MCERTS	Normal
	Total VOC's	N/A	1.6	± 0.4	mgm ⁻³	STP (101.3kPa, 273K)			BS EN 12619	UKAS/MCERTS	Normal

Emission Point Reference	Substance to be Monitored	Emission Limit Value (30 min mean)	Periodic Monitoring Result (30 min mean)	Uncertainty	Units	Reference Conditions	Date of Sampling	Start and Stop Time	Monitoring Method Reference	Accreditation for use of Method	Operating Status
Paint Shop Shot Blast Area D13	Particulates	50mg/Nm ³	8.5	± 0.5	mgm ⁻³	STP (101.3kPa, 273K)	01.07.14	14:47 – 15:19	BS EN 13284-1	UKAS/MCERTS	Normal
DDH Paint Extraction Area D34	Particulates	50mg/Nm ³	5.1	± 0.3	mgm ⁻³	STP (101.3kPa, 273K)	08/08/14	10:52 – 11:24	BS EN 13284-1	UKAS/MCERTS	Normal
	Total VOC's	N/A	16.0	± 3.7	mgm ⁻³	STP (101.3kPa, 273K)			BS EN 13526	UKAS/MCERTS	Normal
NAS Annex Paint Extraction Area A69	Particulates	50mg/Nm ³	6.5	± 0.5	mgm ⁻³	STP (101.3kPa, 273K)	04.07.14	11:02 – 11:34	BS EN 13284-1	UKAS/MCERTS	Normal
	Total VOC's	N/A	2010.4	± 33.9	mgm ⁻³	STP (101.3kPa, 273K)			BS EN 13526	UKAS/MCERTS	Normal
DDH Tile Cutting Facility	Particulates	50mg/Nm ³	2.1	± 0.4	mgm ⁻³	STP (101.3kPa, 273K)	03.07.14	12:52 – 13:22	BS EN 13284-1	UKAS/MCERTS	Normal
Contractors Paint Mixing Facility	Particulates	50mg/Nm ³	1.8	± 0.3	mgm ⁻³	STP (101.3kPa, 273K)	03.07.14	14:46 – 15:16	BS EN 13284-1	UKAS/MCERTS	Normal
	Total VOC's	N/A	356.9	± 3.5	mgm ⁻³	STP (101.3kPa, 273K)			BS EN 13526	UKAS/MCERTS	Normal

1.3 Operating Information

Emission Point Reference	Continuous or Batch Process	Details of Batch during Sampling (Type of paint used)	Feedstock	Abatement	Comparison of Operator CEMS and periodic Monitoring Results			
					Substance	CEM Results	Periodic Monitoring Results	Units
RIF Hand Paint Enclosure Area D16	Batch	Sigma Cover 400 – L574	Various Parts	N/A	N/A	N/A	N/A	N/A
RIF Spray Paint Enclosure Area D16	Batch	L574	N/A	N/A	N/A	N/A	N/A	N/A
Paint Shop Oven Vent Area D13	Batch	Trimite P8000	Various Parts	N/A	N/A	N/A	N/A	N/A
Paint Shop Spray Area D13	Batch	Trimite P8000	Various Parts	Filter System	N/A	N/A	N/A	N/A
Paint Shop Shot Blast Area D13	Batch	N/A	N/A	Bag Filter	N/A	N/A	N/A	N/A
DDH Paint Extraction Area D34	Batch	L574	N/A	N/A	N/A	N/A	N/A	N/A
NAS Annex Area A69	Batch	Primer L574	MDF	Bag Filter	N/A	N/A	N/A	N/A
Tile Cutting Facility	Batch	N/A	CTL 2Tiles	Bag Filter	N/A	N/A	N/A	N/A
Contractors Paint Mixing. Area D00	Batch	L574	Mix Tank	N/A	N/A	N/A	N/A	N/A

1.4 Monitoring Deviations

Emission Point Reference	Substances Not Monitored (including explanation)	Monitoring Deviations (including explanation)	Other Relevant Issues
Paint Shop Spray	-	Blank test slightly higher concentration than actual test Only one port available, number of sample points doubled	-
Paint Shop Shot Blast	-	Only one sample line, number of sample points doubled	-
NAS Annex	-	Only one port available, number of sample points doubled	-
Tile Cutting Facility	-	Blank test slightly higher concentration than actual test	-

Part 2: Supporting Information

2.1 Appendix 1: General Information

2.1.1 Emissions Monitoring Team

Consultant Charles Bell
MCERTS Accreditation Level 2 TE1
MCERTS Number MM 02 015
Degree BSc Hons Energy Technology Management

Project Supervisor Phillip Mothersdale
MCERTS Accreditation Level 2 TE1, 2, 3 & 4
MCERTS Number MM 05 596
Degree BSc Hons Chemistry with Analytical Chemistry

Consultant Tracy Dodds
MCERTS Accreditation Level 2 TE1, 2, 3 & 4
MCERTS Number MM 03 414
Degree BSc Hons Environmental Management & Technology

2.1.2 Substances Monitored

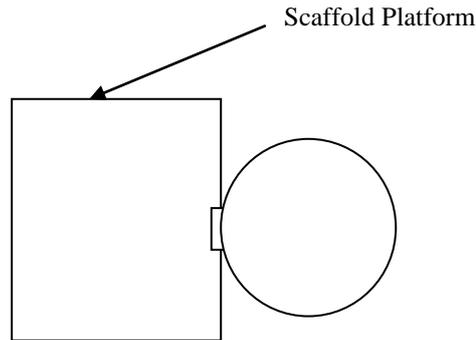
Substances Monitored	Standard Reference Method	EPA Method
Flow	BS EN 13284-1	EPA Method 1
Particulate	BS EN 13284-1	EPA Method 1
Total VOCs by FID	BS EN 12619	EPA Method 6

2.1.3 Site Equipment Log

Equipment Description	EPA Reference Number
Heated Line	EPA/HEAT/04, 07, 01, 06, 05
Pitot Tube	EPA/PITOT/10,11
Thermocouple Probe	EPA/TCP/49, 65
Thermocouple Reader	EPA/MAN/07
Measuring Tape	EPA/TAPE/13
Vion Site Barometer	EPA/BAR/04, 03
Sampling Probe	EPA/PROBE/08, 10
Dry Gas Meter	EPA/DGM/02, 09
Site Balance	EPA/MASS/03, 02
Sampling Nozzle	EPA/N/6, 30, 34, 36
Sick 3006 FID	EPA/FID/02, 01
Sample Box	EPA/SAMP/09A, 01A

2.2 Appendix 2: RIF Hand Paint Enclosure

2.2.1 Sampling Location



Duct Characteristics

	Value	Units
Type of Duct	Circular	-
Diameter / Depth	0.285	m
Width	N/A	m
Area	0.064	m ²
Port Size	4	inch
Port Depth	70	mm
Orientation	Vertical	-

Sampling Platform

General Platform Information	
Permanent / Temporary	Temporary
Inside / Outside	Inside
Height of Platform from Ground Level	~7m
Size of Platform	1.0m x 1.5m
Does the Platform have a weather cover (roof)	N/A
Platform has 2 hand rails (approx 0.5m and 1.0m high)	Yes
Platform has vertical base boards (approx 0.25m high)	Yes
Platform has removable chains / self closing gates at the top of the ladder	Yes
Platform positioned relative to the access ports (free from obstruction that would hamper insertion and removal of the sampling equipment)	Yes
Depth of platform (length of probe + 1m)	No

2.2.2 Flow Criteria Measurements

Traverse Point	A1	A2	A3	A4	A5	A6	A7	A8	A9	A10
Pressure (mm H ₂ O)	11.0	11.0	10.5	10.0	10.0	9.5	10.0	9.5	9.5	9.0
√ΔP	3.32	3.32	3.24	3.16	3.16	3.08	3.16	3.08	3.08	3.00
Temperature (°C)	26	26	26	26	26	26	26	26	26	26

Static Pressure (mmH ₂ O)	11.5	Barometric Pressure (mm Hg)	763.1	Duct Dimensions (m)	0.285
--------------------------------------	------	-----------------------------	-------	---------------------	-------

Velocity (m/s) average	10.7	Actual Flow of stack gas (m ³ /hr)	2642.9
Stack Geometry	Circular	Flow (wet) at STP (m ³ /hr)	2422.9
Dimensions (m)	0.285	Flow (dry) at STP (m ³ /hr)	2346.2
Area (m ²)	0.064		

	Average	Max	Min	Ratio Max/Min	Compliance
Pressure (mm H ₂ O)	10.0	11.0	9.0	1.2	Yes
√ΔP (mm H ₂ O) ^{1/2}	3.16	3.32	3.00	1.1	Yes
Temperature (°C)	26.0	26	26	1.0	Yes
Angle of flow	<15°				Yes
Local Negative Flow	No				Yes

2.2.3 Gas Measurements

	Mean
Oxygen (%)	20.90
Carbon Monoxide (ppm)	0
Carbon Dioxide (%)	0.03

2.2.4 Manual Method Calculations

Test Dates	30/06/14		
Company	Leck Construction (BAE Systems)		
Contact	T Hughes		
Stack	RIF Hand		
	Blank	Test 1	Units
Sample Ref	EPA/14/515/01	EPA/14/515/02	-
Start Time	12:03	12:54	hr:mm
Stop Time	12:08	13:24	hr:mm
% O ₂	20.90	20.90	%
% CO ₂	0.03	0.03	%
%N ₂	-	79.07	%
V _{lc}	-	18	ml
B _{wo}	0.03	0.032	-
P _b	-	762.3	mm Hg
St	-	11.5	mm H ₂ O
T _s	-	27.00	°C
√ΔP	-	3.19	(mm H ₂ O) ^{1/2}
Yd	-	1.023	-
Test Time	5	30	min
T _m	-	21.25	°C
C _p	-	0.833	-
A _s	-	0.068	m ²
D _n	-	7.08	mm
ΔH ave	-	54.66	mm H ₂ O
V _{mstd}	0.6855	0.6855	m ³
V _{wstd}	0.0224	0.0224	m ³
Q _{std,wet}	-	2455.4	Nm ³ /h
Q _{act}	-	2687.3	Nm ³ /h
Isokinetic Rate	-	100.1	%
V _s	-	10.92	m/s
Washings			
Sample Ref	EPA/14/515/01W	EPA/14/515/02W	-
Weight	<0.5	<0.5	mg
Filter			
Sample Ref	EPA/14/515/01F	EPA/14/515/02F	-
Weight	0.13	0.56	mg
Particulate Concentration (Dry, No O ₂ Correction)	0.9	1.5	mg/Nm ³
Particulate Concentration (at Ref Water and Oxygen)	0.9	1.5	mg/Nm ³
Particulate Release Rate	-	3.68	g/hr
Reference Temp	273		K
Reference Pressure	101.3		kPa
Reference Moisture	No correction for moisture		-
Reference Oxygen	No correction for Oxygen		%

Particulates

	Filter (mg)	Washings (mg)
Blank	0.13	<0.5
Run 1	0.56	<0.5

2.2.5 Sampling Measurements

Date	30/06/14	Impinger	Initial Wt (g)	Final Wt(g)	Wt Gained (g)			l/min	Vac (in Hg)				
Start Time	12:54	1	783.3	788.9	5.6		Leak Check (Pre)	0.1	15				
End Time	13:24	2	735.8	736.4	0.6		Leak Check (Post)	0.1	5				
Duration (mm.ss)	30.00	3	665.1	666.2	1.1								
Stack	RIF Hand Paint	4	747.7	758.4	10.7		Pitot ID	Pitot 06				Velocity Head	
Run	1	5	248.6	248.6	0.0		DGM ID	DGM 09				Min	8.5
												Max	8.5
												Max:Min	1.00
							Nozzle ID	N36					
			Sample Ref	EPA/14/515/02			Nozzle Diameter (mm)	7.08					
K Factor	5.33		Filter Number	EPA/14/515/02F									
Stack Diameter (m)	0.30		Probe Washing No	EPA/14/515/02W									
							AH across orifice meter (mm H ₂ O)	DGM (litres)	DGM Temp (°C)		Temp (°C)		
Point	Time	Vac	Stack Temp (°C)	Velocity Head (mmH ₂ O)	√AP			7007.72	In	Out	Probe	Filter	Impinger
a1	0	4	26	14	3.74		74.65	7148	20	20	166	161	
a1	5	4	27	9.5	3.08		50.66	7304	21	20	160	160	
a1	10	4	27	9.5	3.08		50.66	7398	22	21	160	160	
a1	15	4	27	9.5	3.08		50.66	7497	23	20	160	160	
a1	20	4	27	9.5	3.08		50.66	7591	23	20	160	160	
a1	25	4	28	9.5	3.08		50.66	7724.05	24	21	160	160	
Total / Average		4.00	27.00	10.25	3.19		54.66	716.33	22.17	20.33	161.00	160.17	

2.2.6 Instrumental Gas Analyser Site Calibration Measurements

Zero Point

Gas	Analyser Range	Gas Cylinder ID	Gas Conc.	Pre Test			Post Test	
				Pre Span	Post Span	System	System	Zero Drift
VOC (ppm)	100	Ambient Air	0.00	0.05	0.02	0.26	0.59	0.33

Span Gas

Gas	Analyser Range	Gas Cylinder ID	Gas Conc.	Pre Test		Post Test	
				Analyser	System	System	Span Drift
VOC (ppm)	100	EPA/CGAS/77	83.00	83.64	83.21	84.18	0.97

2.2.7 Instrumental Gas Analyser Results

Date	Time	VOC ppm	VOC as C mg/m ³	VOC as C @ Ref O ₂ mg/m ³
30.06.2014	12:54:11	3.5	5.7	5.7
30.06.2014	12:54:26	4.7	7.6	7.6
30.06.2014	12:54:41	5.7	9.1	9.1
30.06.2014	12:54:56	5.4	8.7	8.7
30.06.2014	12:55:11	5.6	9.0	9.0
30.06.2014	12:55:26	6.0	9.6	9.6
30.06.2014	12:55:41	6.0	9.7	9.7
30.06.2014	12:55:56	6.1	9.7	9.7
30.06.2014	12:56:11	5.7	9.2	9.2
30.06.2014	12:56:26	5.4	8.7	8.7
30.06.2014	12:56:41	5.5	8.8	8.8
30.06.2014	12:56:56	5.5	8.8	8.8
30.06.2014	12:57:11	5.3	8.6	8.6
30.06.2014	12:57:26	5.2	8.3	8.3
30.06.2014	12:57:41	5.3	8.4	8.4
30.06.2014	12:57:56	5.1	8.2	8.2
30.06.2014	12:58:11	5.1	8.2	8.2
30.06.2014	12:58:26	5.3	8.5	8.5
30.06.2014	12:58:41	5.4	8.7	8.7
30.06.2014	12:58:56	5.3	8.5	8.5
30.06.2014	12:59:11	5.3	8.5	8.5
30.06.2014	12:59:26	6.3	10.2	10.2
30.06.2014	12:59:41	7.6	12.1	12.1
30.06.2014	12:59:56	9.7	15.7	15.7
30.06.2014	13:00:11	11.0	17.7	17.7
30.06.2014	13:00:26	12.1	19.4	19.4
30.06.2014	13:00:41	11.9	19.1	19.1
30.06.2014	13:00:56	11.3	18.2	18.2
30.06.2014	13:01:11	10.5	16.9	16.9
30.06.2014	13:01:26	11.0	17.7	17.7
30.06.2014	13:01:41	10.4	16.7	16.7

Date	Time	VOC ppm	VOC as C mg/m ³	VOC as C @ Ref O ₂ mg/m ³
30.06.2014	13:01:56	9.0	14.5	14.5
30.06.2014	13:02:11	9.0	14.4	14.4
30.06.2014	13:02:26	9.2	14.8	14.8
30.06.2014	13:02:41	10.2	16.4	16.4
30.06.2014	13:02:56	9.7	15.6	15.6
30.06.2014	13:03:11	9.5	15.2	15.2
30.06.2014	13:03:26	9.0	14.4	14.4
30.06.2014	13:03:41	8.6	13.8	13.8
30.06.2014	13:03:56	8.5	13.7	13.7
30.06.2014	13:04:11	8.6	13.8	13.8
30.06.2014	13:04:26	8.7	14.0	14.0
30.06.2014	13:04:41	8.8	14.2	14.2
30.06.2014	13:04:56	8.5	13.7	13.7
30.06.2014	13:05:11	7.6	12.3	12.3
30.06.2014	13:05:26	7.2	11.5	11.5
30.06.2014	13:05:41	7.3	11.7	11.7
30.06.2014	13:05:56	8.0	12.9	12.9
30.06.2014	13:06:11	8.1	13.1	13.1
30.06.2014	13:06:26	7.8	12.6	12.6
30.06.2014	13:06:41	7.5	12.1	12.1
30.06.2014	13:06:56	7.6	12.2	12.2
30.06.2014	13:07:11	5.7	9.2	9.2
30.06.2014	13:07:26	4.3	6.9	6.9
30.06.2014	13:07:41	5.2	8.4	8.4
30.06.2014	13:07:56	5.5	8.8	8.8
30.06.2014	13:08:11	5.1	8.1	8.1
30.06.2014	13:08:26	4.7	7.6	7.6
30.06.2014	13:08:41	4.6	7.3	7.3
30.06.2014	13:08:56	4.5	7.2	7.2
30.06.2014	13:09:11	4.3	6.9	6.9
30.06.2014	13:09:26	4.8	7.7	7.7
30.06.2014	13:09:41	4.7	7.5	7.5
30.06.2014	13:09:56	4.5	7.3	7.3
30.06.2014	13:10:11	4.7	7.6	7.6
30.06.2014	13:10:26	5.0	8.1	8.1
30.06.2014	13:10:41	5.5	8.8	8.8
30.06.2014	13:10:56	6.0	9.6	9.6
30.06.2014	13:11:11	4.9	7.9	7.9
30.06.2014	13:11:26	5.0	8.1	8.1
30.06.2014	13:11:41	5.8	9.3	9.3
30.06.2014	13:11:56	6.1	9.7	9.7
30.06.2014	13:12:11	5.5	8.9	8.9
30.06.2014	13:12:26	6.6	10.6	10.6
30.06.2014	13:12:41	7.0	11.3	11.3
30.06.2014	13:12:56	6.3	10.1	10.1
30.06.2014	13:13:11	7.4	11.8	11.8
30.06.2014	13:13:26	6.9	11.2	11.2
30.06.2014	13:13:41	7.1	11.5	11.5
30.06.2014	13:13:56	7.2	11.5	11.5

Date	Time	VOC ppm	VOC as C mg/m ³	VOC as C @ Ref O ₂ mg/m ³
30.06.2014	13:14:11	7.9	12.8	12.8
30.06.2014	13:14:26	8.1	13.1	13.1
30.06.2014	13:14:41	9.3	14.9	14.9
30.06.2014	13:14:56	8.1	13.0	13.0
30.06.2014	13:15:11	8.3	13.3	13.3
30.06.2014	13:15:26	8.4	13.4	13.4
30.06.2014	13:15:41	8.8	14.1	14.1
30.06.2014	13:15:56	8.7	14.0	14.0
30.06.2014	13:16:11	7.9	12.7	12.7
30.06.2014	13:16:26	8.8	14.1	14.1
30.06.2014	13:16:41	7.9	12.8	12.8
30.06.2014	13:16:56	7.8	12.5	12.5
30.06.2014	13:17:11	8.6	13.9	13.9
30.06.2014	13:17:26	8.3	13.4	13.4
30.06.2014	13:17:41	7.8	12.6	12.6
30.06.2014	13:17:56	7.5	12.1	12.1
30.06.2014	13:18:11	7.4	11.8	11.8
30.06.2014	13:18:26	7.6	12.2	12.2
30.06.2014	13:18:41	7.6	12.2	12.2
30.06.2014	13:18:56	7.5	12.1	12.1
30.06.2014	13:19:11	7.4	11.9	11.9
30.06.2014	13:19:26	7.5	12.1	12.1
30.06.2014	13:19:41	7.8	12.5	12.5
30.06.2014	13:19:56	7.9	12.8	12.8
30.06.2014	13:20:11	8.0	12.8	12.8
30.06.2014	13:20:26	7.4	11.8	11.8
30.06.2014	13:20:41	7.3	11.7	11.7
30.06.2014	13:20:56	7.4	11.8	11.8
30.06.2014	13:21:11	7.7	12.4	12.4
30.06.2014	13:21:26	8.0	12.8	12.8
30.06.2014	13:21:41	7.6	12.1	12.1
30.06.2014	13:21:56	7.5	12.0	12.0
30.06.2014	13:22:11	7.0	11.3	11.3
30.06.2014	13:22:26	6.8	11.0	11.0
30.06.2014	13:22:41	7.9	12.8	12.8
30.06.2014	13:22:56	8.1	13.0	13.0
30.06.2014	13:23:11	8.1	13.0	13.0
30.06.2014	13:23:26	7.9	12.6	12.6
30.06.2014	13:23:41	7.5	12.0	12.0
30.06.2014	13:23:56	7.2	11.6	11.6
30.06.2014	13:24:11	7.3	11.7	11.7
30.06.2014	13:24:26	7.3	11.7	11.7
30.06.2014	13:24:41	6.9	11.0	11.0
30.06.2014	13:24:56	7.2	11.6	11.6
Mean		7.2	11.5	11.5
Max		12.1	19.4	19.4
Min		3.5	5.7	5.7

2.2.8 Uncertainty Calculations

Particulates

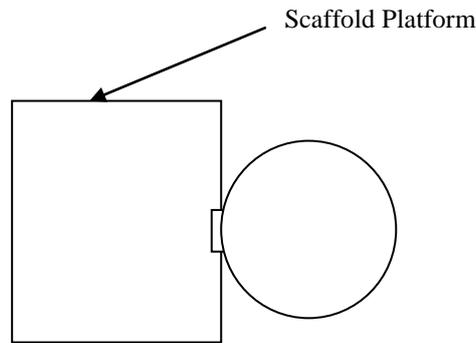
Source of uncertainty	Estimate of Component (1 SD) (± %)	Combined Uncertainty (± %)	Expanded Uncertainty (95% Confidence limit) (± %)
Mass of Particulate	11.17	11.37	As % of result 22.05
O ₂ Concentration	1.62		
Gas Temperature	1.09		
Pitot Co-efficient	0.50		As % of ELV 0.68
Humidity	0.50		
Stack Diameter	0.34		
Leak	0.24		
Nozzle Diameter	0.20		
Pressure	0.12		

Total VOC's

Source of uncertainty	Estimate of Component (1 SD) ppm	Combined Uncertainty ppm	Expanded Uncertainty (95% Confidence limit) ppm
Linearity	0.83	1.16	2.25
Temperature effect (zero)	0.48		
Barometric Pressure	0.42		
Span gas	0.32		
Span drift	0.28		
Temperature effect (span)	0.24		
Zero drift	0.10		Expanded Uncertainty (95% Confidence limit) %
Repeatability	0.07		
Cross sensitivity CO (1.2 % vol)	0.00		
Cross sensitivity NO (127 mgm ⁻³)	0.00		
Cross sensitivity H ₂ O (sat 325K)	0.00		
Cross sensitivity SO ₂ (2767 mgm ⁻³)	0.00		
Cross sensitivity CO ₂ (15.2 % vol)	0.00	As % of Result 31.34	
		As mg/m ³ at ref conditions 3.62	

2.3 Appendix 3: RIF Spray Paint Enclosure

2.3.1 Sampling Location



Duct Characteristics

	Value	Units
Type of Duct	Circular	-
Diameter / Depth	0.295	m
Width	N/A	m
Area	0.068	m ²
Port Size	4	inch
Port Depth	70	mm
Orientation	Vertical	-

Sampling Platform

General Platform Information	
Permanent / Temporary	Temporary
Inside / Outside	Outside
Height of Platform from Ground Level	~12m
Size of Platform	1.5m x 2.0m
Does the Platform have a weather cover (roof)	No
Platform has 2 hand rails (approx 0.5m and 1.0m high)	Yes
Platform has vertical base boards (approx 0.25m high)	Yes
Platform has removable chains / self closing gates at the top of the ladder	Yes
Platform positioned relative to the access ports (free from obstruction that would hamper insertion and removal of the sampling equipment)	Yes
Depth of platform (length of probe + 1m)	Yes

2.3.2 Flow Criteria Measurements

Traverse Point	A1	A2	A3	A4	A5	A6	A7	A8	A9	A10
Pressure (mm H ₂ O)	1.0	1.5	1.0	1.5	1.5	1.3	1.3	1.0	1.0	1.0
√ΔP	1.00	1.22	1.00	1.22	1.22	1.12	1.12	1.00	1.00	1.00
Temperature (°C)	28	28	28	28	28	28	28	28	28	28

Static Pressure (mmH ₂ O)	1	Barometric Pressure (mm Hg)	760.0	Duct Dimensions (m)	0.295
--------------------------------------	---	-----------------------------	-------	---------------------	-------

Velocity (m/s) average	3.7	Actual Flow of stack gas (m ³ /hr)	921.6
Stack Geometry	Circular	Flow (wet) at STP (m ³ /hr)	835.9
Dimensions (m)	0.295	Flow (dry) at STP (m ³ /hr)	818.0
Area (m ²)	0.068		

	Average	Max	Min	Ratio Max/Min	Compliance
Pressure (mm H ₂ O)	1.2	1.5	1.0	1.5	Yes
√ΔP (mm H ₂ O) ^{1/2}	1.09	1.22	1.00	1.2	Yes
Temperature (°C)	28.0	28	28	1.0	Yes
Angle of flow	<15°				Yes
Local Negative Flow	No				Yes

2.3.3 Gas Measurements

	Mean
Oxygen (%)	20.90
Carbon Monoxide (ppm)	0
Carbon Dioxide (%)	0.03

2.3.4 Manual Method Calculations

Test Dates	02/07/14		
Company	Leck Construction (BAE Systems)		
Contact	T Hughes		
Stack	RIF Spray		
	Blank	Test 1	Units
Sample Ref	EPA/14/515/09	EPA/14/515/10	-
Start Time	13:20	13:50	hr:mm
Stop Time	13:25	14:20	hr:mm
% O ₂	20.90	20.90	%
% CO ₂	0.03	0.03	%
%N ₂	-	79.07	%
V _{lc}	-	11.9	ml
B _{wo}	0.02	0.021	-
P _b	-	760.0	mm Hg
St	-	1	mm H ₂ O
T _s	-	29.67	°C
√ΔP	-	1.12	(mm H ₂ O) ^{1/2}
Yd	-	1.023	-
Test Time	5	30	min
T _m	-	23.42	°C
C _p	-	0.828	-
As	-	0.068	m ²
D _n	-	11.71	mm
ΔH ave	-	52.06	mm H ₂ O
V _{mstd}	0.6765	0.6765	m ³
V _{wstd}	0.0148	0.0148	m ³
Q _{std,wet}	-	847.7	Nm ³ /h
Q _{act}	-	939.8	Nm ³ /h
Isokinetic Rate	-	103.4	%
V _s	-	3.82	m/s
Washings			
Sample Ref	EPA/14/515/09W	EPA/14/515/10W	-
Weight	1.2	3	mg
Filter			
Sample Ref	EPA/14/515/09F	EPA/14/515/10F	-
Weight	<0.04	8.68	mg
Particulate Concentration (Dry, No O ₂ Correction)	1.8	17.3	mg/Nm ³
Particulate Concentration (at Ref Water and Oxygen)	1.8	16.9	mg/Nm ³
Particulate Release Rate	-	14.32	g/hr
Reference Temp	273		K
Reference Pressure	101.3		kPa
Reference Moisture	No correction for moisture		-
Reference Oxygen	No correction for Oxygen		%

Particulates

	Filter (mg)	Washings (mg)
Blank	<0.04	1.2
Run 1	8.68	3

2.3.6 Instrumental Gas Analyser Site Calibration Measurements

Zero Point

Gas	Analyser Range	Gas Cylinder ID	Gas Conc.	Pre Test			Post Test	Zero Drift
				Pre Span	Post Span	System	System	
VOC (ppm)	1000	Ambient Air	0.00	1.71	1.45	1.45	2.91	1.46

Span Gas

Gas	Analyser Range	Gas Cylinder ID	Gas Conc.	Pre Test		Post Test	Span Drift
				Analyser	System	System	
VOC (ppm)	1000	EPA/CGAS/72	805.00	808.30	805.11	807.11	2.00

2.3.7 Instrumental Gas Analyser Results

Date	Time	VOC ppm	VOC as C mg/m ³	VOC as C @ Ref O ₂ mg/m ³
02.07.2014	13:50:12	5692.0	9147.9	9147.9
02.07.2014	13:50:27	5702.0	9163.9	9163.9
02.07.2014	13:50:42	5485.0	8815.2	8815.2
02.07.2014	13:50:57	5773.0	9278.0	9278.0
02.07.2014	13:51:12	5937.0	9541.6	9541.6
02.07.2014	13:51:27	6125.0	9843.8	9843.8
02.07.2014	13:51:42	5802.0	9324.6	9324.6
02.07.2014	13:51:57	6085.0	9779.5	9779.5
02.07.2014	13:52:12	6159.0	9898.4	9898.4
02.07.2014	13:52:27	6415.0	10309.8	10309.8
02.07.2014	13:52:42	6674.0	10726.1	10726.1
02.07.2014	13:52:57	7055.0	11338.4	11338.4
02.07.2014	13:53:12	7153.0	11495.9	11495.9
02.07.2014	13:53:27	7255.0	11659.8	11659.8
02.07.2014	13:53:42	7482.0	12024.6	12024.6
02.07.2014	13:53:57	7734.0	12429.6	12429.6
02.07.2014	13:54:12	6867.0	11036.3	11036.3
02.07.2014	13:54:27	6965.0	11193.8	11193.8
02.07.2014	13:54:42	6825.0	10968.8	10968.8
02.07.2014	13:54:57	6420.0	10317.9	10317.9
02.07.2014	13:55:12	6110.0	9819.6	9819.6
02.07.2014	13:55:27	6877.0	11052.3	11052.3
02.07.2014	13:55:42	7148.0	11487.9	11487.9
02.07.2014	13:55:57	7331.0	11782.0	11782.0
02.07.2014	13:56:12	7487.0	12032.7	12032.7
02.07.2014	13:56:27	8188.0	13159.3	13159.3
02.07.2014	13:56:42	8120.0	13050.0	13050.0
02.07.2014	13:56:57	8317.0	13366.6	13366.6
02.07.2014	13:57:12	8349.0	13418.0	13418.0
02.07.2014	13:57:27	8620.0	13853.6	13853.6
02.07.2014	13:57:42	8943.0	14372.7	14372.7

Date	Time	VOC ppm	VOC as C mg/m ³	VOC as C @ Ref O ₂ mg/m ³
02.07.2014	13:57:57	8647.0	13897.0	13897.0
02.07.2014	13:58:12	9160.0	14721.4	14721.4
02.07.2014	13:58:27	9482.0	15238.9	15238.9
02.07.2014	13:58:42	9526.0	15309.6	15309.6
02.07.2014	13:58:57	9866.0	15856.1	15856.1
02.07.2014	13:59:12	9548.0	15345.0	15345.0
02.07.2014	13:59:27	9035.0	14520.5	14520.5
02.07.2014	13:59:42	9573.0	15385.2	15385.2
02.07.2014	13:59:57	8840.0	14207.1	14207.1
02.07.2014	14:00:12	8596.0	13815.0	13815.0
02.07.2014	14:00:27	8523.0	13697.7	13697.7
02.07.2014	14:00:42	8181.0	13148.0	13148.0
02.07.2014	14:00:57	8596.0	13815.0	13815.0
02.07.2014	14:01:12	9499.0	15266.3	15266.3
02.07.2014	14:01:27	9011.0	14482.0	14482.0
02.07.2014	14:01:42	9035.0	14520.5	14520.5
02.07.2014	14:01:57	8913.0	14324.5	14324.5
02.07.2014	14:02:12	9328.0	14991.4	14991.4
02.07.2014	14:02:27	9988.0	16052.1	16052.1
02.07.2014	14:02:42	9451.0	15189.1	15189.1
02.07.2014	14:02:57	8889.0	14285.9	14285.9
02.07.2014	14:03:12	8645.0	13893.8	13893.8
02.07.2014	14:03:27	8718.0	14011.1	14011.1
02.07.2014	14:03:42	8254.0	13265.4	13265.4
02.07.2014	14:03:57	8352.0	13422.9	13422.9
02.07.2014	14:04:12	8107.0	13029.1	13029.1
02.07.2014	14:04:27	8278.0	13303.9	13303.9
02.07.2014	14:04:42	8254.0	13265.4	13265.4
02.07.2014	14:04:57	8156.0	13107.9	13107.9
02.07.2014	14:05:12	8669.0	13932.3	13932.3
02.07.2014	14:05:27	9695.0	15581.3	15581.3
02.07.2014	14:05:42	9646.0	15502.5	15502.5
02.07.2014	14:05:57	9719.0	15619.8	15619.8
02.07.2014	14:06:12	8840.0	14207.1	14207.1
02.07.2014	14:06:27	9084.0	14599.3	14599.3
02.07.2014	14:06:42	9109.0	14639.5	14639.5
02.07.2014	14:06:57	9328.0	14991.4	14991.4
02.07.2014	14:07:12	9353.0	15031.6	15031.6
02.07.2014	14:07:27	9328.0	14991.4	14991.4
02.07.2014	14:07:42	8987.0	14443.4	14443.4
02.07.2014	14:07:57	8523.0	13697.7	13697.7
02.07.2014	14:08:12	8181.0	13148.0	13148.0
02.07.2014	14:08:27	7595.0	12206.3	12206.3
02.07.2014	14:08:42	7521.0	12087.3	12087.3
02.07.2014	14:08:57	8523.0	13697.7	13697.7
02.07.2014	14:09:12	8742.0	14049.6	14049.6
02.07.2014	14:09:27	7863.0	12637.0	12637.0
02.07.2014	14:09:42	7155.0	11499.1	11499.1
02.07.2014	14:09:57	6935.0	11145.5	11145.5

Date	Time	VOC ppm	VOC as C mg/m ³	VOC as C @ Ref O ₂ mg/m ³
02.07.2014	14:10:12	6984.0	11224.3	11224.3
02.07.2014	14:10:27	7155.0	11499.1	11499.1
02.07.2014	14:10:42	7766.0	12481.1	12481.1
02.07.2014	14:10:57	8376.0	13461.4	13461.4
02.07.2014	14:11:12	8767.0	14089.8	14089.8
02.07.2014	14:11:27	7985.0	12833.0	12833.0
02.07.2014	14:11:42	7497.0	12048.8	12048.8
02.07.2014	14:11:57	7521.0	12087.3	12087.3
02.07.2014	14:12:12	7419.0	11923.4	11923.4
02.07.2014	14:12:27	6913.0	11110.2	11110.2
02.07.2014	14:12:42	6674.0	10726.1	10726.1
02.07.2014	14:12:57	6305.0	10133.0	10133.0
02.07.2014	14:13:12	6093.0	9792.3	9792.3
02.07.2014	14:13:27	6469.0	10396.6	10396.6
02.07.2014	14:13:42	6962.0	11188.9	11188.9
02.07.2014	14:13:57	6596.0	10600.7	10600.7
02.07.2014	14:14:12	6168.0	9912.9	9912.9
02.07.2014	14:14:27	6215.0	9988.4	9988.4
02.07.2014	14:14:42	6603.0	10612.0	10612.0
02.07.2014	14:14:57	6894.0	11079.6	11079.6
02.07.2014	14:15:12	7272.0	11687.1	11687.1
02.07.2014	14:15:27	6679.0	10734.1	10734.1
02.07.2014	14:15:42	6295.0	10117.0	10117.0
02.07.2014	14:15:57	6188.0	9945.0	9945.0
02.07.2014	14:16:12	6215.0	9988.4	9988.4
02.07.2014	14:16:27	6217.0	9991.6	9991.6
02.07.2014	14:16:42	6144.0	9874.3	9874.3
02.07.2014	14:16:57	6254.0	10051.1	10051.1
02.07.2014	14:17:12	6662.0	10706.8	10706.8
02.07.2014	14:17:27	6484.0	10420.7	10420.7
02.07.2014	14:17:42	6422.0	10321.1	10321.1
02.07.2014	14:17:57	6559.0	10541.3	10541.3
02.07.2014	14:18:12	6339.0	10187.7	10187.7
02.07.2014	14:18:27	6300.0	10125.0	10125.0
02.07.2014	14:18:42	6071.0	9757.0	9757.0
02.07.2014	14:18:57	5634.0	9054.6	9054.6
02.07.2014	14:19:12	6989.0	11232.3	11232.3
02.07.2014	14:19:27	7238.0	11632.5	11632.5
02.07.2014	14:19:42	7436.0	11950.7	11950.7
02.07.2014	14:19:57	7253.0	11656.6	11656.6
02.07.2014	14:20:12	7299.0	11730.5	11730.5
02.07.2014	14:20:27	7160.0	11507.1	11507.1
02.07.2014	14:20:42	7951.0	12778.4	12778.4
02.07.2014	14:20:57	7773.0	12492.3	12492.3
Mean		7649.5	12293.8	12293.8
Max		9988.0	16052.1	16052.1
Min		5485.0	8815.2	8815.2

2.3.8 Uncertainty Calculations

Particulates

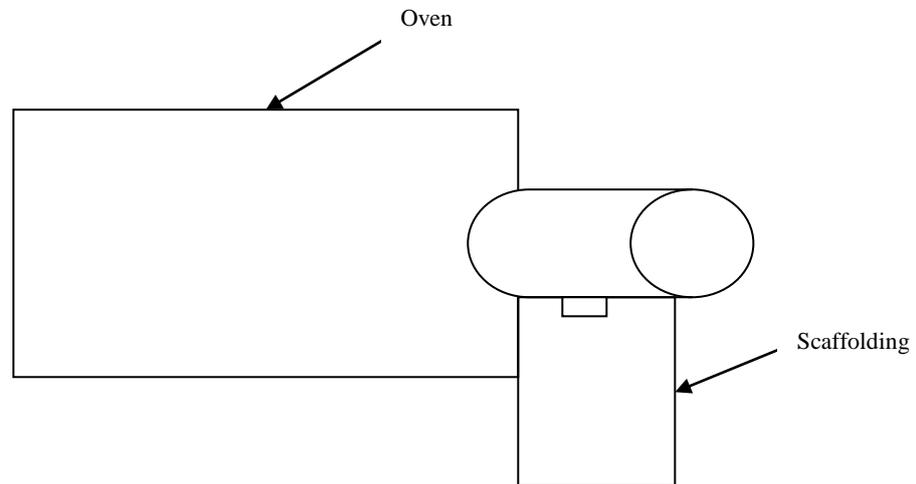
Source of uncertainty	Estimate of Component (1 SD) (± %)	Combined Uncertainty (± %)	Expanded Uncertainty (95% Confidence limit) (± %)
O ₂ Concentration	1.62	2.17	As % of result 4.22
Gas Temperature	0.99		
Mass of Particulate	0.72		
Humidity	0.50		As % of ELV 1.46
Leak	0.36		
Stack Diameter	0.34		
Gas Volume	0.30		As mg/m ³ 0.71
Pressure	0.13		
Nozzle Diameter	0.12		

Total VOC's

Source of uncertainty	Estimate of Component (1 SD) ppm	Combined Uncertainty ppm	Expanded Uncertainty (95% Confidence limit) ppm
Linearity	8.05	10.80	20.94
Temperature effect (zero)	4.65		
Barometric Pressure	4.03		
Span gas	2.75		
Temperature effect (span)	2.32		
Repeatability	0.70		
Span drift	0.58		Expanded Uncertainty (95% Confidence limit) %
Zero drift	0.42		
Cross sensitivity CO (1.2 % vol)	0.00		
Cross sensitivity NO (127 mgm ⁻³)	0.00		
Cross sensitivity H ₂ O (sat 325K)	0.00		
Cross sensitivity SO ₂ (2767 mgm ⁻³)	0.00		
Cross sensitivity CO ₂ (15.2 % vol)	0.00	As % of Result	
		0.27	
		As mg/m ³ at ref conditions	
		33.66	

2.4 Appendix 4: Paint Shop Oven Vent

2.4.1 Sampling Location



Duct Characteristics

	Value	Units
Type of Duct	Circular	-
Diameter / Depth	0.19	m
Width	N/A	m
Area	0.028	m ²
Port Size	4	inch
Port Depth	40	mm
Orientation	Horizontal	-

Sampling Platform

General Platform Information	
Permanent / Temporary	Temporary
Inside / Outside	Inside
Height of Platform from Ground Level	~4m
Size of Platform	1.5m x 1.5m
Does the Platform have a weather cover (roof)	N/A
Platform has 2 hand rails (approx 0.5m and 1.0m high)	Yes
Platform has vertical base boards (approx 0.25m high)	Yes
Platform has removable chains / self closing gates at the top of the ladder	Yes
Platform positioned relative to the access ports (free from obstruction that would hamper insertion and removal of the sampling equipment)	Yes
Depth of platform (length of probe + 1m)	Yes

2.4.2 Flow Criteria Measurements

Traverse Point	A1	A2	A3	A4	A5	A6	A7	A8	A9	A10
Pressure (mm H ₂ O)	2.5	4.0	4.0	5.5	5.5	5.5	5.5	5.5	5.5	5.5
√ΔP	1.58	2.00	2.00	2.35	2.35	2.35	2.35	2.35	2.35	2.35
Temperature (°C)	194	194	194	194	194	194	194	194	194	194

Static Pressure (mmH ₂ O)	6.0	Barometric Pressure (mm Hg)	762.7	Duct Dimensions (m)	0.19
--------------------------------------	-----	-----------------------------	-------	---------------------	------

Velocity (m/s) average	9.4	Actual Flow of stack gas (m ³ /hr)	964.2
Stack Geometry	Circular	Flow (wet) at STP (m ³ /hr)	565.6
Dimensions (m)	0.19	Flow (dry) at STP (m ³ /hr)	548.3
Area (m ²)	0.028		

	Average	Max	Min	Ratio Max/Min	Compliance
Pressure (mm H ₂ O)	4.9	5.5	2.5	2.2	Yes
√ΔP (mm H ₂ O) ^{1/2}	2.20	2.35	1.58	1.5	Yes
Temperature (°C)	194.0	194	194	1.0	Yes
Angle of flow	<15°				Yes
Local Negative Flow	No				Yes

2.3.3 Gas Measurements

	Mean
Oxygen (%)	20.90
Carbon Monoxide (ppm)	0
Carbon Dioxide (%)	0.03

2.4.4 Manual Method Calculations

Test Dates	01/07/14		
Company	Leck Construction (BAE Systems)		
Contact	T Hughes		
Stack	Paint Oven Shop		
	Blank	Test 1	Units
Sample Ref	EPA/14/515/03	EPA/14/515/04	-
Start Time	10:09	10:53	hr:mm
Stop Time	10:14	11:23	hr:mm
% O ₂	20.90	20.90	%
% CO ₂	0.03	0.03	%
%N ₂	-	79.07	%
V _{ic}	-	19.2	ml
B _{wo}	0.03	0.031	-
P _b	-	762.3	mm Hg
St	-	6	mm H ₂ O
T _s	-	201.33	°C
√ΔP	-	2.29	(mm H ₂ O) ^{1/2}
Yd	-	1.023	-
Test Time	5	30	min
T _m	-	25.67	°C
C _p	-	0.825	-
As	-	0.028	m ²
D _a	-	9.70	mm
ΔH ave	-	64.74	mm H ₂ O
V _{mstd}	0.7557	0.7557	m ³
V _{wstd}	0.0239	0.0239	m ³
Q _{std,wet}	-	574.7	Nm ³ /h
Q _{act}	-	995.0	Nm ³ /h
Isokinetic Rate	-	104.1	%
V _s	-	9.75	m/s
Washings			
Sample Ref	EPA/14/515/03W	EPA/14/515/04W	-
Weight	1.1	0.6	mg
Filter			
Sample Ref	EPA/14/515/03F	EPA/14/515/04F	-
Weight	<0.1	<0.1	mg
Particulate Concentration (Dry, No O ₂ Correction)	1.6	0.9	mg/Nm ³
Particulate Concentration (at Ref Water and Oxygen)	1.5	0.9	mg/Nm ³
Particulate Release Rate	-	0.52	g/hr
Reference Temp	273		K
Reference Pressure	101.3		kPa
Reference Moisture	No correction for moisture		-
Reference Oxygen	No correction for Oxygen		%

Particulates

	Filter (mg)	Washings (mg)
Blank	<0.1	1.1
Run 1	<0.1	0.6

2.4.5 Sampling Measurements

Date	01/07/14	Impinger		Initial Wt (g)		Final Wt(g)		Wt Gained (g)		l/min	Vac (in Hg)				
Start Time	10:53	1		787.8		789.2		1.4		0.1	15				
End Time	11:23	2		736.0		739.3		3.3		0.08	7				
Duration (mm.ss)	30.00	3		664.8		666.4		1.6							
Stack	Paint Oven Shop	4		754.9		767.8		12.9		Pitot 06			Velocity Head		
Run	1	5		246.8		246.8		0.0		DGM 09			Min	7.25	
													Max	8	
													Max:Min	1.10	
									Nozzle ID	N6					
			Sample Ref	EPA/14/515/04						Nozzle Diameter (mm)	9.70				
K Factor	12.33		Filter Number	EPA/14/515/04F											
Stack Diameter (m)	0.19		Probe Washing No	EPA/14/515/04W											
									AH across orifice meter (mm H ₂ O)	DGM (litres)	DGM Temp (°C)		Temp (°C)		
Point	Time	Vac	Stack Temp (°C)	Velocity Head (mmH ₂ O)	√ΔP						In	Out	Probe	Filter	Impinger
a1	0	3	219	4	2.00	49.33	7850	25	24	160	169				
a1	5	4	198	5.5	2.35	67.83	7980	25	24	162	160				
a1	10	4	201	5.5	2.35	67.83	8121	25	24	161	160				
a1	15	3	200	5.5	2.35	67.83	8260	28	25	160	160				
a1	20	3	194	5.5	2.35	67.83	8440	28	25	160	160				
a1	25	3	196	5.5	2.35	67.83	8527.91	30	25	160	160				
Total / Average		4.00	201.33	5.25	2.29	64.74	800.85	26.83	24.50	160.50	161.50				

2.4.6 Instrumental Gas Analyser Site Calibration Measurements

Zero Point

Gas	Analyser Range	Gas Cylinder ID	Gas Conc.	Pre Test			Post Test	Zero Drift
				Pre Span	Post Span	System	System	
VOC (ppm)	100	Ambient Air	0.00	0.20	0.20	0.44	0.37	-0.07

Span Gas

Gas	Analyser Range	Gas Cylinder ID	Gas Conc.	Pre Test		Post Test	Span Drift
				Analyser	System	System	
VOC (ppm)	100	EPA/CGAS/77	83.00	82.96	83.00	82.61	-0.39

2.4.7 Instrumental Gas Analyser Results

Date	Time	VOC ppm	VOC as C mg/m ³	VOC as C @Ref O ₂ mg/m ³
01.07.2014	10:53:11	16.1	25.9	25.9
01.07.2014	10:53:26	15.8	25.4	25.4
01.07.2014	10:53:41	15.5	24.9	24.9
01.07.2014	10:53:56	15.2	24.4	24.4
01.07.2014	10:54:11	14.8	23.8	23.8
01.07.2014	10:54:26	14.6	23.5	23.5
01.07.2014	10:54:41	14.3	23.0	23.0
01.07.2014	10:54:56	13.8	22.2	22.2
01.07.2014	10:55:11	13.5	21.7	21.7
01.07.2014	10:55:26	13.3	21.4	21.4
01.07.2014	10:55:41	12.9	20.7	20.7
01.07.2014	10:55:56	12.5	20.1	20.1
01.07.2014	10:56:11	12.3	19.8	19.8
01.07.2014	10:56:26	12.0	19.3	19.3
01.07.2014	10:56:41	11.6	18.6	18.6
01.07.2014	10:56:56	11.5	18.5	18.5
01.07.2014	10:57:11	11.3	18.2	18.2
01.07.2014	10:57:26	11.1	17.8	17.8
01.07.2014	10:57:41	10.8	17.4	17.4
01.07.2014	10:57:56	10.7	17.2	17.2
01.07.2014	10:58:11	10.5	16.9	16.9
01.07.2014	10:58:26	10.4	16.7	16.7
01.07.2014	10:58:41	10.3	16.6	16.6
01.07.2014	10:58:56	10.3	16.6	16.6
01.07.2014	10:59:11	10.2	16.4	16.4
01.07.2014	10:59:26	10.3	16.6	16.6
01.07.2014	10:59:41	10.5	16.9	16.9
01.07.2014	10:59:56	10.5	16.9	16.9
01.07.2014	11:00:11	10.6	17.0	17.0

Date	Time	VOC ppm	VOC as C mg/m ³	VOC as C @Ref O ₂ mg/m ³
01.07.2014	11:00:26	10.6	17.0	17.0
01.07.2014	11:00:41	10.7	17.2	17.2
01.07.2014	11:00:56	10.9	17.5	17.5
01.07.2014	11:01:11	11.1	17.8	17.8
01.07.2014	11:01:26	11.1	17.8	17.8
01.07.2014	11:01:41	11.3	18.2	18.2
01.07.2014	11:01:56	11.5	18.5	18.5
01.07.2014	11:02:11	11.6	18.6	18.6
01.07.2014	11:02:26	11.8	19.0	19.0
01.07.2014	11:02:41	12.1	19.4	19.4
01.07.2014	11:02:56	12.1	19.4	19.4
01.07.2014	11:03:11	12.1	19.4	19.4
01.07.2014	11:03:26	12.3	19.8	19.8
01.07.2014	11:03:41	12.6	20.3	20.3
01.07.2014	11:03:56	12.7	20.4	20.4
01.07.2014	11:04:11	12.6	20.3	20.3
01.07.2014	11:04:26	12.6	20.3	20.3
01.07.2014	11:04:41	12.7	20.4	20.4
01.07.2014	11:04:56	12.8	20.6	20.6
01.07.2014	11:05:11	12.9	20.7	20.7
01.07.2014	11:05:26	13.0	20.9	20.9
01.07.2014	11:05:41	13.2	21.2	21.2
01.07.2014	11:05:56	13.1	21.1	21.1
01.07.2014	11:06:11	13.1	21.1	21.1
01.07.2014	11:06:26	13.3	21.4	21.4
01.07.2014	11:06:41	13.2	21.2	21.2
01.07.2014	11:06:56	13.0	20.9	20.9
01.07.2014	11:07:11	13.0	20.9	20.9
01.07.2014	11:07:26	12.7	20.4	20.4
01.07.2014	11:07:41	12.6	20.3	20.3
01.07.2014	11:07:56	12.3	19.8	19.8
01.07.2014	11:08:11	12.3	19.8	19.8
01.07.2014	11:08:26	12.2	19.6	19.6
01.07.2014	11:08:41	12.2	19.6	19.6
01.07.2014	11:08:56	12.1	19.4	19.4
01.07.2014	11:09:11	12.1	19.4	19.4
01.07.2014	11:09:26	11.9	19.1	19.1
01.07.2014	11:09:41	11.7	18.8	18.8
01.07.2014	11:09:56	11.6	18.6	18.6
01.07.2014	11:10:11	11.5	18.5	18.5
01.07.2014	11:10:26	11.4	18.3	18.3
01.07.2014	11:10:41	11.4	18.3	18.3
01.07.2014	11:10:56	11.4	18.3	18.3
01.07.2014	11:11:11	11.3	18.2	18.2
01.07.2014	11:11:26	11.2	18.0	18.0
01.07.2014	11:11:41	11.3	18.2	18.2
01.07.2014	11:11:56	11.3	18.2	18.2
01.07.2014	11:12:11	11.3	18.2	18.2
01.07.2014	11:12:26	11.4	18.3	18.3

Date	Time	VOC ppm	VOC as C mg/m ³	VOC as C @Ref O ₂ mg/m ³
01.07.2014	11:12:41	11.3	18.2	18.2
01.07.2014	11:12:56	11.2	18.0	18.0
01.07.2014	11:13:11	11.2	18.0	18.0
01.07.2014	11:13:26	11.4	18.3	18.3
01.07.2014	11:13:41	11.4	18.3	18.3
01.07.2014	11:13:56	11.4	18.3	18.3
01.07.2014	11:14:11	11.5	18.5	18.5
01.07.2014	11:14:26	11.6	18.6	18.6
01.07.2014	11:14:41	11.6	18.6	18.6
01.07.2014	11:14:56	11.5	18.5	18.5
01.07.2014	11:15:11	11.5	18.5	18.5
01.07.2014	11:15:26	11.6	18.6	18.6
01.07.2014	11:15:41	11.7	18.8	18.8
01.07.2014	11:15:56	11.7	18.8	18.8
01.07.2014	11:16:11	11.8	19.0	19.0
01.07.2014	11:16:26	12.1	19.4	19.4
01.07.2014	11:16:41	11.9	19.1	19.1
01.07.2014	11:16:56	11.8	19.0	19.0
01.07.2014	11:17:11	11.9	19.1	19.1
01.07.2014	11:17:26	11.9	19.1	19.1
01.07.2014	11:17:41	12.0	19.3	19.3
01.07.2014	11:17:56	12.0	19.3	19.3
01.07.2014	11:18:11	12.3	19.8	19.8
01.07.2014	11:18:26	12.3	19.8	19.8
01.07.2014	11:18:41	12.3	19.8	19.8
01.07.2014	11:18:56	12.3	19.8	19.8
01.07.2014	11:19:11	12.4	19.9	19.9
01.07.2014	11:19:26	12.3	19.8	19.8
01.07.2014	11:19:41	12.1	19.4	19.4
01.07.2014	11:19:56	12.2	19.6	19.6
01.07.2014	11:20:11	12.2	19.6	19.6
01.07.2014	11:20:26	12.5	20.1	20.1
01.07.2014	11:20:41	13.9	22.3	22.3
01.07.2014	11:20:56	13.9	22.3	22.3
01.07.2014	11:21:11	14.0	22.5	22.5
01.07.2014	11:21:26	13.9	22.3	22.3
01.07.2014	11:21:41	13.7	22.0	22.0
01.07.2014	11:21:56	13.5	21.7	21.7
01.07.2014	11:22:11	13.3	21.4	21.4
01.07.2014	11:22:26	13.1	21.1	21.1
01.07.2014	11:22:41	13.0	20.9	20.9
01.07.2014	11:22:56	12.9	20.7	20.7
01.07.2014	11:23:11	12.8	20.6	20.6
01.07.2014	11:23:26	12.8	20.6	20.6
01.07.2014	11:23:41	12.8	20.6	20.6
01.07.2014	11:23:56	12.8	20.6	20.6
Mean		12.2	19.6	19.6
Max		16.1	25.9	25.9
Min		10.2	16.4	16.4

2.4.8 Uncertainty Calculations

Particulates

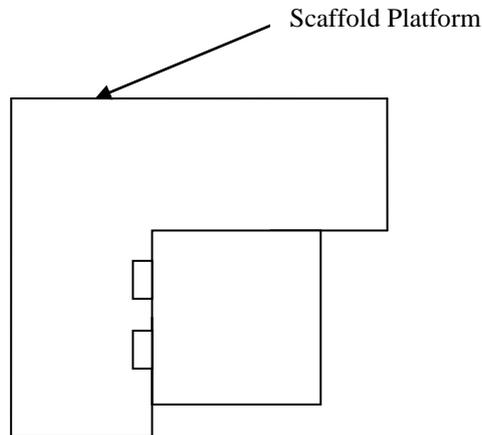
Source of uncertainty	Estimate of Component (1 SD) (± %)	Combined Uncertainty (± %)	Expanded Uncertainty (95% Confidence limit) (± %)	
Mass of Particulate	16.91	17.03	As % of result 33.05	
O ₂ Concentration	1.62			
Gas Temperature	0.90			
Stack Diameter	0.53		As % of ELV 0.61	
Pitot Co-efficient	0.50			
Humidity	0.50			
Leak	0.20			As mg/m ³ 0.30
Nozzle Diameter	0.15			
Pressure	0.12			

Total VOC's

Source of uncertainty	Estimate of Component (1 SD) ppm	Combined Uncertainty ppm	Expanded Uncertainty (95% Confidence limit) ppm	
Linearity	0.83	1.13	2.19	
Temperature effect (zero)	0.48			
Barometric Pressure	0.42			
Span gas	0.32		Expanded Uncertainty (95% Confidence limit) %	
Temperature effect (span)	0.24			
Span drift	0.11			
Repeatability	0.07			As % of Result 17.93
Zero drift	0.02			
Cross sensitivity CO (1.2 % vol)	0.00			
Cross sensitivity NO (127 mgm ⁻³)	0.00		As mg/m ³ at ref conditions 3.52	
Cross sensitivity H ₂ O (sat 325K)	0.00			
Cross sensitivity SO ₂ (2767 mgm ⁻³)	0.00			
Cross sensitivity CO ₂ (15.2 % vol)	0.00			

2.5 Appendix 5: Paint Shop Spray Area

2.5.1 Sampling Location



Duct Characteristics

	Value	Units
Type of Duct	Rectangular	-
Diameter / Depth	0.74	m
Width	0.74	m
Area	0.548	m ²
Port Size	4	inch
Port Depth	90	mm
Orientation	Vertical	-

Sampling Platform

General Platform Information	
Permanent / Temporary	Temporary
Inside / Outside	Outside
Height of Platform from Ground Level	~ 10m
Size of Platform	2m x 1.5m
Does the Platform have a weather cover (roof)	No
Platform has 2 hand rails (approx 0.5m and 1.0m high)	Yes
Platform has vertical base boards (approx 0.25m high)	Yes
Platform has removable chains / self closing gates at the top of the ladder	Yes
Platform positioned relative to the access ports (free from obstruction that would hamper insertion and removal of the sampling equipment)	Yes
Depth of platform (length of probe + 1m)	Yes

2.5.2 Flow Criteria Measurements

Traverse Point	A1	A2	A3	A4	A5	A6	A7	A8	A9	A10
Pressure (mm H ₂ O)	10.0	11.5	12.5	12.0	11.0	8.5	7.0	6.0	6.0	6.5
√ΔP	3.16	3.39	3.54	3.46	3.32	2.92	2.65	2.45	2.45	2.55
Temperature (°C)	25	25	25	25	25	25	25	25	25	25

Static Pressure (mmH ₂ O)	16	Barometric Pressure (mm Hg)	763.4	Duct Dimensions (m)	0.74 x 0.74
--------------------------------------	----	-----------------------------	-------	---------------------	-------------

Velocity (m/s) average	10.1	Actual Flow of stack gas (m ³ /hr)	19978.9
Stack Geometry	Rectangular	Flow (wet) at STP (m ³ /hr)	18385.4
Dimensions (m)	0.74 x 0.74	Flow (dry) at STP (m ³ /hr)	17883.3
Area (m ²)	0.548		

	Average	Max	Min	Ratio Max/Min	Compliance
Pressure (mm H ₂ O)	9.1	12.5	6.0	2.1	Yes
√ΔP (mm H ₂ O) ^{1/2}	2.99	3.54	2.45	1.4	Yes
Temperature (°C)	25.0	25	25	1.0	Yes
Angle of flow	<15°				Yes
Local Negative Flow	No				Yes

2.5.3 Gas Measurements

	Mean
Oxygen (%)	20.90
Carbon Monoxide (ppm)	0
Carbon Dioxide (%)	0.03

2.5.4 Manual Method Calculations

Test Dates	01/07/14		
Company	Leck Construction (BAE Systems)		
Contact	T Hughes		
Stack	Paint Shop Spray Area		
	Blank	Test 1	Units
Sample Ref	EPA/14/515/05	EPA/14/515/06	-
Start Time	12:25	12:48	hr:mm
Stop Time	12:30	13:20	hr:mm
% O ₂	20.90	20.90	%
% CO ₂	0.03	0.03	%
%N ₂	-	79.07	%
V _{lc}	-	10.1	ml
B _{wo}	0.03	0.027	-
P _b	-	762.3	mm Hg
St	-	16	mm H ₂ O
T _s	-	26.13	°C
√ΔP	-	2.55	(mm H ₂ O) ^{1/2}
Y _d	-	0.987	-
Test Time	5	32	min
T _m	-	28.94	°C
C _p	-	0.834	-
As	-	0.548	m ²
D _n	-	6.13	mm
ΔH ave	-	20.84	mm H ₂ O
V _{mstd}	0.4477	0.4477	m ³
V _{wstd}	0.0126	0.0126	m ³
Q _{std,wet}	-	15744.5	Nm ³ /h
Q _{act}	-	17173.7	Nm ³ /h
Isokinetic Rate	-	101.7	%
V _s	-	8.71	m/s
Washings			
Sample Ref	EPA/14/515/05W	EPA/14/515/06W	-
Weight	<0.5	<0.5	mg
Filter			
Sample Ref	EPA/14/515/05F	EPA/14/515/06F	-
Weight	<0.04	0.29	mg
Particulate Concentration (Dry, No O ₂ Correction)	<1.21	1.8	mg/Nm ³
Particulate Concentration (at Ref Water and Oxygen)	<1.18	1.7	mg/Nm ³
Particulate Release Rate	-	27.02	g/hr
Reference Temp	273		K
Reference Pressure	101.3		kPa
Reference Moisture	No correction for moisture		-
Reference Oxygen	No correction for Oxygen		%

Particulates

	Filter (mg)	Washings (mg)
Blank	<0.04	<0.5
Run 1	0.29	<0.5

2.5.5 Sampling Measurements

Date	01/07/14	Impinger		Initial Wt (g)		Final Wt(g)		Wt Gained (g)		l/min	Vac (in Hg)					
Start Time	12:48	1		789.2		789.0		-0.2		0.2	15					
End Time	13:20	2		739.3		742.8		3.5		0.2	5					
Duration (mm.ss)	32.00	3		666.4		666.3		-0.1								
Stack	Paint Shop Spray Area	4		754.6		761.5		6.9		Pitot ID	Pitot 14			Velocity Head		
Run	1	5		246.8		246.8		0.0		DGM ID	DGM 09			Min	6.5	
														Max	6.5	
														Max:Min	1.00	
										Nozzle ID	n30					
			Sample Ref	EPA/14/515/06							Nozzle Diameter (mm)	6.13				
K Factor	3.21		Filter Number	EPA/14/515/06F												
Stack Diameter (m)	0.74		Probe Washing No	EPA/14/515/06W												
									AH across orifice meter (mm H ₂ O)	DGM (litres)	DGM Temp (°C)		Temp (°C)			
Point	Time	Vac	Stack Temp (°C)	Velocity Head (mmH ₂ O)	√ΔP				8825.11	In	Out	Probe	Filter	Impinger		
A1	0	2	27	6.5	2.55			20.84	8591	29	28	50				
A2	4	2	26	6.5	2.55			20.84	8659	29	28	50				
A3	8	2	26	6.5	2.55			20.84	8711	29	28	50				
A4	12	2	26	6.5	2.55			20.84	8784	29	28	50				
A5	16	2	26	6.5	2.55			20.84	8848	30	29	50				
A6	20	2	26	6.5	2.55			20.84	8910	29	28	50				
A7	24	2	26	6.5	2.55			20.84	8977	31	28	50				
A8	28	2	26	6.5	2.55			20.84	9036.99	31	29	50				
Total / Average		2.00	26.13	6.50	2.55			20.84	499.01	29.63	28.25	50.0				

2.5.6 Instrumental Gas Analyser Site Calibration Measurements

Zero Point

Gas	Analyser Range	Gas Cylinder ID	Gas Conc.	Pre Test			Post Test	Zero Drift
				Pre Span	Post Span	System	System	
VOC (ppm)	100	Ambient Air	0.00	0.03	0.09	0.23	0.15	-0.08

Span Gas

Gas	Analyser Range	Gas Cylinder ID	Gas Conc.	Pre Test		Post Test	Span Drift
				Analyser	System	System	
VOC (ppm)	100	EPA/CGAS /73	8.40	8.39	8.29	8.21	-0.08

2.5.7 Instrumental Gas Analyser Results

Date	Time	VOC ppm	VOC as C mg/m ³	VOC as C @ Ref O ₂ mg/m ³
01.07.2014	12:48:11	2.3	3.6	3.6
01.07.2014	12:48:26	2.1	3.3	3.3
01.07.2014	12:48:41	1.9	3.0	3.0
01.07.2014	12:48:56	1.8	2.9	2.9
01.07.2014	12:49:11	1.8	2.9	2.9
01.07.2014	12:49:26	1.8	2.8	2.8
01.07.2014	12:49:41	1.7	2.7	2.7
01.07.2014	12:49:56	1.6	2.6	2.6
01.07.2014	12:50:11	1.5	2.5	2.5
01.07.2014	12:50:26	1.6	2.6	2.6
01.07.2014	12:50:41	1.5	2.5	2.5
01.07.2014	12:50:56	1.5	2.4	2.4
01.07.2014	12:51:11	1.5	2.4	2.4
01.07.2014	12:51:26	1.5	2.4	2.4
01.07.2014	12:51:41	1.5	2.3	2.3
01.07.2014	12:51:56	1.4	2.2	2.2
01.07.2014	12:52:11	1.4	2.2	2.2
01.07.2014	12:52:26	1.4	2.2	2.2
01.07.2014	12:52:41	1.4	2.3	2.3
01.07.2014	12:52:56	1.3	2.1	2.1
01.07.2014	12:53:11	1.3	2.1	2.1
01.07.2014	12:53:26	1.2	2.0	2.0
01.07.2014	12:53:41	1.3	2.1	2.1
01.07.2014	12:53:56	1.3	2.0	2.0
01.07.2014	12:54:11	1.2	2.0	2.0
01.07.2014	12:54:26	1.2	1.9	1.9
01.07.2014	12:54:41	1.2	1.9	1.9
01.07.2014	12:54:56	1.2	1.9	1.9
01.07.2014	12:55:11	1.1	1.8	1.8

Date	Time	VOC ppm	VOC as C mg/m ³	VOC as C @ Ref O ₂ mg/m ³
01.07.2014	12:55:26	1.1	1.7	1.7
01.07.2014	12:55:41	1.1	1.7	1.7
01.07.2014	12:55:56	1.1	1.7	1.7
01.07.2014	12:56:11	1.0	1.6	1.6
01.07.2014	12:56:26	1.1	1.7	1.7
01.07.2014	12:56:41	1.0	1.7	1.7
01.07.2014	12:56:56	1.0	1.7	1.7
01.07.2014	12:57:11	1.1	1.7	1.7
01.07.2014	12:57:26	1.0	1.7	1.7
01.07.2014	12:57:41	1.0	1.6	1.6
01.07.2014	12:57:56	1.0	1.5	1.5
01.07.2014	12:58:11	1.0	1.5	1.5
01.07.2014	12:58:26	1.0	1.6	1.6
01.07.2014	12:58:41	1.0	1.5	1.5
01.07.2014	12:58:56	0.9	1.5	1.5
01.07.2014	12:59:11	1.0	1.5	1.5
01.07.2014	12:59:26	0.9	1.5	1.5
01.07.2014	12:59:41	1.0	1.6	1.6
01.07.2014	12:59:56	0.9	1.5	1.5
01.07.2014	13:00:11	0.9	1.5	1.5
01.07.2014	13:00:26	0.9	1.5	1.5
01.07.2014	13:00:41	0.9	1.4	1.4
01.07.2014	13:00:56	0.9	1.5	1.5
01.07.2014	13:01:11	0.9	1.4	1.4
01.07.2014	13:01:26	0.9	1.4	1.4
01.07.2014	13:01:41	0.9	1.4	1.4
01.07.2014	13:01:56	0.9	1.4	1.4
01.07.2014	13:02:11	0.8	1.4	1.4
01.07.2014	13:02:26	0.8	1.4	1.4
01.07.2014	13:02:41	0.9	1.4	1.4
01.07.2014	13:02:56	0.8	1.4	1.4
01.07.2014	13:03:11	0.9	1.4	1.4
01.07.2014	13:03:26	0.8	1.3	1.3
01.07.2014	13:03:41	0.8	1.3	1.3
01.07.2014	13:03:56	0.8	1.3	1.3
01.07.2014	13:04:11	0.8	1.3	1.3
01.07.2014	13:04:26	0.8	1.3	1.3
01.07.2014	13:04:41	0.8	1.3	1.3
01.07.2014	13:04:56	0.8	1.3	1.3
01.07.2014	13:05:11	0.8	1.3	1.3
01.07.2014	13:05:26	0.8	1.3	1.3
01.07.2014	13:05:41	0.8	1.3	1.3
01.07.2014	13:05:56	0.8	1.2	1.2
01.07.2014	13:06:11	0.8	1.2	1.2
01.07.2014	13:06:26	0.8	1.3	1.3
01.07.2014	13:06:41	0.8	1.3	1.3
01.07.2014	13:06:56	0.8	1.3	1.3
01.07.2014	13:07:11	0.8	1.3	1.3
01.07.2014	13:07:26	0.8	1.2	1.2
01.07.2014	13:07:41	0.8	1.3	1.3

Date	Time	VOC ppm	VOC as C mg/m ³	VOC as C @ Ref O ₂ mg/m ³
01.07.2014	13:07:56	0.8	1.3	1.3
01.07.2014	13:08:11	0.8	1.3	1.3
01.07.2014	13:08:26	0.8	1.3	1.3
01.07.2014	13:08:41	0.8	1.3	1.3
01.07.2014	13:08:56	0.8	1.3	1.3
01.07.2014	13:09:11	0.8	1.3	1.3
01.07.2014	13:09:26	0.8	1.3	1.3
01.07.2014	13:09:41	0.8	1.3	1.3
01.07.2014	13:09:56	0.8	1.3	1.3
01.07.2014	13:10:11	0.8	1.3	1.3
01.07.2014	13:10:26	0.8	1.3	1.3
01.07.2014	13:10:41	0.8	1.3	1.3
01.07.2014	13:10:56	0.8	1.2	1.2
01.07.2014	13:11:11	0.8	1.3	1.3
01.07.2014	13:11:26	0.8	1.2	1.2
01.07.2014	13:11:41	0.8	1.2	1.2
01.07.2014	13:11:56	0.8	1.3	1.3
01.07.2014	13:12:11	0.7	1.2	1.2
01.07.2014	13:12:26	0.8	1.2	1.2
01.07.2014	13:12:41	0.7	1.2	1.2
01.07.2014	13:12:56	0.8	1.2	1.2
01.07.2014	13:13:11	0.7	1.2	1.2
01.07.2014	13:13:26	0.7	1.2	1.2
01.07.2014	13:13:41	0.8	1.2	1.2
01.07.2014	13:13:56	0.8	1.2	1.2
01.07.2014	13:14:11	0.7	1.2	1.2
01.07.2014	13:14:26	0.7	1.2	1.2
01.07.2014	13:14:41	0.7	1.2	1.2
01.07.2014	13:14:56	0.7	1.2	1.2
01.07.2014	13:15:11	0.8	1.2	1.2
01.07.2014	13:15:26	0.7	1.2	1.2
01.07.2014	13:15:41	0.7	1.2	1.2
01.07.2014	13:15:56	0.7	1.2	1.2
01.07.2014	13:16:11	0.7	1.2	1.2
01.07.2014	13:16:26	0.7	1.2	1.2
01.07.2014	13:16:41	0.7	1.2	1.2
01.07.2014	13:16:56	0.7	1.2	1.2
01.07.2014	13:17:11	0.7	1.1	1.1
01.07.2014	13:17:26	0.7	1.1	1.1
01.07.2014	13:17:41	0.7	1.1	1.1
01.07.2014	13:17:56	0.7	1.1	1.1
01.07.2014	13:18:11	0.7	1.1	1.1
01.07.2014	13:18:26	0.7	1.1	1.1
01.07.2014	13:18:41	0.7	1.1	1.1
01.07.2014	13:18:56	0.7	1.1	1.1
01.07.2014	13:19:11	0.7	1.1	1.1
01.07.2014	13:19:26	0.7	1.2	1.2
01.07.2014	13:19:41	0.7	1.1	1.1
01.07.2014	13:19:56	0.7	1.1	1.1
01.07.2014	13:20:11	0.7	1.1	1.1

Date	Time	VOC ppm	VOC as C mg/m ³	VOC as C @ Ref O ₂ mg/m ³
01.07.2014	13:20:26	0.7	1.1	1.1
01.07.2014	13:20:41	0.7	1.1	1.1
01.07.2014	13:20:56	0.7	1.1	1.1
Mean		1.0	1.6	1.6
Max		2.3	3.6	3.6
Min		0.7	1.1	1.1

2.5.8 Uncertainty Calculations

Particulates

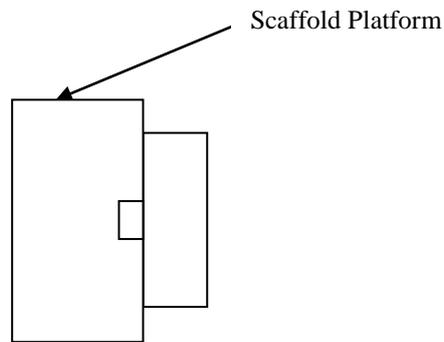
Source of uncertainty	Estimate of Component (1 SD) (± %)	Combined Uncertainty (± %)	Expanded Uncertainty (95% Confidence limit) (± %)	
Mass of Particulate	14.98	15.13	As % of result 29.35	
O ₂ Concentration	1.62			
Gas Temperature	0.80			
Leak	0.74		As % of ELV 1.04	
Pitot Co-efficient	0.50			
Humidity	0.50			
Nozzle Diameter	0.24			As mg/m ³ 0.50
Pressure	0.19			
Stack Diameter	0.14			

Total VOC's

Source of uncertainty	Estimate of Component (1 SD) ppm	Combined Uncertainty ppm	Expanded Uncertainty (95% Confidence limit) ppm
Linearity	0.08	0.14	0.27
Span gas	0.08		
Temperature effect (zero)	0.05		
Barometric Pressure	0.04		
Temperature effect (span)	0.02		Expanded Uncertainty (95% Confidence limit) %
Span drift	0.02		
Zero drift	0.02		
Repeatability	0.01		As % of Result 27.55 As mg/m ³ at ref conditions 0.43
Cross sensitivity CO (1.2 % vol)	0.00		
Cross sensitivity NO (127 mgm ⁻³)	0.00		
Cross sensitivity H ₂ O (sat 325K)	0.00		
Cross sensitivity SO ₂ (2767 mgm ⁻³)	0.00		
Cross sensitivity CO ₂ (15.2 % vol)	0.00		

2.6 Appendix 6: Paint Shop Shot Blast

2.6.1 Sampling Location



Duct Characteristics

	Value	Units
Type of Duct	Rectangular	-
Diameter / Depth	0.25	m
Width	0.85	m
Area	0.213	m ²
Port Size	4	inch
Port Depth	90	mm
Orientation	Vertical	-

Sampling Platform

General Platform Information	
Permanent / Temporary	Temporary
Inside / Outside	Outside
Height of Platform from Ground Level	~5m
Size of Platform	2.5m x 1.5m
Does the Platform have a weather cover (roof)	No
Platform has 2 hand rails (approx 0.5m and 1.0m high)	Yes
Platform has vertical base boards (approx 0.25m high)	Yes
Platform has removable chains / self closing gates at the top of the ladder	Yes
Platform positioned relative to the access ports (free from obstruction that would hamper insertion and removal of the sampling equipment)	Yes
Depth of platform (length of probe + 1m)	Yes

2.6.2 Flow Criteria Measurements

Traverse Point	A1	A2	A3	A4	A5	A6	A7	A8	A9	A10
Pressure (mm H ₂ O)	3.5	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0
√ΔP	1.87	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00
Temperature (°C)	31	31	31	31	31	31	31	31	31	31

Static Pressure (mmH ₂ O)	3	Barometric Pressure (mm Hg)	762.3	Duct Dimensions (m)	0.25 x 0.85
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Velocity (m/s) average	5.9	Actual Flow of stack gas (m ³ /hr)	5267.5
Stack Geometry	Rectangular	Flow (wet) at STP (m ³ /hr)	4745.7
Dimensions (m)	0.25 x 0.85	Flow (dry) at STP (m ³ /hr)	4733.1
Area (m ²)	0.213		

	Average	Max	Min	Ratio Max/Min	Compliance
Pressure (mm H ₂ O)	4.0	4.0	3.5	1.1	Yes
√ΔP (mm H ₂ O) ^{1/2}	1.99	2.00	1.87	1.1	Yes
Temperature (°C)	31.0	31	31	1.0	Yes
Angle of flow	<15°				Yes
Local Negative Flow	No				Yes

2.6.3 Gas Measurements

	Mean
Oxygen (%)	20.90
Carbon Monoxide (ppm)	0
Carbon Dioxide (%)	0.03

2.6.4 Manual Method Calculations

Test Dates	01/07/14		
Company	Leack Construction (BAE Systems)		
Contact	T Hughes		
Stack	Shot Blast		
	Blank	Test 1	Units
Sample Ref	EPA/14/515/07	EPA/14/515/08	-
Start Time	14:29	14:47	hr:mm
Stop Time	14:34	15:19	hr:mm
% O ₂	20.90	20.90	%
% CO ₂	0.03	0.03	%
%N ₂	-	79.07	%
V _{lc}	-	1.7	ml
B _{wo}	0.00	0.003	-
P _b	-	762.3	mm Hg
St	-	3	mm H ₂ O
T _s	-	30.63	°C
√ΔP	-	1.87	(mm H ₂ O) ^{1/2}
Yd	-	1.023	-
Test Time	5	32	min
T _m	-	26.56	°C
C _p	-	0.825	-
A _s	-	0.213	m ²
D _n	-	9.70	mm
ΔH ave	-	64.45	mm H ₂ O
V _{mstd}	0.7980	0.7980	m ³
V _{wstd}	0.0021	0.0021	m ³
Q _{std,wet}	-	4378.7	Nm ³ /h
Q _{act}	-	4854.2	Nm ³ /h
Isokinetic Rate	-	98.5	%
V _s	-	6.35	m/s
Washings			
Sample Ref	EPA/14/515/07W	EPA/14/515/08W	-
Weight	1.3	0.7	mg
Filter			
Sample Ref	EPA/14/515/07F	EPA/14/515/08F	-
Weight	2.55	6.07	mg
Particulate Concentration (Dry, No O ₂ Correction)	4.8	8.5	mg/Nm ³
Particulate Concentration (at Ref Water and Oxygen)	4.8	8.5	mg/Nm ³
Particulate Release Rate	-	37.05	g/hr
Reference Temp	273		K
Reference Pressure	101.3		kPa
Reference Moisture	No correction for moisture		-
Reference Oxygen	No correction for Oxygen		%

Particulates

	Filter (mg)	Washings (mg)
Blank	2.55	1.3
Run 1	6.07	0.7

2.6.5 Sampling Measurements

Date	01/07/14	Impinger		Initial Wt (g)		Final Wt(g)		Wt Gained (g)		l/min	Vac (in Hg)					
Start Time	14:47	1		789.0		783.6		-5.4		0.2	15					
End Time	15:19	2		742.8		747.2		4.4		0.2	15					
Duration (mm.ss)	32.00	3		663.8		664.8		1.0								
Stack	Shot Blast	4		761.5		763.2		1.7		Pitot 06				Velocity Head		
Run	1	5		246.8		246.8		0.0		DGM 09				Min	3.5	
														Max	3.5	
														Max:Min	1.00	
									Nozzle ID	N9						
			Sample Ref	EPA/14/515/08						Nozzle Diameter (mm)	9.70					
K Factor	18.41		Filter Number	EPA/14/515/08F												
Stack Diameter (m)	0.25		Probe Washing No	EPA/14/515/08W												
									AH across orifice meter (mm H ₂ O)	DGM (litres)	DGM Temp (°C)		Temp (°C)			
Point	Time	Vac	Stack Temp (°C)	Velocity Head (mmH ₂ O)		√ΔP					In	Out	Probe	Filter	Impinger	
a1	0	2	31	3.5		1.87		64.45	9150	26	26	160	160	155		
a2	4	2	30	3.5		1.87		64.45	9251	25	25	160	160			
a3	8	2	30	3.5		1.87		64.45	9361	26	26	160	161			
a4	12	2	30	3.5		1.87		64.45	9471	27	26	160	160			
a5	16	2	31	3.5		1.87		64.45	9579	28	25	160	160			
a6	20	2	31	3.5		1.87		64.45	9686	28	26	160	160			
a7	24	2	31	3.5		1.87		64.45	9782	29	26	160	160			
a8	28	2	31	3.5		1.87		64.45	9887.26	30	26	161	160			
Total / Average		3.00	26.75	3.50		1.87		64.45	848.21	27.38	25.75	160.13	159.50			

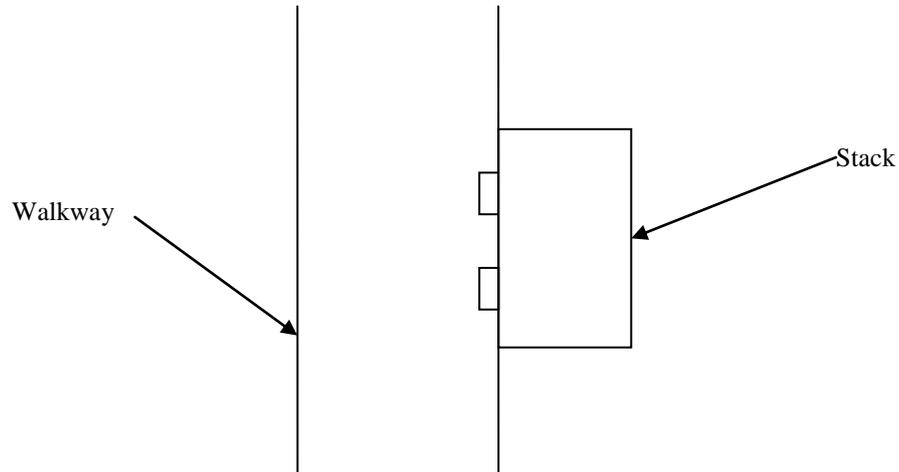
2.6.6 Uncertainty Calculations

Particulates

Source of uncertainty	Estimate of Component (1 SD) (\pm %)	Combined Uncertainty (\pm %)	Expanded Uncertainty (95% Confidence limit) (\pm %)
Mass of Particulate	1.75	2.71	As % of result 5.25
O ₂ Concentration	1.62		
Gas Temperature	0.87		
Pitot Co-efficient	0.50		
Humidity	0.50		
Leak	0.43		
Stack Diameter	0.40		
Nozzle Diameter	0.15		
Pressure	0.12		
			As % of ELV 0.89
			As mg/m ³ 0.45

2.7 Appendix 7: DDH Hall Paint Extract

2.7.1 Sampling Location



Duct Characteristics

	Value	Units
Type of Duct	Rectangular	-
Diameter / Depth	0.40	m
Width	0.59	m
Area	0.236	m ²
Port Size	4	inch
Port Depth	40	mm
Orientation	Vertical	-

Sampling Platform

General Platform Information	
Permanent / Temporary	Permanent
Inside / Outside	Inside
Height of Platform from Ground Level	~35m
Size of Platform	N/A
Does the Platform have a weather cover (roof)	N/A
Platform has 2 hand rails (approx 0.5m and 1.0m high)	Yes
Platform has vertical base boards (approx 0.25m high)	Yes
Platform has removable chains / self closing gates at the top of the ladder	N/A
Platform positioned relative to the access ports (free from obstruction that would hamper insertion and removal of the sampling equipment)	Yes
Depth of platform (length of probe + 1m)	Yes

2.7.2 Flow Criteria Measurements

Traverse Point	A1	A2	A3	A4	A5	A6	A7	A8	A9	A10
Pressure (mm H₂O)	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5
√ΔP	0.71	0.71	0.71	0.71	0.71	0.71	0.71	0.71	0.71	0.71
Temperature (°C)	25	25	25	25	25	25	25	25	25	25
Traverse Point	B1	B2	B3	B4	B5	B6	B7	B8	B9	B10
Pressure (mm H₂O)	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
√ΔP	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Temperature (°C)	25	25	25	25	25	25	25	25	25	25

Static Pressure (mmH₂O)	1	Barometric Pressure (mm Hg)	751.7	Duct Dimensions (m)	0.40 x 0.65
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Velocity (m/s) average	2.9	Actual Flow of stack gas (m³/hr)	2466.6
Stack Geometry	Rectangular	Flow (wet) at STP (m³/hr)	2235.4
Dimensions (m)	0.40 x 0.59	Flow (dry) at STP (m³/hr)	2214.8
Area (m²)	0.236		

	Average	Max	Min	Ratio Max/Min	Compliance
Pressure (mm H₂O)	0.8	1.0	0.5	2.0	Yes
√ΔP (mm H₂O)^{1/2}	0.85	1.00	0.71	1.4	Yes
Temperature (°C)	25.0	25	25	1.0	Yes
Angle of flow	<15°				Yes
Local Negative Flow	No				Yes

2.7.3 Gas Measurements

	Mean
Oxygen (%)	20.90
Carbon Monoxide (ppm)	0
Carbon Dioxide (%)	0.03

2.7.4 Manual Method Calculations

Test Dates	08/08/14		
Company	Leck Construction (BAE Systems)		
Contact	T Hughes		
Stack	DDH Paint Extract		
	Blank	Test 1	Units
Sample Ref	EPA/14/515/20	EPA/14/515/21	-
Start Time	10:28	10:52	hr:mm
Stop Time	10:33	11:24	hr:mm
% O ₂	20.90	20.90	%
% CO ₂	0.03	0.03	%
%N ₂	-	79.07	%
V _{lc}	-	4.6	ml
B _{wo}	0.01	0.009	-
P _b	-	751.7	mm Hg
St	-	1	mm H ₂ O
T _s	-	25.00	°C
√ΔP	-	1.00	(mm H ₂ O) ^{1/2}
Yd	-	1.347	-
Test Time	-	32	min
T _m	-	22.31	°C
C _p	-	0.820	-
A _s	-	0.236	m ²
D _n	-	11.70	mm
ΔH ave	-	48.32	mm H ₂ O
V _{mstd}	0.6174	0.6174	m ³
V _{wstd}	0.0057	0.0057	m ³
Q _{std,wet}	-	2592.8	Nm ³ /h
Q _{act}	-	2861.0	Nm ³ /h
Isokinetic Rate	-	98.9	%
V _s	-	3.37	m/s
Washings			
Sample Ref	EPA/14/515/20W	EPA/14/515/21W	-
Weight	<0.5	1.1	mg
Filter			
Sample Ref	EPA/14/515/20F	EPA/14/515/21F	-
Weight	<0.04	2.07	mg
Particulate Concentration (Dry, No O ₂ Correction)	<0.87	5.1	mg/Nm ³
Particulate Concentration (at Ref Water and Oxygen)	<0.86	5.1	mg/Nm ³
Particulate Release Rate	-	13.19	g/hr
Reference Temp	273		K
Reference Pressure	101.3		kPa
Reference Moisture	No correction for moisture		-
Reference Oxygen	No correction for Oxygen		%

Particulates

	Filter (mg)	Washings (mg)
Blank	<0.04	<0.5
Run 1	2.07	1.1

2.7.5 Sampling Measurements

Date	07/08/13	Impinger		Initial Wt (g)		Final Wt(g)		Wt Gained (g)		l/min	Vac (in Hg)					
Start Time	11:28	1		247.2		247.2		0.0		0.1	10					
End Time	12:02	2		738.4		736.2		-2.2		0.08	7					
Duration (mm.ss)	32.00	3		780.2		779.7		-0.5								
Stack	DDH Paint Extract	4		635.0		635.7		0.7		Pitot 06				Velocity Head		
Run	1	5		664.7		674.4		9.7		DGM 02				Min	1	
														Max	1	
														Max:Min	1.00	
									Nozzle ID	N34						
			Sample Ref	EPA/14/515/21						Nozzle Diameter (mm)	11.70					
K Factor	48.32		Filter Number	EPA/14/515/21F												
Stack Diameter (m)	0.40		Probe Washing No	EPA/14/515/21W												
									AH across orifice meter (mm H ₂ O)	DGM (litres)	DGM Temp (°C)		Temp (°C)			
Point	Time	Vac	Stack Temp (°C)	Velocity Head (mmH ₂ O)		√ΔP				9382.32	In	Out	Probe	Filter	Impinger	
a1	0 4	5	25	1		1.00		48.32	9438	22	22	70				
a1	4 8	5	25	1		1.00		48.32	9502	22	22	70				
a2	8 12	5	25	1		1.00		48.32	9564	22	22	70				
a2	12 16	5	25	1		1.00		48.32	9629	22	22	70				
b1	16 20	5	25	1		1.00		48.32	9705	22	22	70				
b1	20 24	5	25	1		1.00		48.32	9757	23	22	70				
b2	24 28	5	25	1		1.00		48.32	9815	23	22	70				
b2	28 32	5	25	1		1.00		48.32	9881.21	24	23	70				
Total / Average		3.00	24.63	1.00		1.00		48.32	498.89	22.50	22.13	70.00				

2.7.6 Instrumental Gas Analyser Site Calibration Measurements

Zero Point

Gas	Analyser Range	Gas Cylinder ID	Gas Conc.	Pre Test			Post Test	
				Pre Span	Post Span	System	System	Zero Drift
VOC (ppm)	100	Ambient Air	0.00	0.00	0.00	0.10	0.00	-0.10

Span Gas

Gas	Analyser Range	Gas Cylinder ID	Gas Conc.	Pre Test		Post Test	
				Analyser	System	System	Span Drift
VOC (ppm)	100	EPA/CGAS/77	83.00	83.23	82.17	83.47	1.30

2.7.7 Instrumental Gas Analyser Results

Date	Time	VOC ppm	VOC as C mg/m ³	VOC as C @ Ref O ₂ mg/m ³
08.08.2014	10:52:09	0.9	1.4	1.4
08.08.2014	10:52:24	0.8	1.2	1.2
08.08.2014	10:52:39	0.8	1.2	1.2
08.08.2014	10:52:54	0.9	1.5	1.5
08.08.2014	10:53:09	1.0	1.6	1.6
08.08.2014	10:53:24	0.9	1.4	1.4
08.08.2014	10:53:39	0.8	1.2	1.2
08.08.2014	10:53:54	0.8	1.3	1.3
08.08.2014	10:54:39	2.5	4.0	4.0
08.08.2014	10:54:54	1.9	3.1	3.1
08.08.2014	10:55:09	1.5	2.4	2.4
08.08.2014	10:55:24	1.1	1.7	1.7
08.08.2014	10:55:39	0.9	1.5	1.5
08.08.2014	10:55:54	0.8	1.3	1.3
08.08.2014	10:56:09	0.8	1.3	1.3
08.08.2014	10:56:24	0.9	1.4	1.4
08.08.2014	10:56:39	0.9	1.4	1.4
08.08.2014	10:56:54	0.8	1.3	1.3
08.08.2014	10:57:09	0.8	1.2	1.2
08.08.2014	10:57:24	0.8	1.2	1.2
08.08.2014	10:57:39	0.8	1.3	1.3
08.08.2014	10:57:54	0.8	1.3	1.3
08.08.2014	10:58:09	0.7	1.1	1.1
08.08.2014	10:58:24	0.7	1.1	1.1
08.08.2014	10:58:39	0.7	1.1	1.1
08.08.2014	10:58:54	0.6	1.0	1.0
08.08.2014	10:59:09	0.7	1.1	1.1
08.08.2014	10:59:24	0.8	1.3	1.3
08.08.2014	10:59:39	0.8	1.3	1.3
08.08.2014	10:59:54	0.9	1.4	1.4
08.08.2014	11:00:09	0.8	1.3	1.3

Date	Time	VOC ppm	VOC as C mg/m ³	VOC as C @ Ref O ₂ mg/m ³
08.08.2014	11:00:24	0.8	1.2	1.2
08.08.2014	11:00:39	0.8	1.2	1.2
08.08.2014	11:00:54	0.8	1.3	1.3
08.08.2014	11:01:09	0.7	1.2	1.2
08.08.2014	11:01:24	0.7	1.1	1.1
08.08.2014	11:01:39	0.7	1.0	1.0
08.08.2014	11:01:54	0.6	1.0	1.0
08.08.2014	11:02:09	0.6	0.9	0.9
08.08.2014	11:02:24	0.6	0.9	0.9
08.08.2014	11:02:39	0.6	1.0	1.0
08.08.2014	11:02:54	0.6	0.9	0.9
08.08.2014	11:03:09	0.6	0.9	0.9
08.08.2014	11:03:24	0.5	0.9	0.9
08.08.2014	11:03:39	0.6	1.0	1.0
08.08.2014	11:03:54	0.8	1.3	1.3
08.08.2014	11:04:09	0.8	1.3	1.3
08.08.2014	11:04:24	0.9	1.4	1.4
08.08.2014	11:04:39	0.6	1.0	1.0
08.08.2014	11:04:54	0.5	0.9	0.9
08.08.2014	11:05:09	0.5	0.8	0.8
08.08.2014	11:05:24	0.6	1.0	1.0
08.08.2014	11:05:39	0.7	1.0	1.0
08.08.2014	11:05:54	0.7	1.0	1.0
08.08.2014	11:06:09	0.7	1.0	1.0
08.08.2014	11:06:24	0.6	0.9	0.9
08.08.2014	11:06:39	0.7	1.1	1.1
08.08.2014	11:06:54	0.7	1.1	1.1
08.08.2014	11:07:09	0.6	1.0	1.0
08.08.2014	11:07:24	0.6	1.0	1.0
08.08.2014	11:07:39	0.6	0.9	0.9
08.08.2014	11:07:54	1.1	1.7	1.7
08.08.2014	11:08:09	0.8	1.4	1.4
08.08.2014	11:08:24	0.7	1.2	1.2
08.08.2014	11:08:39	1.8	2.9	2.9
08.08.2014	11:08:54	1.4	2.2	2.2
08.08.2014	11:11:09	110.6	177.8	177.8
08.08.2014	11:11:24	85.7	137.7	137.7
08.08.2014	11:11:39	75.7	121.7	121.7
08.08.2014	11:11:54	82.1	131.9	131.9
08.08.2014	11:12:09	89.9	144.5	144.5
08.08.2014	11:12:24	65.4	105.1	105.1
08.08.2014	11:12:39	68.6	110.3	110.3
08.08.2014	11:12:54	113.6	182.6	182.6
08.08.2014	11:13:09	96.7	155.4	155.4
08.08.2014	11:13:24	63.0	101.3	101.3
08.08.2014	11:13:39	40.5	65.1	65.1
08.08.2014	11:13:54	27.8	44.7	44.7
08.08.2014	11:14:09	21.7	34.9	34.9
08.08.2014	11:14:24	17.0	27.3	27.3
08.08.2014	11:14:39	13.9	22.3	22.3

Date	Time	VOC ppm	VOC as C mg/m ³	VOC as C @ Ref O ₂ mg/m ³
08.08.2014	11:14:54	13.3	21.4	21.4
08.08.2014	11:15:09	11.6	18.6	18.6
08.08.2014	11:15:24	9.4	15.1	15.1
08.08.2014	11:15:39	8.3	13.3	13.3
08.08.2014	11:15:54	7.3	11.8	11.8
08.08.2014	11:16:09	11.2	18.0	18.0
08.08.2014	11:16:24	9.3	15.0	15.0
08.08.2014	11:16:39	7.2	11.5	11.5
08.08.2014	11:16:54	5.8	9.4	9.4
08.08.2014	11:17:09	6.5	10.4	10.4
08.08.2014	11:17:24	7.0	11.3	11.3
08.08.2014	11:17:39	6.2	10.0	10.0
08.08.2014	11:17:54	5.0	8.1	8.1
08.08.2014	11:18:09	4.5	7.3	7.3
08.08.2014	11:18:24	6.0	9.6	9.6
08.08.2014	11:18:39	6.4	10.2	10.2
08.08.2014	11:18:54	5.1	8.2	8.2
08.08.2014	11:19:09	4.4	7.1	7.1
08.08.2014	11:19:24	4.2	6.7	6.7
08.08.2014	11:19:39	3.8	6.0	6.0
08.08.2014	11:19:54	3.5	5.7	5.7
08.08.2014	11:20:09	3.4	5.4	5.4
08.08.2014	11:20:24	3.1	5.0	5.0
08.08.2014	11:20:39	2.9	4.6	4.6
08.08.2014	11:20:54	2.8	4.4	4.4
08.08.2014	11:21:09	2.7	4.3	4.3
08.08.2014	11:21:24	2.5	4.1	4.1
08.08.2014	11:21:39	2.5	4.0	4.0
08.08.2014	11:21:54	2.4	3.9	3.9
08.08.2014	11:22:09	2.3	3.6	3.6
08.08.2014	11:22:24	2.2	3.5	3.5
08.08.2014	11:22:39	2.1	3.4	3.4
08.08.2014	11:22:54	2.0	3.3	3.3
08.08.2014	11:23:09	1.9	3.1	3.1
08.08.2014	11:23:24	1.8	2.9	2.9
08.08.2014	11:23:39	1.8	2.9	2.9
08.08.2014	11:23:54	1.8	2.8	2.8
08.08.2014	11:24:09	1.7	2.7	2.7
08.08.2014	11:24:24	1.7	2.7	2.7
08.08.2014	11:24:39	1.7	2.7	2.7
08.08.2014	11:24:54	1.6	2.6	2.6
Mean		10.0	16.0	16.0
Max		113.6	182.6	182.6
Min		0.5	0.8	0.8

2.7.8 Uncertainty Calculations

Particulates

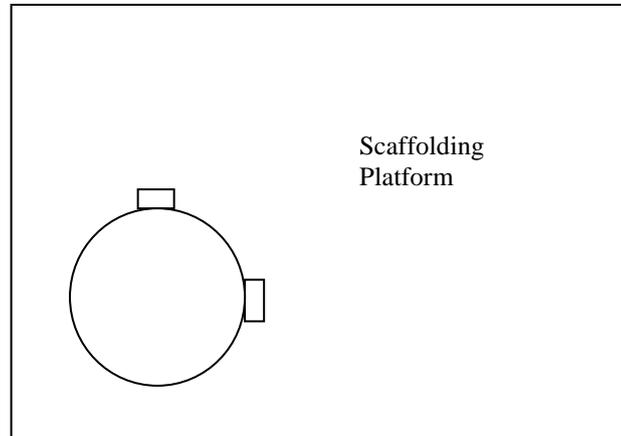
Source of uncertainty	Estimate of Component (1 SD) (± %)	Combined Uncertainty (± %)	Expanded Uncertainty (95% Confidence limit) (± %)
Mass of Particulate	2.64	3.35	As % of result 6.50
O ₂ Concentration	1.62		
Gas Temperature	1.04		
Humidity	0.50		As % of ELV 0.67
Leak	0.33		
Gas Volume	0.30		
Stack Diameter	0.25		As mg/m ³ 0.33
Pressure	0.13		
Nozzle Diameter	0.12		

Total VOC's

Source of uncertainty	Estimate of Component (1 SD) ppm	Combined Uncertainty ppm	Expanded Uncertainty (95% Confidence limit) ppm
Linearity	0.83	1.18	2.30
Temperature effect (zero)	0.48		
Barometric Pressure	0.42		
Span drift	0.38		Expanded Uncertainty (95% Confidence limit) %
Span gas	0.32		
Temperature effect (span)	0.24		
Repeatability	0.07		As % of Result 23.01
Zero drift	0.03		
Cross sensitivity CO (1.2 % vol)	0.00		
Cross sensitivity NO (127 mgm ⁻³)	0.00		As mg/m ³ at ref conditions 3.69
Cross sensitivity SO ₂ (2767 mgm ⁻³)	0.00		
Cross sensitivity CO ₂ (15.2 % vol)	0.00		
Cross sensitivity H ₂ O (sat 325K)	0.00		

2.8 Appendix 8: NAS Annex

2.8.1 Sampling Location



Duct Characteristics

	Value	Units
Type of Duct	Circular	-
Diameter / Depth	0.45	m
Width	-	m
Area	0.159	m ²
Port Size	4	inch
Port Depth	95	mm
Orientation	Vertical	-

Sampling Platform

General Platform Information	
Permanent / Temporary	Temporary
Inside / Outside	Inside
Height of Platform from Ground Level	~20m
Size of Platform	2.5m x 2.5m
Does the Platform have a weather cover (roof)	Yes
Platform has 2 hand rails (approx 0.5m and 1.0m high)	Yes
Platform has vertical base boards (approx 0.25m high)	Yes
Platform has removable chains / self closing gates at the top of the ladder	Yes
Platform positioned relative to the access ports (free from obstruction that would hamper insertion and removal of the sampling equipment)	Yes
Depth of platform (length of probe + 1m)	Yes

2.8.2 Flow Criteria Measurements

Traverse Point	A1	A2	A3	A4	A5	A6	A7	A8	A9	A10
Pressure (mm H₂O)	6.5	7.0	7.0	6.5	6.5	7.0	7.5	8.5	10.0	10.0
√ΔP	2.55	2.65	2.65	2.55	2.55	2.65	2.74	2.92	3.16	3.16
Temperature (°C)	26	26	26	26	26	26	26	26	26	26
Traverse Point	B1	B2	B3	B4	B5	B6	B7	B8	B9	B10
Pressure (mm H₂O)	5.5	6.0	6.5	6.0	6.5	6.0	6.5	6.5	6.5	8.0
√ΔP	2.35	2.45	2.55	2.45	2.55	2.45	2.55	2.55	2.55	2.83
Temperature (°C)	26	26	26	26	26	26	26	26	26	26

Static Pressure (mmH₂O)	15	Barometric Pressure (mm Hg)	752.1	Duct Dimensions (m)	0.45
---	----	------------------------------------	-------	----------------------------	------

Velocity (m/s) average	9.1	Actual Flow of stack gas (m³/hr)	5233.6
Stack Geometry	Circular	Flow (wet) at STP (m³/hr)	4728.8
Dimensions (m)	0.45	Flow (dry) at STP (m³/hr)	4622.3
Area (m²)	0.159		

	Average	Max	Min	Ratio Max/Min	Compliance
Pressure (mm H₂O)	7.0	10.0	5.5	1.8	Yes
√ΔP (mm H₂O)^{1/2}	2.64	3.16	2.35	1.3	Yes
Temperature (°C)	26.0	26	26	1.0	Yes
Angle of flow	<15°				Yes
Local Negative Flow	No				Yes

2.8.3 Gas Measurements

	Mean
Oxygen (%)	20.90
Carbon Monoxide (ppm)	0
Carbon Dioxide (%)	0.03

2.8.4 Manual Method Calculations

Test Dates	04/07/14		
Company	Leck Construction (BAE Systems)		
Contact	T Hughes		
Stack	NAS Annex		
	Blank	Test 1	Units
Sample Ref	EPA/14/515/15	EPA/14/515/16	-
Start Time	10:15	11:02	hr:mm
Stop Time	10:20	11:34	hr:mm
% O ₂	20.90	20.90	%
% CO ₂	0.03	0.03	%
%N ₂	-	79.07	%
V _{lc}	-	11	ml
B _{wo}	0.02	0.023	-
P _b	-	751.0	mm Hg
St	-	15	mm H ₂ O
T _s	-	26.00	°C
√ΔP	-	2.45	(mm H ₂ O) ^{1/2}
Yd	-	0.987	-
Test Time	5	32	min
T _m	-	19.71	°C
C _p	-	0.834	-
A _s	-	0.159	m ²
D _n	-	7.08	mm
ΔH ave	-	33.55	mm H ₂ O
V _{mstd}	0.5938	0.5938	m ³
V _{wstd}	0.0137	0.0137	m ³
Q _{std,wet}	-	4357.6	Nm ³ /h
Q _{act}	-	4822.8	Nm ³ /h
Isokinetic Rate	-	105.6	%
V _s	-	8.42	m/s
Washings			
Sample Ref	EPA/14/515/15W	EPA/14/515/16W	-
Weight	<0.5	1.9	mg
Filter			
Sample Ref	EPA/14/515/15F	EPA/14/515/16F	-
Weight	<0.04	2.05	mg
Particulate Concentration (Dry, No O ₂ Correction)	<0.91	6.7	mg/Nm ³
Particulate Concentration (at Ref Water and Oxygen)	<0.89	6.5	mg/Nm ³
Particulate Release Rate	-	28.33	g/hr
Reference Temp	273		K
Reference Pressure	101.3		kPa
Reference Moisture	No correction for moisture		-
Reference Oxygen	No correction for Oxygen		%

Particulates

	Filter (mg)	Washings (mg)
Blank	<0.04	<0.5
Run 1	2.05	1.9

2.8.5 Sampling Measurements

Date	04/07/14	Impinger		Initial Wt (g)		Final Wt(g)		Wt Gained (g)		l/min	Vac (in Hg)					
Start Time	11:02	1		783.4		785.0		1.6		0.1	10					
End Time	11:34	2		741.5		742.0		0.5		0.1	8					
Duration (mm.ss)	32.00	3		668.6		668.1		-0.5								
Stack	NAS Annex	4		784.4		793.8		9.4		Pitot ID	Pitot 14			Velocity Head		
Run	1	5		246.8		246.8		0.0		DGM ID	DGM 09			Min	6	
														Max	6	
														Max:Min	1.00	
										Nozzle ID	N36					
			Sample Ref	EPA/14/515/16							Nozzle Diameter (mm)	7.08				
K Factor	5.59		Filter Number	EPA/14/515/16F												
Stack Diameter (m)	0.45		Probe Washing No	EPA/14/515/16W												
									AH across orifice meter (mm H ₂ O)	DGM (litres)	DGM Temp (°C)		Temp (°C)			
Point	Time	Vac	Stack Temp (°C)	Velocity Head (mmH ₂ O)		√ΔP				2005.36	In	Out	Probe	Filter	Impinger	
A1	0 4	3	26	6		2.45		33.55	2090	19	19	50				
A1	4 8	3	26	6		2.45		33.55	2172	19	19	50				
A2	8 12	3	26	6		2.45		33.55	2252	19	19	51				
A2	12 16	3	26	6		2.45		33.55	2334	20	19	51				
B1	16 20	3	26	6		2.45		33.55	2415	21	18	50				
B1	20 24	3	26	6		2.45		33.55	2495	22	19	50				
B2	24 28	3	26	6		2.45		33.55	2576	23	20	50				
B2	28 32	3	26	6		2.45		33.55	2655.79	23	19	50				
Total / Average		3.00	26.00	6.00		2.45		33.55	650.43	20.75	19.00	50.25				

2.8.6 Instrumental Gas Analyser Site Calibration Measurements

Zero Point

Gas	Analyser Range	Gas Cylinder ID	Gas Conc.	Pre Test			Post Test	
				Pre Span	Post Span	System	System	Zero Drift
VOC (ppm)	100	Ambient Air	0.00	0.22	0.10	0.83	0.95	0.12

Span Gas

Gas	Analyser Range	Gas Cylinder ID	Gas Conc.	Pre Test		Post Test	
				Analyser	System	System	Span Drift
VOC (ppm)	100	EPA/CGAS/77	83.00	83.22	81.88	83.11	1.23

2.8.7 Instrumental Gas Analyser Results

Date	Time	VOC ppm	VOC as C mg/m ³	VOC as C @ Ref O ₂ mg/m ³
04.07.2014	11:02:00	981.7	1577.7	1577.7
04.07.2014	11:02:15	1548.0	2487.9	2487.9
04.07.2014	11:02:30	1568.0	2520.0	2520.0
04.07.2014	11:02:45	1485.0	2386.6	2386.6
04.07.2014	11:03:00	1407.0	2261.3	2261.3
04.07.2014	11:03:15	1385.0	2225.9	2225.9
04.07.2014	11:03:30	1238.0	1989.6	1989.6
04.07.2014	11:03:45	1328.0	2134.3	2134.3
04.07.2014	11:04:00	1661.0	2669.5	2669.5
04.07.2014	11:04:15	1438.0	2311.1	2311.1
04.07.2014	11:04:30	1712.0	2751.4	2751.4
04.07.2014	11:04:45	1536.0	2468.6	2468.6
04.07.2014	11:05:00	1521.0	2444.5	2444.5
04.07.2014	11:05:15	1614.0	2593.9	2593.9
04.07.2014	11:05:30	1350.0	2169.6	2169.6
04.07.2014	11:05:45	1595.0	2563.4	2563.4
04.07.2014	11:06:00	1626.0	2613.2	2613.2
04.07.2014	11:06:15	1788.0	2873.6	2873.6
04.07.2014	11:06:30	1893.0	3042.3	3042.3
04.07.2014	11:06:45	1927.0	3097.0	3097.0
04.07.2014	11:07:00	1458.0	2343.2	2343.2
04.07.2014	11:07:15	1277.0	2052.3	2052.3
04.07.2014	11:07:30	1443.0	2319.1	2319.1
04.07.2014	11:07:45	1270.0	2041.1	2041.1
04.07.2014	11:08:00	1487.0	2389.8	2389.8
04.07.2014	11:08:15	1104.0	1774.3	1774.3
04.07.2014	11:08:30	1263.0	2029.8	2029.8
04.07.2014	11:08:45	1512.0	2430.0	2430.0
04.07.2014	11:09:00	1524.0	2449.3	2449.3
04.07.2014	11:09:15	1221.0	1962.3	1962.3
04.07.2014	11:09:30	1292.0	2076.4	2076.4

Date	Time	VOC ppm	VOC as C mg/m ³	VOC as C @ Ref O ₂ mg/m ³
04.07.2014	11:09:45	1062.0	1706.8	1706.8
04.07.2014	11:10:00	1414.0	2272.5	2272.5
04.07.2014	11:10:15	964.6	1550.3	1550.3
04.07.2014	11:10:30	1372.0	2205.0	2205.0
04.07.2014	11:10:45	1079.0	1734.1	1734.1
04.07.2014	11:11:00	1238.0	1989.6	1989.6
04.07.2014	11:11:15	842.5	1354.0	1354.0
04.07.2014	11:11:30	1253.0	2013.8	2013.8
04.07.2014	11:11:45	1199.0	1927.0	1927.0
04.07.2014	11:12:00	1690.0	2716.1	2716.1
04.07.2014	11:12:15	1700.0	2732.1	2732.1
04.07.2014	11:12:30	1294.0	2079.6	2079.6
04.07.2014	11:12:45	1470.0	2362.5	2362.5
04.07.2014	11:13:00	935.3	1503.2	1503.2
04.07.2014	11:13:15	796.1	1279.4	1279.4
04.07.2014	11:13:30	1348.0	2166.4	2166.4
04.07.2014	11:13:45	1070.0	1719.6	1719.6
04.07.2014	11:14:00	1687.0	2711.3	2711.3
04.07.2014	11:14:15	1451.0	2332.0	2332.0
04.07.2014	11:14:30	908.4	1459.9	1459.9
04.07.2014	11:14:45	1326.0	2131.1	2131.1
04.07.2014	11:15:00	1121.0	1801.6	1801.6
04.07.2014	11:15:15	1394.0	2240.4	2240.4
04.07.2014	11:15:30	1148.0	1845.0	1845.0
04.07.2014	11:15:45	1355.0	2177.7	2177.7
04.07.2014	11:16:00	1194.0	1918.9	1918.9
04.07.2014	11:16:15	1201.0	1930.2	1930.2
04.07.2014	11:16:30	1350.0	2169.6	2169.6
04.07.2014	11:16:45	1189.0	1910.9	1910.9
04.07.2014	11:17:00	1624.0	2610.0	2610.0
04.07.2014	11:17:15	1275.0	2049.1	2049.1
04.07.2014	11:17:30	820.5	1318.7	1318.7
04.07.2014	11:17:45	1045.0	1679.5	1679.5
04.07.2014	11:18:00	869.4	1397.3	1397.3
04.07.2014	11:18:15	1148.0	1845.0	1845.0
04.07.2014	11:18:30	813.2	1306.9	1306.9
04.07.2014	11:18:45	1253.0	2013.8	2013.8
04.07.2014	11:19:00	864.5	1389.4	1389.4
04.07.2014	11:19:15	598.3	961.6	961.6
04.07.2014	11:19:30	1004.0	1613.6	1613.6
04.07.2014	11:19:45	752.1	1208.7	1208.7
04.07.2014	11:20:00	515.3	828.2	828.2
04.07.2014	11:20:15	1016.0	1632.9	1632.9
04.07.2014	11:20:30	793.7	1275.6	1275.6
04.07.2014	11:20:45	1250.0	2008.9	2008.9
04.07.2014	11:21:00	1177.0	1891.6	1891.6
04.07.2014	11:21:15	742.4	1193.1	1193.1
04.07.2014	11:21:30	1155.0	1856.3	1856.3
04.07.2014	11:21:45	1009.0	1621.6	1621.6
04.07.2014	11:22:00	1260.0	2025.0	2025.0

Date	Time	VOC ppm	VOC as C mg/m ³	VOC as C @ Ref O ₂ mg/m ³
04.07.2014	11:22:15	866.9	1393.2	1393.2
04.07.2014	11:22:30	1214.0	1951.1	1951.1
04.07.2014	11:22:45	1570.0	2523.2	2523.2
04.07.2014	11:23:00	1111.0	1785.5	1785.5
04.07.2014	11:23:15	915.8	1471.8	1471.8
04.07.2014	11:23:30	1006.0	1616.8	1616.8
04.07.2014	11:23:45	981.7	1577.7	1577.7
04.07.2014	11:24:00	1048.0	1684.3	1684.3
04.07.2014	11:24:15	1089.0	1750.2	1750.2
04.07.2014	11:24:30	1311.0	2107.0	2107.0
04.07.2014	11:24:45	849.8	1365.8	1365.8
04.07.2014	11:25:00	864.5	1389.4	1389.4
04.07.2014	11:25:15	1451.0	2332.0	2332.0
04.07.2014	11:25:30	1167.0	1875.5	1875.5
04.07.2014	11:25:45	1275.0	2049.1	2049.1
04.07.2014	11:26:00	949.9	1526.6	1526.6
04.07.2014	11:26:15	1214.0	1951.1	1951.1
04.07.2014	11:26:30	1355.0	2177.7	2177.7
04.07.2014	11:26:45	1245.0	2000.9	2000.9
04.07.2014	11:27:00	1123.0	1804.8	1804.8
04.07.2014	11:27:15	1035.0	1663.4	1663.4
04.07.2014	11:27:30	1189.0	1910.9	1910.9
04.07.2014	11:27:45	1150.0	1848.2	1848.2
04.07.2014	11:28:00	1043.0	1676.3	1676.3
04.07.2014	11:28:15	1145.0	1840.2	1840.2
04.07.2014	11:28:30	810.7	1302.9	1302.9
04.07.2014	11:28:45	1221.0	1962.3	1962.3
04.07.2014	11:29:00	1109.0	1782.3	1782.3
04.07.2014	11:29:15	1050.0	1687.5	1687.5
04.07.2014	11:29:30	1070.0	1719.6	1719.6
04.07.2014	11:29:45	796.1	1279.4	1279.4
04.07.2014	11:30:00	1162.0	1867.5	1867.5
04.07.2014	11:30:15	1404.0	2256.4	2256.4
04.07.2014	11:30:30	949.9	1526.6	1526.6
04.07.2014	11:30:45	1043.0	1676.3	1676.3
04.07.2014	11:31:00	1690.0	2716.1	2716.1
04.07.2014	11:31:15	2586.0	4156.1	4156.1
04.07.2014	11:31:30	1685.0	2708.0	2708.0
04.07.2014	11:31:45	2034.0	3268.9	3268.9
04.07.2014	11:32:00	1609.0	2585.9	2585.9
04.07.2014	11:32:15	1504.0	2417.1	2417.1
04.07.2014	11:32:30	1560.0	2507.1	2507.1
04.07.2014	11:32:45	2427.0	3900.5	3900.5
04.07.2014	11:33:00	1748.0	2809.3	2809.3
04.07.2014	11:33:15	1126.0	1809.6	1809.6
04.07.2014	11:33:30	969.5	1558.1	1558.1
04.07.2014	11:33:45	1521.0	2444.5	2444.5
04.07.2014	11:34:00	1350.0	2169.6	2169.6
04.07.2014	11:34:15	840.0	1350.0	1350.0
04.07.2014	11:34:30	647.1	1040.0	1040.0

Date	Time	VOC ppm	VOC as C mg/m ³	VOC as C @ Ref O ₂ mg/m ³
04.07.2014	11:34:45	549.5	883.1	883.1
Mean		1250.9	2010.4	2010.4
Max		2586.0	4156.1	4156.1
Min		515.3	828.2	828.2

2.8.8 Uncertainty Calculations

Particulates

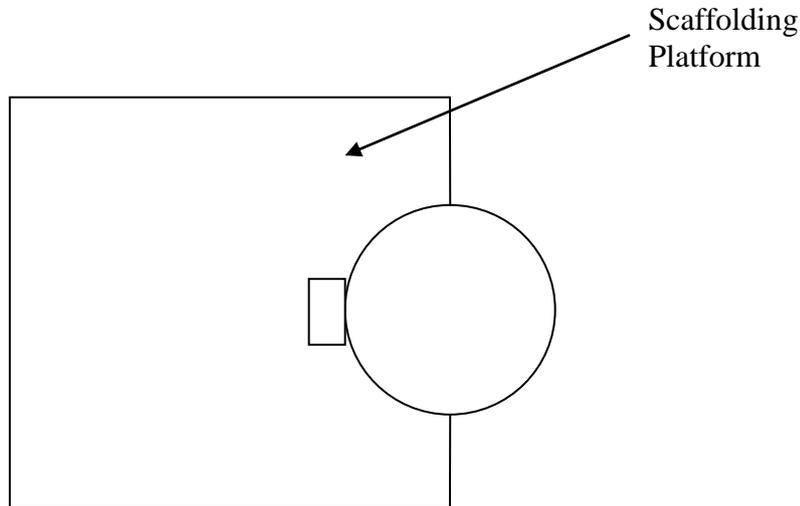
Source of uncertainty	Estimate of Component (1 SD) (± %)	Combined Uncertainty (± %)	Expanded Uncertainty (95% Confidence limit) (± %)	
Mass of Particulate	3.00	3.70	As % of result 7.17	
O ₂ Concentration	1.62			
Gas Temperature	1.17			
Pitot Co-efficient	0.50		As % of ELV 0.95	
Humidity	0.50			
Leak	0.28			
Stack Diameter	0.22			As mg/m ³ 0.47
Nozzle Diameter	0.20			
Pressure	0.15			

Total VOC's

Source of uncertainty	Estimate of Component (1 SD) ppm	Combined Uncertainty ppm	Expanded Uncertainty (95% Confidence limit) ppm	
Linearity	0.83	1.18	2.28	
Temperature effect (zero)	0.48			
Barometric Pressure	0.42			
Span drift	0.36			
Span gas	0.32			
Temperature effect (span)	0.24			
Repeatability	0.07		Expanded Uncertainty (95% Confidence limit) % 0.18	
Zero drift	0.03			
Cross sensitivity CO (1.2 % vol)	0.00			As mg/m ³ at ref conditions 3.67
Cross sensitivity NO (127 mgm ⁻³)	0.00			
Cross sensitivity H ₂ O (sat 325K)	0.00			
Cross sensitivity SO ₂ (2767 mgm ⁻³)	0.00			
Cross sensitivity CO ₂ (15.2 % vol)	0.00			

2.9 Appendix 9: DDH Tile Cutting Facility

2.9.1 Sampling Location



Duct Characteristics

	Value	Units
Type of Duct	Circular	-
Diameter / Depth	0.245	m
Width	-	m
Area	0.047	m ²
Port Size	4	inch
Port Depth	45	mm
Orientation	Vertical	-

Sampling Platform

General Platform Information	
Permanent / Temporary	Temporary
Inside / Outside	Outside
Height of Platform from Ground Level	~8m
Size of Platform	2.5m x 2.5m
Does the Platform have a weather cover (roof)	No
Platform has 2 hand rails (approx 0.5m and 1.0m high)	Yes
Platform has vertical base boards (approx 0.25m high)	Yes
Platform has removable chains / self closing gates at the top of the ladder	Yes
Platform positioned relative to the access ports (free from obstruction that would hamper insertion and removal of the sampling equipment)	Yes
Depth of platform (length of probe + 1m)	Yes

2.9.2 Flow Criteria Measurements

Traverse Point	A1	A2	A3	A4	A5	A6	A7	A8	A9	A10
Pressure (mm H ₂ O)	8.0	8.5	8.5	8.0	8.0	8.0	8.0	8.0	8.0	8.0
√ΔP	2.83	2.92	2.92	2.83	2.83	2.83	2.83	2.83	2.83	2.83
Temperature (°C)	26	26	26	26	26	26	26	26	26	26

Static Pressure (mmH ₂ O)	8.5	Barometric Pressure (mm Hg)	760.6	Duct Dimensions (m)	0.245
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Velocity (m/s) average	9.7	Actual Flow of stack gas (m ³ /hr)	1644.0
Stack Geometry	Circular	Flow (wet) at STP (m ³ /hr)	1502.3
Dimensions (m)	0.245	Flow (dry) at STP (m ³ /hr)	1475.0
Area (m ²)	0.047		

	Average	Max	Min	Ratio Max/Min	Compliance
Pressure (mm H ₂ O)	8.1	8.5	8.0	1.1	Yes
√ΔP (mm H ₂ O) ^{1/2}	2.85	2.92	2.83	1.0	Yes
Temperature (°C)	26.0	26	26	1.0	Yes
Angle of flow	<15°				Yes
Local Negative Flow	No				Yes

2.9.3 Gas Measurements

	Mean
Oxygen (%)	20.90
Carbon Monoxide (ppm)	0
Carbon Dioxide (%)	0.03

2.9.4 Manual Method Calculations

Test Dates	03/07/14		
Company	Leck Construction (BAE Systems)		
Contact	T Hughes		
Stack	Tile Cutting Facility		
	Blank	Test 1	Units
Sample Ref	EPA/14/515/11	EPA/14/515/12	-
Start Time	09:56	12:52	hr:mm
Stop Time	10:01	13:22	hr:mm
% O ₂	20.90	20.90	%
% CO ₂	0.03	0.03	%
%N ₂	-	79.07	%
V _{lc}	-	9.8	ml
B _{wo}	0.02	0.018	-
P _b	-	760.0	mm Hg
St	-	8.5	mm H ₂ O
T _s	-	28.83	°C
√ΔP	-	2.97	(mm H ₂ O) ^{1/2}
Yd	-	1.023	-
Test Time	-	30	min
T _m	-	33.58	°C
C _p	-	0.833	-
A _s	-	0.047	m ²
D _n	-	7.08	mm
ΔH ave	-	49.24	mm H ₂ O
V _{mstd}	0.6591	0.6591	m ³
V _{wstd}	0.0122	0.0122	m ³
Q _{std,wet}	-	1565.2	Nm ³ /h
Q _{act}	-	1729.1	Nm ³ /h
Isokinetic Rate	-	102.7	%
V _s	-	10.19	m/s
Washings			
Sample Ref	EPA/14/515/11W	EPA/14/515/12W	-
Weight	1.5	1.1	mg
Filter			
Sample Ref	EPA/14/515/11F	EPA/14/515/12F	-
Weight	0.21	0.29	mg
Particulate Concentration (Dry, No O ₂ Correction)	2.6	2.1	mg/Nm ³
Particulate Concentration (at Ref Water and Oxygen)	2.5	2.1	mg/Nm ³
Particulate Release Rate	-	3.24	g/hr
Reference Temp	273		K
Reference Pressure	101.3		kPa
Reference Moisture	No correction for moisture		-
Reference Oxygen	No correction for Oxygen		%

Particulates

	Filter (mg)	Washings (mg)
Blank	0.21	1.5
Run 1	0.29	1.1

2.9.5 Sampling Measurements

Date	03/07/14		Impinger		Initial Wt (g)		Final Wt(g)		Wt Gained (g)		l/min	Vac (in Hg)				
Start Time	12:52		1		786.6		784.6		-2.0		0.1	15				
End Time	13:22		2		738.5		738.8		0.3		0.1	10				
Duration (mm.ss)	30.00		3		665.2		666.4		1.2							
Stack	Tile Cutting Facility		4		705.9		716.2		10.3		Pitot 06				Velocity Head	
Run	1		5		246.8		246.8		0.0		DGM 09				Min	8
															Max	9
															Max:Min	1.13
										N3	N36					
			Sample Ref		EPA/14/515/12					Nozzle Diameter (mm)	7.08					
K Factor	5.57		Filter Number		EPA/14/515/12F											
Stack Diameter (m)	0.25		Probe Washing No		EPA/14/515/12W											
										ΔH across orifice meter (mm H ₂ O)	DGM (litres)	DGM Temp (°C)		Temp (°C)		
Point	Time	Vac	Stack Temp (°C)		Velocity Head (mmH ₂ O)		√ΔP			624.68	In	Out	Probe	Filter	Impinger	
a1	0	2	28		8		2.83		44.60	734	25	125	161	159		
a1	5	2	29		9		3.00		50.17	862	24	24	160	161		
a1	10	2	29		9		3.00		50.17	980	25	25	159	160		
a1	15	2	29		9		3.00		50.17	1100	26	25	161	159		
a1	20	2	29		9		3.00		50.17	1223	27	25	161	160		
a1	25	2	29		9		3.00		50.17	1344.79	27	25	160	160		
Total / Average		2.00	29.17		8.83		2.97		49.24	720.11	25.67	41.50	160.33	159.83		

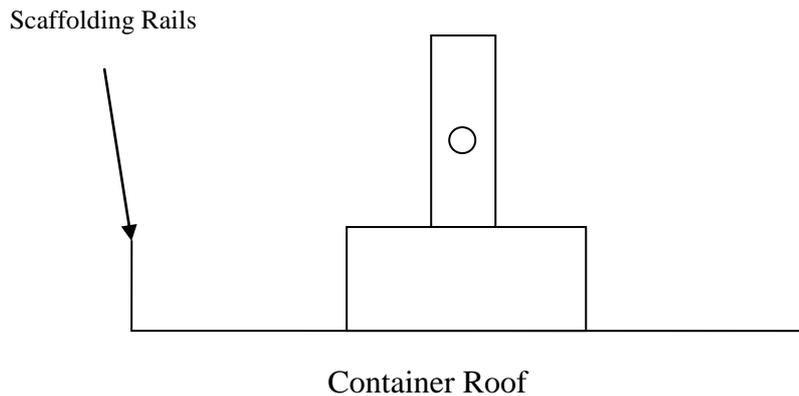
2.9.6 Uncertainty Calculations

Particulates

Source of uncertainty	Estimate of Component (1 SD) (± %)	Combined Uncertainty (± %)	Expanded Uncertainty (95% Confidence limit) (± %)
Mass of Particulate	8.51	8.74	As % of result 16.96
O ₂ Concentration	1.62		
Gas Temperature	0.69		
Pitot Co-efficient	0.50		As % of ELV
Humidity	0.50		
Stack Diameter	0.41		
Leak	0.24		
Nozzle Diameter	0.20		
Pressure	0.13		
			0.72
			As mg/m ³
			0.35

2.10 Appendix 10: Contractors Paint Mixing Facility

2.10.1 Sampling Location



Duct Characteristics

	Value	Units
Type of Duct	Circular	-
Diameter / Depth	0.29	m
Width	-	m
Area	0.066	m ²
Port Size	4	inch
Port Depth	45	mm
Orientation	Vertical	-

Sampling Platform

General Platform Information	
Permanent / Temporary	Temporary
Inside / Outside	Outside
Height of Platform from Ground Level	~ 5m
Size of Platform	~ 6m x 3m
Does the Platform have a weather cover (roof)	No
Platform has 2 hand rails (approx 0.5m and 1.0m high)	Yes
Platform has vertical base boards (approx 0.25m high)	Yes
Platform has removable chains / self closing gates at the top of the ladder	Yes
Platform positioned relative to the access ports (free from obstruction that would hamper insertion and removal of the sampling equipment)	Yes
Depth of platform (length of probe + 1m)	Yes

2.10.2 Flow Criteria Measurements

Traverse Point	A1	A2	A3	A4	A5	A6	A7	A8	A9	A10
Pressure (mm H ₂ O)	13.5	7.5	6.0	5.5	5.5	5.5	5.5	6.0	6.0	10.0
√ΔP	3.67	2.74	2.45	2.35	2.35	2.35	2.35	2.45	2.45	3.16
Temperature (°C)	26	26	26	26	26	26	26	26	26	26

Static Pressure (mmH ₂ O)	19	Barometric Pressure (mm Hg)	760.0	Duct Dimensions (m)	0.29
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Velocity (m/s) average	9.1	Actual Flow of stack gas (m ³ /hr)	2170.7
Stack Geometry	Circular	Flow (wet) at STP (m ³ /hr)	1985.6
Dimensions (m)	0.29	Flow (dry) at STP (m ³ /hr)	1953.2
Area (m ²)	0.066		

	Average	Max	Min	Ratio Max/Min	Compliance
Pressure (mm H ₂ O)	7.1	13.5	5.5	2.5	Yes
√ΔP (mm H ₂ O) ^{1/2}	2.63	3.67	2.35	1.6	Yes
Temperature (°C)	26.0	26	26	1.0	Yes
Angle of flow	<15°				Yes
Local Negative Flow	No				Yes

2.10.3 Gas Measurements

	Mean
Oxygen (%)	20.90
Carbon Monoxide (ppm)	0
Carbon Dioxide (%)	0.03

2.10.4 Manual Method Calculations

Test Dates	03/07/14		
Company	Leck Construction (BAE Systems)		
Contact	T Hughes		
Stack	Contractors Paint Mixing Facility		
	Blank	Test 1	Units
Sample Ref	EPA/14/515/13	EPA/14/515/14	-
Start Time	14:28	14:46	hr:mm
Stop Time	14:33	15:16	hr:mm
% O ₂	20.90	20.90	%
% CO ₂	0.03	0.03	%
%N ₂	-	79.07	%
V _{ic}	-	7.8	ml
B _{wo}	0.02	0.016	-
P _b	-	760.0	mm Hg
St	-	19	mm H ₂ O
T _s	-	22.00	°C
√ΔP	-	2.65	(mm H ₂ O) ^{1/2}
Yd	-	0.987	-
Test Time	-	30	min
T _m	-	27.33	°C
C _p	-	0.834	-
As	-	0.066	m ²
D _n	-	7.08	mm
ΔH ave	-	41.84	mm H ₂ O
V _{mstd}	0.5841	0.5841	m ³
V _{wstd}	0.0097	0.0097	m ³
Q _{std,wet}	-	1977.8	Nm ³ /h
Q _{act}	-	2133.2	Nm ³ /h
Isokinetic Rate	-	100.8	%
V _s	-	8.97	m/s
Washings			
Sample Ref	EPA/14/515/13W	EPA/14/515/14W	-
Weight	0.8	1	mg
Filter			
Sample Ref	EPA/14/515/13F	EPA/14/515/14F	-
Weight	<0.04	0.06	mg
Particulate Concentration (Dry, No O ₂ Correction)	1.4	1.8	mg/Nm ³
Particulate Concentration (at Ref Water and Oxygen)	1.4	1.8	mg/Nm ³
Particulate Release Rate	-	3.53	g/hr
Reference Temp	273		K
Reference Pressure	101.3		kPa
Reference Moisture	No correction for moisture		-
Reference Oxygen	No correction for Oxygen		%

Particulates

	Filter (mg)	Washings (mg)
Blank	<0.04	0.8
Run 1	0.06	1

2.10.5 Sampling Measurements

Date	03/07/14		Impinger	Initial Wt (g)	Final Wt(g)	Wt Gained (g)			l/min	Vac (in Hg)			
Start Time	14:46		1	784.6	784.7	0.1		Leak Check (Pre)	0.1	15			
End Time	15:16		2	738.8	739.9	1.1		Leak Check (Post)	0.1	5			
Duration (mm.ss)	30.00		3	666.4	667.0	0.6							
Stack	Contractors Paint Mix Room		4	713.2	719.2	6.0		Pitot ID	Pitot 14			Velocity Head	
Run	1		5	246.8	246.8	0.0		DGM ID	DGM 09			Min	7
												Max	7
												Max:Min	1.00
								Nozzle ID	N36				
			Sample Ref	EPA/14/515/14				Nozzle Diameter (mm)	7.08				
K Factor	5.8		Filter Number	EPA/14/515/14F									
Stack Diameter (m)	0.29		Probe Washing No	EPA/14/515/14W									
							AH across orifice meter (mm H ₂ O)	DGM (litres)	DGM Temp (°C)		Temp (°C)		
Point	Time	Vac	Stack Temp (°C)	Velocity Head (mmH ₂ O)	√ΔP				In	Out	Probe	Filter	Impinger
a1	0	3	22	7	2.65		41.84	1457	27	27	50		
a1	5	3	22	7	2.65		41.84	1565	27	27	50		
a1	10	3	22	7	2.65		41.84	1673	27	27	50		
a1	15	3	22	7	2.65		41.84	1784	28	26	50		
a1	20	3	22	7	2.65		41.84	1891	29	27	50		
a1	25	3	22	7	2.65		41.84	1997.45	29	27	50		
Total / Average		2.00	25.50	7.00	2.65		41.84	648.23	27.83	26.83	50		

2.10.6 Instrumental Gas Analyser Site Calibration Measurements

Zero Point

Gas	Analyser Range	Gas Cylinder ID	Gas Conc.	Pre Test			Post Test	Zero Drift
				Pre Span	Post Span	System	System	
VOC (ppm)	100	Ambient Air	0.00	0.78	0.78	1.95	1.71	-0.25

Span Gas

Gas	Analyser Range	Gas Cylinder ID	Gas Conc.	Pre Test		Post Test	Span Drift
				Analyser	System	System	
VOC (ppm)	100	EPA/CGAS /77	83.00	83.69	83.03	83.52	0.49

2.10.7 Instrumental Gas Analyser Results

Date	Time	VOC ppm	VOC as C mg/m ³	VOC as C mg/m ³
03.07.2014	14:46:06	74.7	120.1	120.1
03.07.2014	14:46:21	70.6	113.5	113.5
03.07.2014	14:46:36	78.4	126.0	126.0
03.07.2014	14:46:51	102.8	165.2	165.2
03.07.2014	14:47:06	85.0	136.6	136.6
03.07.2014	14:47:21	72.0	115.7	115.7
03.07.2014	14:47:36	67.2	108.0	108.0
03.07.2014	14:47:51	67.9	109.1	109.1
03.07.2014	14:48:06	165.8	266.5	266.5
03.07.2014	14:48:21	199.3	320.3	320.3
03.07.2014	14:48:36	208.5	335.1	335.1
03.07.2014	14:48:51	228.8	367.7	367.7
03.07.2014	14:49:06	216.1	347.3	347.3
03.07.2014	14:49:21	251.0	403.4	403.4
03.07.2014	14:49:36	237.4	381.5	381.5
03.07.2014	14:49:51	213.7	343.4	343.4
03.07.2014	14:50:06	212.0	340.7	340.7
03.07.2014	14:50:21	222.5	357.6	357.6
03.07.2014	14:50:36	225.9	363.1	363.1
03.07.2014	14:50:51	230.5	370.4	370.4
03.07.2014	14:51:06	173.9	279.5	279.5
03.07.2014	14:51:21	156.8	252.0	252.0
03.07.2014	14:51:36	248.1	398.7	398.7
03.07.2014	14:51:51	217.8	350.0	350.0
03.07.2014	14:52:06	169.5	272.4	272.4
03.07.2014	14:52:21	257.4	413.7	413.7
03.07.2014	14:52:36	319.7	513.8	513.8
03.07.2014	14:52:51	342.4	550.3	550.3
03.07.2014	14:53:06	310.9	499.7	499.7
03.07.2014	14:53:21	327.5	526.3	526.3
03.07.2014	14:53:36	268.4	431.4	431.4

Date	Time	VOC ppm	VOC as C mg/m ³	VOC as C mg/m ³
03.07.2014	14:53:51	292.1	469.4	469.4
03.07.2014	14:54:06	268.4	431.4	431.4
03.07.2014	14:54:21	261.8	420.8	420.8
03.07.2014	14:54:36	242.2	389.3	389.3
03.07.2014	14:54:51	250.3	402.3	402.3
03.07.2014	14:55:06	204.9	329.3	329.3
03.07.2014	14:55:21	221.7	356.3	356.3
03.07.2014	14:55:36	206.6	332.0	332.0
03.07.2014	14:55:51	220.8	354.9	354.9
03.07.2014	14:56:06	213.4	343.0	343.0
03.07.2014	14:56:21	212.7	341.8	341.8
03.07.2014	14:56:36	238.1	382.7	382.7
03.07.2014	14:56:51	233.9	375.9	375.9
03.07.2014	14:57:06	213.7	343.4	343.4
03.07.2014	14:57:21	212.2	341.0	341.0
03.07.2014	14:57:36	228.1	366.6	366.6
03.07.2014	14:57:51	274.0	440.4	440.4
03.07.2014	14:58:06	292.6	470.3	470.3
03.07.2014	14:58:21	331.4	532.6	532.6
03.07.2014	14:58:36	361.7	581.3	581.3
03.07.2014	14:58:51	353.4	568.0	568.0
03.07.2014	14:59:06	295.0	474.1	474.1
03.07.2014	14:59:21	234.2	376.4	376.4
03.07.2014	14:59:36	360.9	580.0	580.0
03.07.2014	14:59:51	288.2	463.2	463.2
03.07.2014	15:00:06	239.3	384.6	384.6
03.07.2014	15:00:21	280.6	451.0	451.0
03.07.2014	15:00:36	227.1	365.0	365.0
03.07.2014	15:00:51	179.7	288.8	288.8
03.07.2014	15:01:06	252.5	405.8	405.8
03.07.2014	15:01:21	174.8	280.9	280.9
03.07.2014	15:01:36	182.2	292.8	292.8
03.07.2014	15:01:51	196.1	315.2	315.2
03.07.2014	15:02:06	208.8	335.6	335.6
03.07.2014	15:02:21	208.5	335.1	335.1
03.07.2014	15:02:36	207.3	333.2	333.2
03.07.2014	15:02:51	162.4	261.0	261.0
03.07.2014	15:03:06	176.3	283.3	283.3
03.07.2014	15:03:21	142.6	229.2	229.2
03.07.2014	15:03:36	175.6	282.2	282.2
03.07.2014	15:03:51	213.9	343.8	343.8
03.07.2014	15:04:06	228.8	367.7	367.7
03.07.2014	15:04:21	213.4	343.0	343.0
03.07.2014	15:04:36	199.3	320.3	320.3
03.07.2014	15:04:51	203.2	326.6	326.6
03.07.2014	15:05:06	177.8	285.8	285.8
03.07.2014	15:05:21	194.1	311.9	311.9
03.07.2014	15:05:36	171.7	275.9	275.9
03.07.2014	15:05:51	176.3	283.3	283.3
03.07.2014	15:06:06	189.3	304.2	304.2

Date	Time	VOC ppm	VOC as C mg/m ³	VOC as C mg/m ³
03.07.2014	15:06:21	204.6	328.8	328.8
03.07.2014	15:06:36	203.9	327.7	327.7
03.07.2014	15:06:51	179.7	288.8	288.8
03.07.2014	15:07:06	171.9	276.3	276.3
03.07.2014	15:07:21	179.7	288.8	288.8
03.07.2014	15:07:36	182.2	292.8	292.8
03.07.2014	15:07:51	215.9	347.0	347.0
03.07.2014	15:08:06	316.7	509.0	509.0
03.07.2014	15:08:21	288.2	463.2	463.2
03.07.2014	15:08:36	292.1	469.4	469.4
03.07.2014	15:08:51	264.2	424.6	424.6
03.07.2014	15:09:06	263.0	422.7	422.7
03.07.2014	15:09:21	261.1	419.6	419.6
03.07.2014	15:09:36	296.9	477.2	477.2
03.07.2014	15:09:51	259.3	416.7	416.7
03.07.2014	15:10:06	242.2	389.3	389.3
03.07.2014	15:10:21	227.8	366.1	366.1
03.07.2014	15:10:36	268.6	431.7	431.7
03.07.2014	15:10:51	313.8	504.3	504.3
03.07.2014	15:11:06	309.9	498.1	498.1
03.07.2014	15:11:21	312.3	501.9	501.9
03.07.2014	15:11:36	306.5	492.6	492.6
03.07.2014	15:11:51	312.8	502.7	502.7
03.07.2014	15:12:06	279.1	448.6	448.6
03.07.2014	15:12:21	208.5	335.1	335.1
03.07.2014	15:12:36	189.5	304.6	304.6
03.07.2014	15:12:51	203.7	327.4	327.4
03.07.2014	15:13:06	179.5	288.5	288.5
03.07.2014	15:13:21	182.4	293.1	293.1
03.07.2014	15:13:36	160.4	257.8	257.8
03.07.2014	15:13:51	175.8	282.5	282.5
03.07.2014	15:14:06	172.6	277.4	277.4
03.07.2014	15:14:21	193.4	310.8	310.8
03.07.2014	15:14:36	197.3	317.1	317.1
03.07.2014	15:14:51	212.9	342.2	342.2
03.07.2014	15:15:06	192.4	309.2	309.2
03.07.2014	15:15:21	172.4	277.1	277.1
03.07.2014	15:15:36	189.7	304.9	304.9
03.07.2014	15:15:51	218.8	351.6	351.6
03.07.2014	15:16:06	260.3	418.3	418.3
03.07.2014	15:16:21	268.6	431.7	431.7
03.07.2014	15:16:36	259.1	416.4	416.4
03.07.2014	15:16:51	227.4	365.5	365.5
Mean		222.0	356.9	356.9
Max		361.7	581.3	581.3
Min		67.2	108.0	108.0

2.10.8 Uncertainty Calculations

Particulates

Source of uncertainty	Estimate of Component (1 SD) (± %)	Combined Uncertainty (± %)	Expanded Uncertainty (95% Confidence limit) (± %)
Mass of Particulate	7.90	8.14	As % of result 15.80
O ₂ Concentration	1.62		
Gas Temperature	0.84		
Humidity	0.50		As % of ELV 0.57
Stack Diameter	0.34		
Gas Volume	0.30		
Leak	0.27		As mg/m ³ 0.28
Nozzle Diameter	0.20		
Pressure	0.14		

Total VOC's

Source of uncertainty	Estimate of Component (1 SD) ppm	Combined Uncertainty ppm	Expanded Uncertainty (95% Confidence limit) ppm
Linearity	0.83	1.13	2.20
Temperature effect (zero)	0.48		
Barometric Pressure	0.42		
Span gas	0.32		
Temperature effect (span)	0.24		
Span drift	0.14		
Repeatability	0.07		Expanded Uncertainty (95% Confidence limit) %
Zero drift	0.07		
Cross sensitivity CO (1.2 % vol)	0.00		
Cross sensitivity NO (127 mgm ⁻³)	0.00		
Cross sensitivity H ₂ O (sat 325K)	0.00		
Cross sensitivity SO ₂ (2767 mgm ⁻³)	0.00		
Cross sensitivity CO ₂ (15.2 % vol)	0.00	As % of Result 0.99	
		As mg/m ³ at ref conditions 3.53	

2.11 Certificates of Analysis



Test Certificate

Date 18/08/2014

Client	EPA Union Street Helton Le Hole Sunderland Tyne & Wear DH5 9HU	Order No.	EPA/14/030
		Certificate No.	WK14-5297
		Issue No.	1
Contact	Tracy Dodds	Date Received	13/08/2014
Description	2 filters & 2 washes for TPM	Technique	Gravimetric Stack

Sample No.	804446	112089 EPA/14/515/20F	Method
Total particulate matter	<0.04 mg		D9(U)
Sample No.	804447	112074 EPA/14/515/20F	Method
Total particulate matter	2.07 mg		D9(U)
Sample No.	804448	EPA/14/515/20W	Method
Total particulate matter	<0.5 mg		D9(U)
Sample No.	804449	EPA/14/515/20W	Method
Total particulate matter	1.1 mg		D9(U)



Test Certificate

Date 25/07/2014

Client	EPA Union Street Helton Le Hole Sunderland Tyne & Wear DH5 9HU	Order No.	EPA/14/022
		Certificate No.	WK14-4696
		Issue No.	1
Contact	Tracy Dodds	Date Received	17/07/2014
Description	16 filters & 16 washes for TPM	Technique	Gravimetric Stack

Sample No.	800655	EPA/14/01F	Method
Total particulate matter	0.13 mg		D9(U)
Sample No.	800656	EPA/14/02F	Method
Total particulate matter	0.56 mg		D9(U)
Sample No.	800657	EPA/14/03F	Method
Total particulate matter	<0.1 mg		D9(U)
Sample No.	800658	EPA/14/04F	Method
Total particulate matter	<0.1 mg		D9(U)
Sample No.	800659	EPA/14/05F	Method
Total particulate matter	<0.04 mg		D9(U)
Sample No.	800660	EPA/14/06F	Method
Total particulate matter	0.29 mg		D9(U)
Sample No.	800661	EPA/14/07F	Method
Total particulate matter	2.55 mg		D9(U)
Sample No.	800662	EPA/14/08F	Method
Total particulate matter	6.07 mg		D9(U)



Test Certificate

Date 25/07/2014

Client	EPA	Certificate No.	WK14-4696
		Issue No.	1
Sample No.	800663	EPA/14/09F	Method
Total particulate matter	<0.04 mg		D9(U)
Sample No.	800664	EPA/14/10F	Method
Total particulate matter	8.68 mg		D9(U)
Sample No.	800665	EPA/14/11F	Method
Total particulate matter	0.21 mg		D9(U)
Sample No.	800666	EPA/14/12F	Method
Total particulate matter	0.29 mg		D9(U)
Sample No.	800667	EPA/14/13F	Method
Total particulate matter	<0.04 mg		D9(U)
Sample No.	800668	EPA/14/14F	Method
Total particulate matter	0.06 mg		D9(U)
Sample No.	800669	EPA/14/15F	Method
Total particulate matter	<0.04 mg		D9(U)
Sample No.	800670	EPA/14/16F	Method
Total particulate matter	2.05 mg		D9(U)
Sample No.	800671	EPA/14/01W	Method
Total particulate matter	<0.5 mg		D9(U)
Sample No.	800672	EPA/14/02W	Method
Total particulate matter	<0.5 mg		D9(U)
Sample No.	800673	EPA/14/03W	Method
Total particulate matter	1.1 mg		D9(U)



Test Certificate

Date 25/07/2014

Client	EPA	Certificate No.	WK14-4696
Issue No.	1	Method	
Sample No.	800674	EPA/14/04W	Method
Total particulate matter	0.6 mg		D9(U)
Sample No.	800675	EPA/14/05W	Method
Total particulate matter	<0.5 mg		D9(U)
Sample No.	800676	EPA/14/06W	Method
Total particulate matter	<0.5 mg		D9(U)
Sample No.	800677	EPA/14/07W	Method
Total particulate matter	1.3 mg		D9(U)
Sample No.	800678	EPA/14/08W	Method
Total particulate matter	0.7 mg		D9(U)
Sample No.	800679	EPA/14/09W	Method
Total particulate matter	1.2 mg		D9(U)
Sample No.	800680	EPA/14/10W	Method
Total particulate matter	3.0 mg		D9(U)
Sample No.	800681	EPA/14/11W	Method
Total particulate matter	1.5 mg		D9(U)
Sample No.	800682	EPA/14/12W	Method
Total particulate matter	1.1 mg		D9(U)
Sample No.	800683	EPA/14/13W	Method
Total particulate matter	0.8 mg		D9(U)
Sample No.	800684	EPA/14/14W	Method
Total particulate matter	1.0 mg		D9(U)



Test Certificate

Date 25/07/2014

Client	EPA		Certificate No.	WK14-4696
			Issue No.	1
Sample No.	800885	EPA/14/15W	Method	
Total particulate matter	<0.5 mg		D9(U)	
Sample No.	800886	EPA/14/16W	Method	
Total particulate matter	1.9 mg		D9(U)	

Tested By Kirstie Davenport Date 22/07/2014
23/07/2014

Approved By  Date 25/07/2014
Joanne Dewhurst
Laboratory Manager

For and on authority of RPS Laboratories Ltd.

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

Concentration values (mg/m³ and ppm) are calculated on the basis of information provided by the customer.
Results stated as ml are referring to the sample volume.

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Analysis carried out on samples 'as received'
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2.12 Calibration Certificates

CERTIFIED REFERENCE MATERIAL CERTIFICATE OF CALIBRATION

Component	Nominal Concentration	Certified Concentration	Absolute Uncertainty	Relative Uncertainty	Analysis Technique
PROPANE SYNTHETIC AIR	800 ppm Balance	805 ppm	+/-6 ppm	0.7 %	FID

All concentrations are molar

EPA / CGAS / 72

Cylinder Number: 219877
Issuing Laboratory: UKAS Accredited Calibration Laboratory 0408 & Reference Material Producer 4183
Production Order Number: 2397875

Page 2 of 2

UKAS 1316253 MET/GEN/001/1008/04



CERTIFIED REFERENCE MATERIAL
CERTIFICATE OF CALIBRATION

Component	Nominal Concentration	Certified Concentration	Absolute Uncertainty	Relative Uncertainty	Analysis Technique
PROPANE	8 ppm	8.32 ppm	+/-0.17 ppm	2.0 %	NDIR
SYNTHETIC AIR	Balance				

All concentrations are molar

EPA / CGAS / 88

Cylinder Number: 233372
Issuing Laboratory: UKAS Accredited Calibration Laboratory 0408 & Reference Material Producer 4183

Production Order Number: 2457419

**CERTIFIED REFERENCE MATERIAL
CERTIFICATE OF CALIBRATION**

Component	Nominal Concentration	Certified Concentration	Absolute Uncertainty	Relative Uncertainty	Analysis Technique
PROPANE SYNTHETIC AIR	80 ppm Balance	83.0 ppm	+/-0.6 ppm	0.8 %	FID

All concentrations are molar

EPA / CGAS / 77

Cylinder Number: 219871
Issuing Laboratory: UKAS Accredited Calibration Laboratory 0408 & Reference Material Producer 4183

Production Order Number: 2397927

Page 2 of 2

UKAS: 13162753 HQ/200860/ANUK/1008/SM

