valspar

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26th September 2014

Natural Resources Wales
Chester road
Buckley,
CH7 3AJ

For the attention of Lara Cubley

Dear Lara,

See attached information as required by:- **Reference Permit BU7545IM:**

Q3 submissions

1. VOC's Q2 report for Q3 2014

Yours sincerely

Julian Fairhurst
HSE Manager
Valspar (UK) Corporation Ltd

REC
Resource & Environmental Consultants Ltd

UKAS TESTING 2082

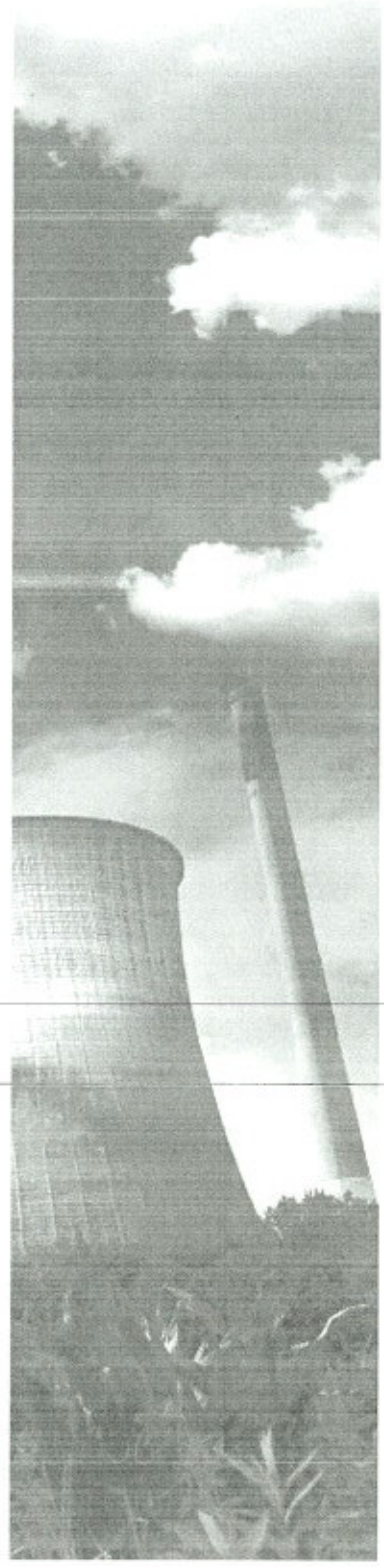
MONITORING OF EMISSIONS FROM THE PAINT & LACQUER PRODUCTION PROCESS

9 September, 2014 (QUARTER 3)

Prepared for Valspar Corporation (UK) Ltd

REC Report 71779p3r0

Issued: 25 September, 2014



REC Air Quality

GREEN ACHIEVER

safecontractor APPROVED

REC Air Quality

UKAS TESTING 2082

Prepared for:

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Prepared by:

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Issued: 25 September, 2014
Reference: 71779p3r0

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MM08 984, MCERTS Level 2 TE1-4

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Lee Swanson, Team Leader
MM04 483, MCERTS Level 2 TE1&TE2

CONTENTS

EXECUTIVE SUMMARY

Resource & Environmental Consultants (REC) Ltd was commissioned by Valspar Corporation (UK) Ltd to monitor emissions of pollutants from various stages of their paint and lacquer production processes at their site in Deeside.

In accordance with the requirements of their site permit, monitoring has been undertaken for the following pollutants:-

- Total Volatile Organic Compounds (VOCs) expressed as carbon (C)
- Speciated VOCs, in particular the Class A compounds Ethyl Acrylate and Methyl Acrylate
- Total Particulate Matter

The results of the monitoring survey are summarised in the tables below. Mass emission rates have also been calculated based upon the emission concentration data and measured flowrates. Mass emission rates have been calculated in gram per hour (g/hr) for the Class A VOCs and in kilogram per hour (kg/hr) for the Class B total VOCs.

The following results were obtained from the emission monitoring survey and are compared with the current permit limit:-

PAINT PLANT VOC EMISSIONS

Species	UKAS Status	Average Emission Concentration (mg/Nm^3)	Mass Emission Rate	Permit Emission Rate Limit
		A5	A5	
Total VOCs (as carbon)	C	456.9	0.207	2.0 kg/hr
Ethyl acrylate	B	<0.6	<0.3	100 g/hr
Methyl acrylate	B	<0.6	<0.3	100 g/hr

NOTE 1: All data are expressed in mg/Nm^3 at 273K, 101.3kPa, without correction for water vapour and oxygen content unless otherwise stated.
NOTE 2: (B) REC Ltd accredited for sampling only, UKAS accredited analysis conducted by SAL Ltd. (C) REC Ltd accredited for sampling, sub-contracted analysis by SAL Ltd not UKAS accredited.

RESIN PLANT VOC EMISSION CONCENTRATIONS

Species	UKAS Status	Average Emission Concentration (mg/Nm^3)		
		A1	A2	A3
Total VOCs (as carbon)	C	216.7	23.5	239.1
Ethyl acrylate	B	<0.6	<0.5	<0.6
Methyl acrylate	B	<0.6	<0.5	<0.6

NOTE 1: All data are expressed in mg/Nm^3 at 273K, 101.3kPa, without correction for water vapour and oxygen content unless otherwise stated.
NOTE 2: (B) REC Ltd accredited for sampling only, UKAS accredited analysis conducted by SAL Ltd. (C) REC Ltd accredited for sampling, sub-contracted analysis by SAL Ltd not UKAS.

RESIN PLANT VOC MASS EMISSION RATES

Species	UKAS Status	Mass Emission Rate			Permit Emission Rate Limit
		A1	A2	A3	
Total VOCs (as carbon kg/hr)	C	0.114	0.012	0.075	2.0 kg/hr
Ethyl acrylate (g/hr)	B	<0.3	<0.3	<0.2	100 g/hr
Methyl acrylate (g/hr)	B	<0.3	<0.3	<0.2	100 g/hr

NOTE 1: All data are expressed in mg/Nm^3 at 273K, 101.3kPa, without correction for water vapour and oxygen content unless otherwise stated.
NOTE 2 (B) REC Ltd accredited for sampling only, UKAS accredited analysis conducted by SAL Ltd. (C) REC Ltd accredited for sampling, sub-contracted analysis by SAL Ltd not UKAS.

PARTICULATE EMISSIONS

Species	UKAS Status	Average Emission Concentration (mg/Nm^3)		Permit Limit (mg/Nm^3)
		A2	A6	
Particulate Matter	D	<0.2	<0.2	20

NOTE 1: All data are expressed in mg/Nm^3 at 273K, 101.3kPa, without correction for water vapour and oxygen content unless otherwise stated.
NOTE 2: (D) REC Ltd not accredited for sampling, UKAS accredited analysis conducted by SAL Ltd.

1. INTRODUCTION

1.1 Background

Valspar Corporation (UK) Ltd commissioned REC Ltd to conduct an emission monitoring survey on their paint and lacquer production processes, at their site in Deeside.

Although the site is covered by a Part (A1) permit issued by the EA the intrinsic safety issues at the site present significant issues in undertaking the work to the MCERTS standard. In agreement with the Agency the methodology utilised for this work ensures safety requirements at the site are met, albeit using methodology not covered or approved in EA TGN M2.

Due to the IS issues at the site the use of FID monitoring equipment to BS EN 12619 is not possible and adsorption tube sampling therefore undertaken. Sampling for particulate matter cannot be undertaken in accordance with BS EN 13284 again due to the IS issues at the site.

This sampling methodology does not comply with EA Technical Guidance Note M2 requirements for sampling total VOCs and therefore MCERTS requirements. Also it is not possible to identify all of the VOCs present prior to sampling as they contain complicated aliphatic and aromatic hydrocarbon mixtures e.g. white spirit and low aromatic white spirit.

1.2 Scope of the Survey

An emission monitoring survey was required to determine the release concentrations of volatile organic compounds (VOCs) and particulate matter released from the paint and lacquer production processes.

Ancillary measurements of stack dimensions, temperature and velocity were also to be made.

All results were to be reported at 273K, 101.3kPa, without correction for water vapour and oxygen content. Emission rates expressed in kilogram per hour (kg/hr) for total VOCs and gram per hour (g/hr) for the target VOCs were also to be calculated.

1.3 Sampling Personnel

Monitoring was conducted by the following REC Ltd permanent staff:-

- Lee Swanson - Team Leader, MM04 483, MCERTS Level 2, TE1&2

2. METHODOLOGY

2.1 Species and Techniques

The following table shows the reference methods used for the emission monitoring survey:

Species	Accreditation Status	Method	Uncertainty±%	Limit of Detection
Particulate Matter	D	Based on BS 3405	25	1 mg/m^3
Methyl Acrylate + Ethyl Acrylate	B	In house method MM0011 based on BS EN 13649	30	0.1 mg/m^3
Total VOCs	C	In house method MM0011 based on BS EN 13649	33 to 300	0.1 mg/m^3

NOTE: UKAS Status:- (B) REC Ltd accredited for sampling only, UKAS accredited analysis conducted by SAL Ltd. (C) REC Ltd accredited for sampling, sub-contracted analysis by SAL Ltd not UKAS accredited (D) REC Ltd not accredited for sampling, UKAS accredited analysis conducted by SAL.

2.2 Sampling & Analytical Methodology

The Valspar site is intrinsically safe, making the use of normal particulate sampling equipment which satisfies the requirements of BS EN 13284 and BS ISO 9096 impracticable.

The equipment utilised in the survey satisfied the requirements of BS 3405. This standard describes methodology for measuring particulate matter under defined conditions and at discrete locations in the duct. If all the procedural requirements of the test are complied with, the accuracy of the test results can be quoted as ± 25%.

REC is not accredited for sampling to this test procedure.

To determine the concentration of particulate matter in emissions, SKC isokinetic stack sampling equipment was utilised. The sampling train consisted of an in stack nozzle/ stainless steel filter holder containing a 37 mm GF filter.

This was connected to an intrinsically safe battery operated sampling pump. Isokinetic sampling was maintained, as far as practicable, by selection of a suitable diameter nozzle to suit the maximum sampling flowrate through the pump (5.0 l/min). The flowrate was checked using a calibrated rotameter.

Total VOCs

To determine the concentration of VOCs in emissions, stack sampling equipment satisfying the requirements of BS EN 13649 was employed. In house method MM0011 was followed.

Sampling was carried out under non-isokinetic sampling conditions. A sample of the exhaust stream was removed from the stack via a probe. The gas is then passed through two charcoal adsorption tubes placed in series.

The adsorption tubes are used to absorb the VOCs. The tubes were connected to either low flow (20-200ml/min) sampling pumps or dry gas meters to measure the volume sampled.

Upon completion of sampling the tubes were capped, labelled and placed in a cool box for transport back to the laboratory.

The tubes were chemically desorbed and analysed by a high resolution GC/MS operating in the scanning mode to identify and semi-quantify the compounds of interest. The main VOCs detected are identified against the instruments vast spectral library and concentrations "semi-quantified" against the deuterated toluene internal standard.

This technique is "semi-quantitative" in that the compounds are quantified against an internal standard as opposed to the compounds themselves. This increases the systematic errors and the true result, in 95% of cases, actually lies between a factor of ⅓ and three times the concentration quoted. No laboratory can be UKAS accredited for this type of semi-quantitative work.

Each tube has two sections (front and back) and each section is analysed separately to allow breakthrough to be assessed.

Target VOCs

Sampling for Methyl Acrylate and Ethyl Acrylate (Class A VOCs) was carried out using charcoal adsorption tubes using methodology as per BS EN 13649 (in house method MM0011). The tubes were connected to either low flow sampling pumps fitted with a stroke meter to determine the volume sampled or dry gas meters to measure the volume sampled. The pump stroke rate was determined quarterly against a UKAS calibrated bubble flow meter.

The tubes were chemically desorbed and analysed by a high resolution GC/MS operating in the target mode to identify and quantify the compounds of interest against prepared standards.

From the mass of each target VOC detected on the tube in microgram (µg/tube) and volume sampled, an emission concentration was calculated.

Stack Temperature and Velocity

Due to the IS restrictions an intrinsically safe thermocouple/reader and pitot/manometer were used in the survey to measure temperature and velocity.

2.3 Laboratory Analysis

An approved UKAS accredited sub-contractor, SAL Ltd, undertook the sample analysis for particulates and total/target VOCs on adsorption tubes.

A copy of their Certificate of Analysis is enclosed in Appendix 1.

3. SAMPLING AND OPERATIONAL DETAILS

3.1 Process Description

The process operations at Valspar Corporation (UK) Ltd are authorised as a Part A (1) process under the Pollution Prevention & Control (PPC) Regulations. They operate in accordance with a permit issued by the Environment Agency, Permit No. BU7545IM.

Valspar are paint and lacquer manufacturing company. The processes at the site are batch processes with various durations typically ranging from 8 to 24 hours. The following paints/lacquers were being produced during the sampling:

WE0215P Bx # 24221, WE0215P Bx # 24225, 8513A4R/10D Bx # 24261, WDER2PD Bx # 24360, 28Q20EA Bx # 24191, CE0176M Bx # 24254, 400W56R/13DIL Bx # 24285

Due to intrinsic safety requirements at the site sampling cannot be undertaken in accordance with the requirements of MCERTS and the scope therefore reduced, in agreement with the EA, to methodology some of which does not satisfy the requirements of EA TGN M2.

3.2 Sampling Positions

The Valspar site is intrinsically safe working area which limits the sampling equipment and monitoring techniques that can be utilised. The following summarises the access at each emission point:

A1 - 2 x 1" holes drilled in a vertical section of the stack. The hole is located at best 2 hydraulic diameters downstream and 2 hydraulic diameters upstream of any possible flow disturbance. Access was inside the main building.

A2 - 1 x 2" hole drilled on a circular stack. The hole is located approximately 5 hydraulic diameters downstream and 1 hydraulic diameters upstream of any possible flow disturbance. Access was via a short ladder and located outside the main building.

A3 - 1 x 1" hole drilled in a vertical section of the stack. The hole was located at least 5 hydraulic diameters upstream and downstream of any possible flow disturbance. Access to the stack was via the roof.

A5 - 1 x 2" port on a circular stack. The hole is located approximately 5 hydraulic diameters downstream and 3 hydraulic diameters upstream of any possible flow disturbance. Access was via some steps and located inside the main building.

A6 – 2 x 2" ports on square stack on the same vertical plane above each other. They are located more than 3 hydraulic diameters upstream and downstream of any possible flow disturbance. Access is via a small permanent ladder and platform.

Whilst the sampling locations do not fully meet the requirements of EA Technical Guidance Note M1 in terms of port size and distances from bends, the flow profiles established show the flow and temperature variations to be with M1 requirements and the port sizes are adequate to allow access for the sampling equipment.

Diagrams detailing the sampling positions and taken from Site Worksheets are provided in Appendix 1

3.3 Uncertainty

All standard methods were fully complied with, consequently the standard uncertainties apply.

REC has calculated uncertainty budgets for all of the pollutants listed in the Method Details Table in Section 2.1 above in accordance with calculations and methodology supplied by the Source Testing Association (STA). These uncertainties are quoted in the Tables section of this report.

For total VOCs the peaks are quantified against an internal standard as opposed to the compounds themselves. This increases the systematic errors and the true result, in 95% of cases, actually lies between a factor of ⅓ and three times the concentration quoted.

3.4 Emission Monitoring Survey Details

The emission monitoring survey was carried out on the processes on 9 September, 2014. The table below summarises the actual sampling periods.

SAMPLING PERIODS

Stack	Parameter	Sample Time (& Date)
A1	Total & Target VOCs	10:33 – 11:33 (09/09/14)
A2	Particulates	09:40 – 10:40 (09/09/14)
	Total & Target VOCs	09:30 – 10:30 (09/09/14)
A3	Total & Target VOCs	11:45 – 12:45 (09/09/14)
A5	Total & Target VOCs	12:50 – 13:50 (09/09/14)
A6	Particulates	14:30 -15:30 (09/09/14)

4. RESULTS AND DISCUSSION

4.1 Initial Velocity and Temperature Traverse

An initial pitot-static pressure and temperature traverse was carried out. From these data stack velocity, expressed in metres per second (m/s), and volumetric flowrates expressed in cubic metre per hour (m^3/hr) have been calculated.

The results are reported at actual stack conditions and the volumetric flowrate is further expressed at the standard reference conditions of 273K, 101.3kPa i.e. standard temperature and pressure (STP). The results are summarised in Table 1.

4.2 Particulate Matter

The results of the particulate sampling runs are summarised in Table 2.

From the mass of particulate matter on the filter and volume sampled an emission concentration was calculated.

The results are expressed in mg/m^3 at 273K, 101.3kPa, on a wet gas basis without correction for oxygen content.

4.3 Total VOC Emission Data

The results of the total VOC monitoring tests are summarised in Table 3.

From the total mass of all of the peaks detected on the tubes in microgram (µg) and volume sampled in litres an emission concentration was calculated. Concentrations are expressed in mg/m^3 at the standard reference conditions of 273K, 101.3kPa without correction for water vapour or oxygen content.

Mass emission rates of total Class B VOCs expressed in kilogram per hour (kg/hr) have also been calculated from the emission data and volume flows from Table 1.

4.4 Target VOC Emission Data

The results of the target VOC monitoring tests for Methyl acrylate and Ethyl acylate are summarised in Table 3. Mass emission rates of these Class A VOCs, expressed in gram per hour (g/hr) have also been calculated from the emission data and volume flows from Table 1.

From the mass of the target VOCs on the tubes in microgram (µg) and volume sampled in litres an emission concentration was calculated. Concentrations are expressed in mg/m^3 at the standard reference conditions of 273K, 101.3kPa without correction for water vapour or oxygen content.

====== End of Report Text ======

TABLES

TABLE 1

FLOW DATA

Stack Ref.	Stack Temp	Av Pitot ΔP	X-Sect. Area	Velocity (actual)	Volume Flow (m^3/hr)	
	(°C)	(Pa)	(m^2)	(m/s)	(actual)	(@ ntp)
A1	12	15	0.031	5.0	554	525
A2	13	14	0.031	4.9	544	507
A3	13	140	0.006	15.3	330	314
A5	13	20	0.023	5.8	476	452
A6	14	10	0.168	4.1	2,465	2,338

TABLE 2

PARTICULATE EMISSION DATA

Sampling Data	A2	A6
Start Time/Date	09:40, 09/09/14	14:30, 09/09/14
End Time/Date	10:40, 09/09/14	15:30, 09/09/14
Sampling Period (min)	60	60
Volume Sampled (dry m^3)	0.300	0.298
Ambient Temp (°C)	15	16
Ambient Press (kPa)	99.7	99.7
Volume Sampled, 273K, 101.3kPa (m^3)	0.280	0.277
Analytical Data		
Total particulate matter (mg)	<0.05	<0.05
Emission Concentration Data		
Particulates (mg/m^3)	<0.2	<0.2

TABLE 3

VOC EMISSION DATA

Sampling Data	A1	A2	A3	A5
DGM Ref (AQ No.)	203	203	203	203
Start Time	10:33	09:30	11:45	12:50
End Time	11:33	10:30	12:45	13:50
Counter Start	348817.0	322245.0	372707.0	396567.0
Counter End	372583.0	348759.0	396546.0	420569.0
Volume Sampled (litres)	18.300	20.416	18.356	18.482
Ambient Temp (°C)	15	15	16	16
Ambient Press (kPa)	99.7	99.7	99.7	99.7
Volume Sampled, 273K, 101.3kPa (litres)	17.073	19.047	17.066	17.183
Analytical Data				
Ethyl Acrylate on tube front section (µg)	<5	<5	<5	<5
Ethyl Acrylate on tube rear section (µg)	<5	<5	<5	<5
Mass on Back-up Section (%)	N/A*	N/A*	N/A*	N/A*
Methyl Acrylate on tube front section (µg)	6	<5	<5	<5
Methyl Acrylate on tube rear section (µg)	<5	<5	<5	<5
Mass on Back-up Section (%)	N/A*	N/A*	N/A*	N/A*
Total VOCs on tube front section (µg)	3,699	447	4,080	7,850
Total VOCs on tube rear section (µg)	<1	<1	<1	<1
Mass on Back-up Section (%)	0.0	0.2	0.0	0.0
Emission Concentration Data				
Ethyl Acrylate (mg/m^3)	0.6	0.5	0.6	0.6
Uncertainty (± mg/m^3)	0.2	0.2	0.2	0.2
Methyl Acrylate (mg/m^3)	0.6	0.5	0.6	0.6
Uncertainty (± mg/m^3)	0.2	0.2	0.2	0.2
Total VOCs(mg/m^3)	216.7	23.5	239.1	456.9
Uncertainty (± mg/m^3)	65.0 | 650.2	7.1 | 70.6	71.7 | 717.4	137.1 | 1370.7
Volume Flowrate (m^3/hr)	525	507	314	452
Ethyl Acrylate (g/hr)	0.3	0.3	0.2	0.3
Methyl Acrylate (g/hr)	0.3	0.3	0.2	0.3
Total VOCs (kg/hr)	0.114	0.012	0.075	0.207

*% Breakthrough not applicable due to low levels measured.

APPENDIX 1

Certificate of Analysis

Scientific Analysis Laboratories Ltd
Hadfield House
Hadfield Street
Cornbrook
Manchester
M16 9FE
Tel : 0161 874 2400
Fax : 0161 874 2404

Scientific Analysis Laboratories Ltd

Certificate of Analysis

Report Number: 422199-1

Date of Report: 22-Sep-2014

Customer: Resource Environmental Consultants Ltd
Osprey House
Pacific Quay
Broadway
Salford
M50 2UE

Customer Contact: Mr Lee Swanson

Customer Job Reference: 71779
Customer Site Reference: Date Collected: 9/9/14
Date Job Received at SAL: 12-Sep-2014
Date Analysis Started: 17-Sep-2014
Date Analysis Completed: 22-Sep-2014

The results reported relate to samples received in the laboratory
Opinions and interpretations expressed herein are outside the scope of UKAS accreditation
This report should not be reproduced except in full without the written approval of the laboratory
Tests covered by this certificate were conducted in accordance with SAL SOPs
All results have been reviewed in accordance with QP22

UKAS TESTING
1549

Report checked and authorised by :
James Allan
Project Manager

Issued by :
James Allan
Project Manager

Signature Not Verified
Digitally signed by James Allan
Date: 2014.09.22 17:40:41 BST
Reason: Issue
Location: SAL

SAL Reference: 422199
Project Site: Date Collected: 9/9/14
Customer Reference: 71779

Filter Quartz 37mm Analysed as Filter Quartz 37mm
Miscellaneous

				SAL Reference	422199 006	422199 019	422199 024
				Customer Sample Reference	71779/3	71779/10	71779/13
				Test Sample	AR	AR	AR
				Filter Reference	131	132	133
Determinand	Method	LOD	Units	Symbol			
Particulates (Total)	Grav (5 Dec)	0.05	mg	U	<0.05	<0.05	<0.05

SAL Reference: 422199
Project Site: Date Collected: 9/9/14
Customer Reference: 71779

Tube (Charcoal 226-09) Analysed as Tube (Charcoal 226-09)
Suite B

				SAL Reference	422199 001	422199 002	422199 004	422199 005	422199 007
				Customer Sample Reference	71779/1 FRONT	71779/1 BACK	71779/2 FRONT	71779/2 BACK	71779/4 FRONT
				Test Sample	AR	AR	AR	AR	AR
Determinand	Method	LOD	Units	Symbol					
Ethyl acrylate	GC/MS	5	µg	U	<5	<5	<5	<5	<5
Methyl acrylate	GC/MS	5	µg	U	<5	<5	<5	<5	6
VOC (Total excluding targets)	GC/MS	1	µg	N	440	7	<1	<1	3600

SAL Reference: 422199
Project Site: Date Collected: 9/9/14
Customer Reference: 71779

Tube (Charcoal 226-09) Analysed as Tube (Charcoal 226-09)
Suite B

				SAL Reference	422199 008	422199 009	422199 010	422199 011	422199 012
				Customer Sample Reference	71779/4 BACK	71779/5 FRONT	71779/5 BACK	71779/6 FRONT	71779/6 BACK
				Test Sample	AR	AR	AR	AR	AR
Determinand	Method	LOD	Units	Symbol					
Ethyl acrylate	GC/MS	5	µg	U	<5	<5	<5	<5	<5
Methyl acrylate	GC/MS	5	µg	U	<5	<5	<5	<5	<5
VOC (Total excluding targets)	GC/MS	1	µg	N	<1	99	<1	3900	<1

SAL Reference: 422199
Project Site: Date Collected: 9/9/14
Customer Reference: 71779

Tube (Charcoal 226-09) Analysed as Tube (Charcoal 226-09)
Suite B

				SAL Reference	422199 013	422199 014	422199 015	422199 016	422199 017
				Customer Sample Reference	71779/7 FRONT	71779/7 BACK	71779/8 FRONT	71779/8 BACK	71779/9 FRONT
				Test Sample	AR	AR	AR	AR	AR
Determinand	Method	LOD	Units	Symbol					
Ethyl acrylate	GC/MS	5	µg	U	<5	<5	<5	<5	<5
Methyl acrylate	GC/MS	5	µg	U	<5	<5	<5	<5	<5
VOC (Total excluding targets)	GC/MS	1	µg	N	180	<1	7500	<1	350

SAL Reference: 422199
Project Site: Date Collected: 9/9/14
Customer Reference: 71779

Tube (Charcoal 226-09) Analysed as Tube (Charcoal 226-09)
Suite B

					SAL Reference	422199 018	422199 020	422199 021	422199 022	422199 023
					Customer Sample Reference	71779/9 BACK	71779/11 FRONT	71779/11 BACK	71779/12 FRONT	71779/12 BACK
					Test Sample	AR	AR	AR	AR	AR
Determinand	**Method**	**LOD**	**Units**	**Symbol**						
Ethyl acrylate	GC/MS	5	µg	U		<5	<5	<5	<5	<5
Methyl acrylate	GC/MS	5	µg	U		<5	<5	<5	<5	<5
VOC (Total excluding targets)	GC/MS	1	µg	N		<1	18	<1	<1	<1

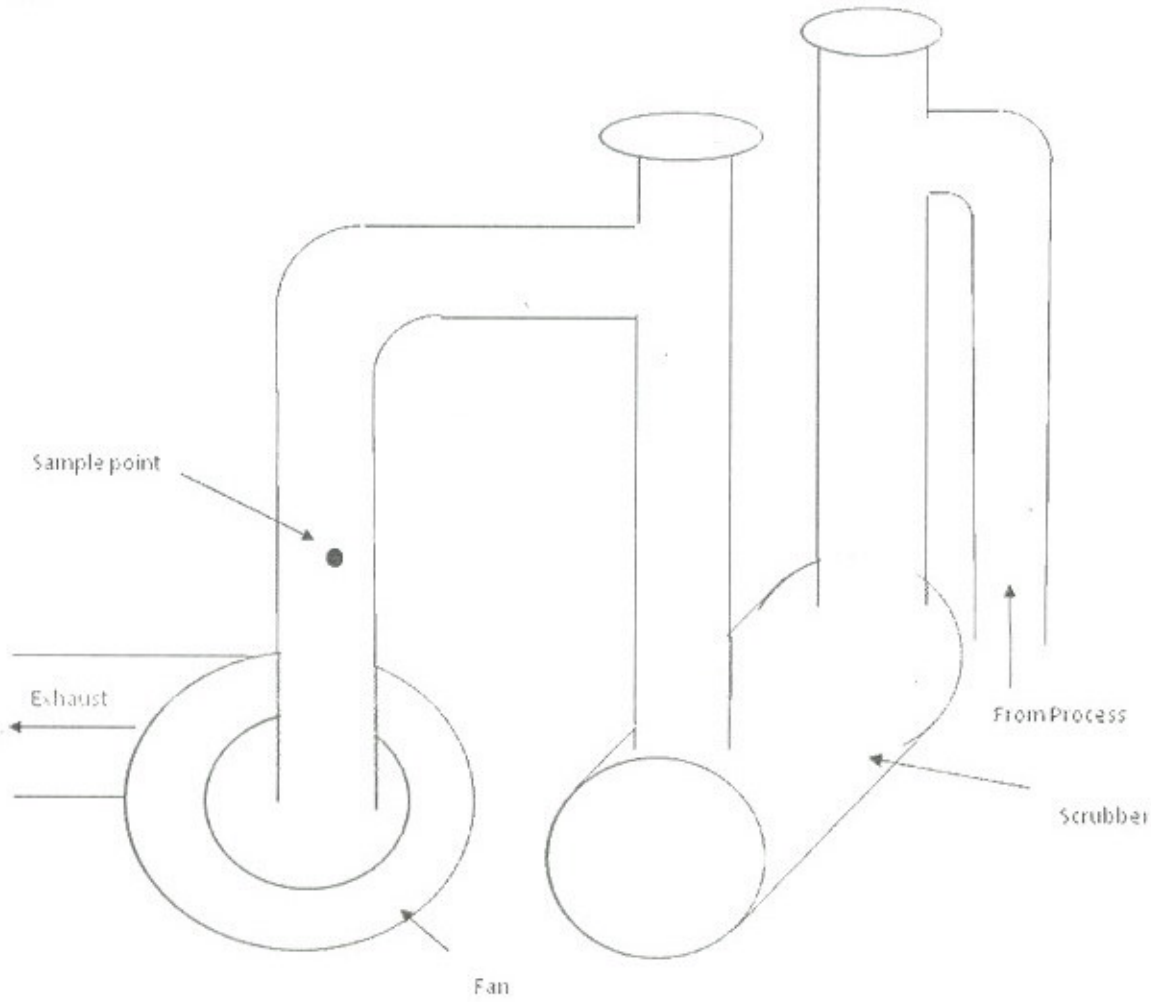
Index to symbols used in 422199-1

Value	Description
AR	As Received
U	Analysis is UKAS accredited
N	Analysis is not UKAS accredited

APPENDIX 2

Diagrams of Sampling Points

A1



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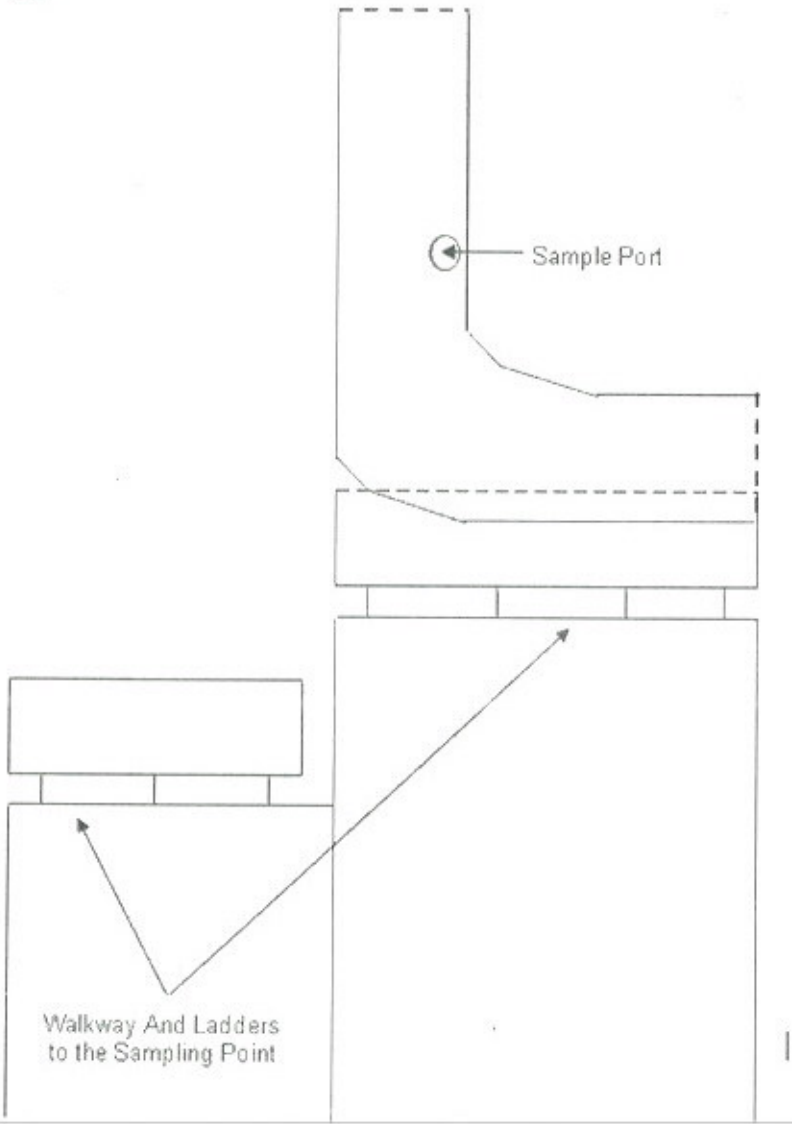

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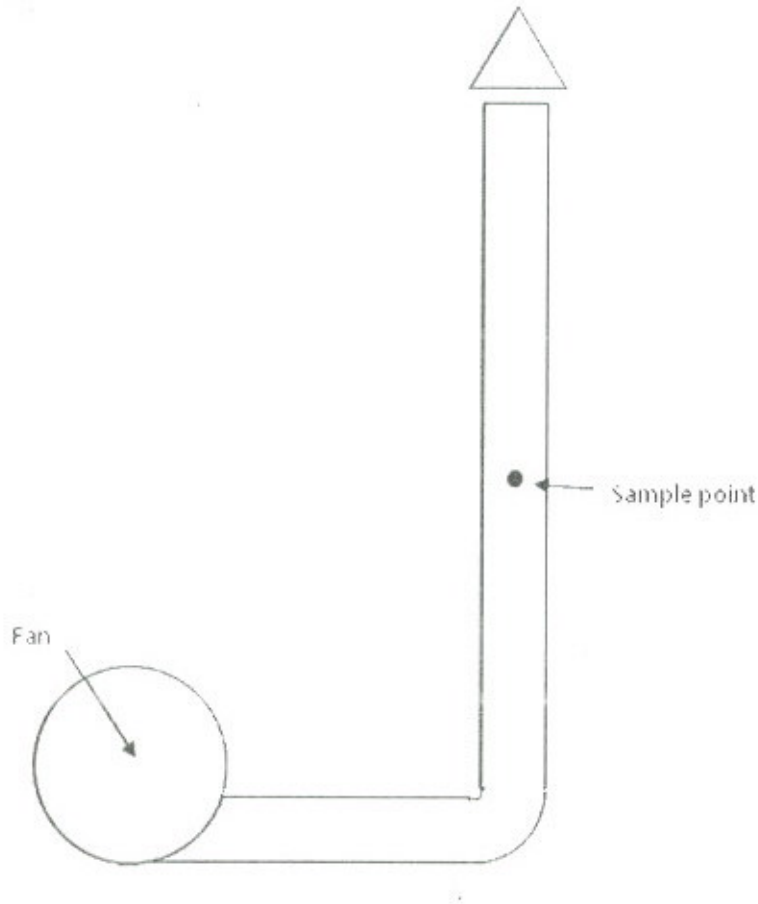

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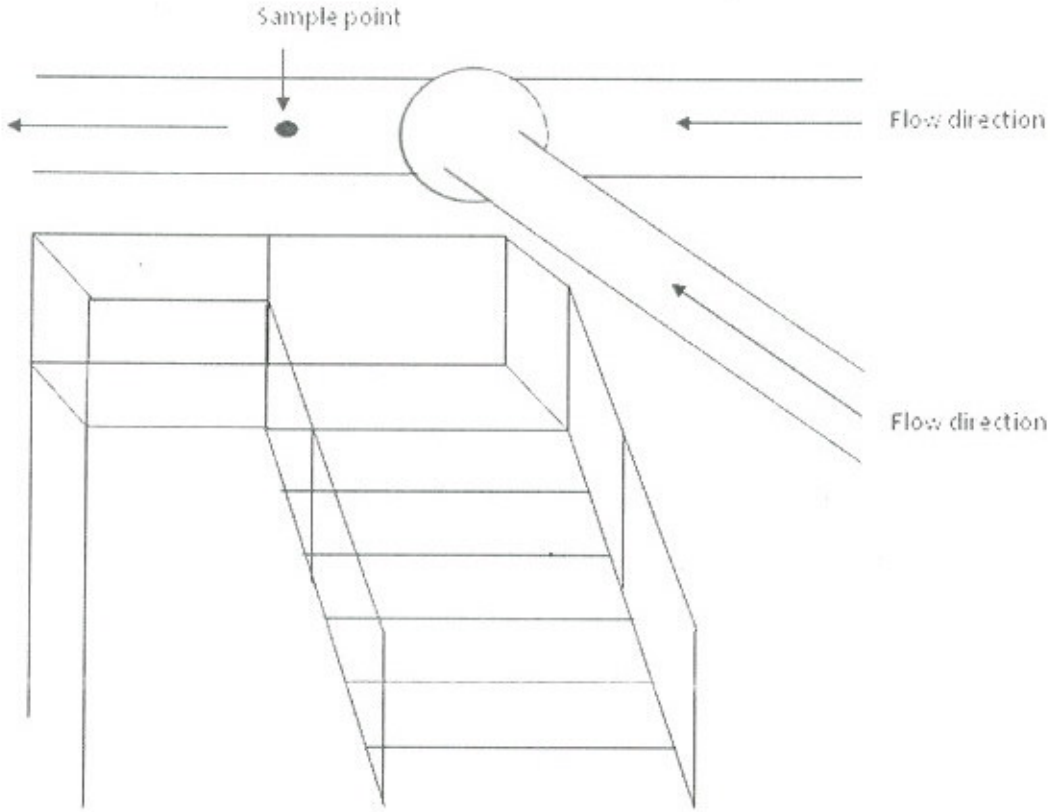

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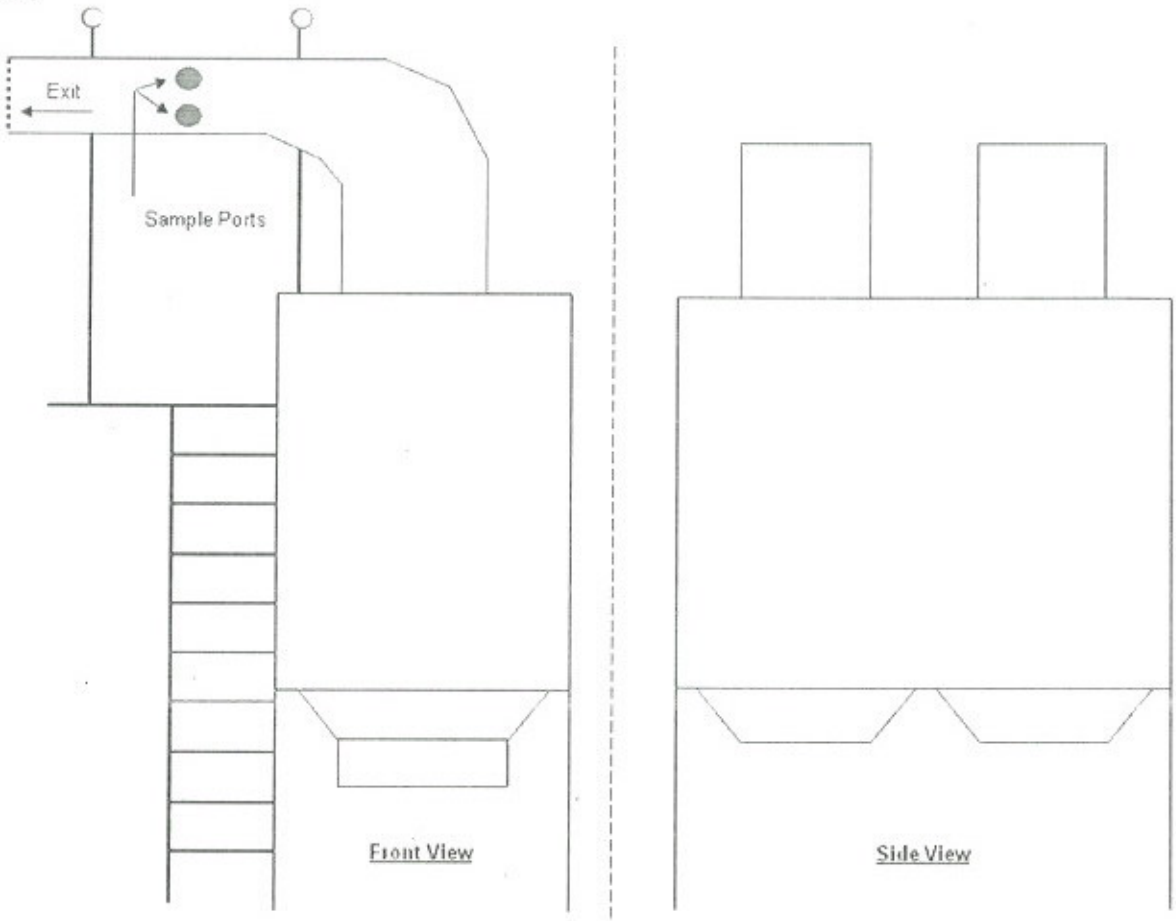

APPENDIX 3

Calculations

Conversion Factors

ppm ® mg/Nm³ (at 273K, 101.3kPa: STP)			
CO	x	1.25	
SO_2	x	2.86	
VOC's	x	1.61	(ppm as C_3H_8 to mg/Nm^3 as C)
NO_X	x	2.05	(ppm NO + NO_2 to mg/m^3 as NO_2)

Oxygen Correction to Reference Value

Concentration at (STP) -> Concentration at 273K, 101.3kPa, reference O_2 and Dry Gas, i.e.

Concentration X ((20.9-O_2 ref)/(20.9-O_2 measured)) = Concentration at ref Oxygen state.

Example Calculation

SO_2 concentration at STP	=	170.7 mg/Nm³
Oxygen percentage in gas stream	=	13.8%
Reference Oxygen	=	11%
SO_2 concentration at reference O_2 conditions	=	170.7 ((20.9-11)/(20.9-13.8))
	=	238 mg/Nm³ at 273K, 101.3kPa, 11% O_2 and Dry Gas

Moisture Correction (Wet to Dry)

Concentration of Gas Dry = Concentration of x 100/100-Bws Gas Wet

Concentration of Gas Wet = Concentration of x 100-Bws/100 Gas Dry

Where Bws = moisture content of gas stream in percent (Vol/Vol).

Example

VOC concentration	=	25 mg/Nm³ (Wet)
Moisture Content	=	27.1%
Concentration of VOC	=	25 (100/(100-27.1))

Carbon (C) to Trichloethylene (TCE)

ppm TCE = ppm C x 0.6715

TCE in mg/m^3 = TCE ppm x 5.864 (Mol Wt/22.4)