



Resource & Environmental Consultants Ltd



MONITORING OF EMISSIONS FROM THE PAINT & LACQUER PRODUCTION PROCESS

26 March, 2015 (QUARTER 1)

Prepared for Valspar Corporation (UK) Ltd

REC Report EM-02840p1r0

Issued: 29 May, 2015



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Sampling identified as UKAS accredited was conducted in accordance with REC Ltd accredited Monitoring Methods.

Analyses identified as UKAS accredited were conducted by REC or approved sub-contractors in accordance with their SOPs

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Issued: 29 May, 2015

Reference: EM 02840p1r0

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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	1233.4	0.580	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/Nm³ 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	<0.1	<0.4	11.1
Ethyl acrylate	B	<0.3	<0.2	<0.2
Methyl acrylate	B	<0.3	<0.2	<0.2

NOTE 1: All data are expressed in mg/Nm³ 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	<0.00003	<0.0002	0.004	2.0 kg/hr
Ethyl acrylate (g/hr)	B	<0.2	<0.2	<0.2	100 g/hr
Methyl acrylate (g/hr)	B	<0.2	<0.2	<0.2	100 g/hr

NOTE 1: All data are expressed in mg/Nm³ 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)
		A1	A6	
Particulate Matter	D	2.4	18.4	20

NOTE 1: All data are expressed in mg/Nm³ 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:-

- Rob Jones - Team Leader, MM08 984, MCERTS Level 2, TE1 – 4
- Michael Stiff Site Assistant, MM 14 1318, MCERTS Trainee

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 $\pm 25\%$.

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 $\frac{1}{3}$ 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 ($\mu\text{g}/\text{tube}$) 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.

3.3 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 Natural Resources Wales, 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:

28Q07AD, 32S02ADO3, 4000W56R/21BDIL, , 4800AQO7R, 28Q46AH, M22780, 33Q03EC.

During this quarter's monitoring visit the resin plant was undergoing maintenance and was not in operation. Monitoring was still conducted at request of the client.

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

3.4 Uncertainty

Standard methods were fully complied with for all sampling with the exception of A1 TVOCs run, where greater than 5% of the total result was found on the rear section of the tube. This is a deviation to the standard and will increase uncertainties above the quoted value for this result. Standard uncertainties apply to remaining results.

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 1/3 and three times the concentration quoted.

3.4 Emission Monitoring Survey Details

The emission monitoring survey was carried out on the processes on 28 November, 2014. The table below summarises the actual sampling periods.

SAMPLING PERIODS

Stack	Parameter	Sample Time (& Date)
A1	Total & Target VOCs	11:00 – 12:04 (23/3/15)
	Particulates	10:40 – 11:40 (23/3/15)
A2	Total & Target VOCs	10:40 – 11:42 (23/3/15)
A3	Total & Target VOCs	12:17 – 13:17 (23/3/15)
A5	Total & Target VOCs	12:11 – 13:11 (23/3/15)
A6	Particulates	12:09 – 13:31 (23/3/15)

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 (m³/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/m³ 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/m³ 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.

Greater than 5% of the total mass of VOCs were found on the rear section of the A1 TVOC run. This is a deviation to the standard and will increase the uncertainty of the result above that quoted.

4.4 Target VOC Emission Data

The results of the target VOC monitoring tests for Methyl Acrylate and Ethyl Acrylate 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/m³ 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	16	10	0.031	4.1	462	435
A2	14	15	0.031	5.0	565	534
A3	11	167	0.006	16.5	357	337
A5	14	15	0.023	5.8	470	443
A6	15	21	0.168	5.9	3,540	3,358

TABLE 2**PARTICULATE EMISSION DATA**

Sampling Data	A1	A6
Start Time/Date	10:40, 26/03/15	12:09, 26/03/15
End Time/Date	11:40, 26/03/15	13:31, 26/03/15
Sampling Period (min)	60	82.00
DGM start (dry m ³)	88.730	89.020
DGM end (dry m ³)	89.019	89.310
Volume Sampled (dry m ³)	0.289	0.290
Ambient Temp (°C)	12	14
Ambient Press (kPa)	100.7	100.7
Volume Sampled, 273K, 101.3kPa (m ³)	0.275	0.274
Analytical Data		
Wt gain filter (mg)	0.05	0.05
Wt gain rinse (mg)	0.60	5.00
Total particulate matter (mg)	0.65	5.05
Emission Concentration Data		
Particulates (mg/m ³)	2.4	18.4

Bold type denotes a result above the limit of detection of the analysis method

TABLE 3

VOC EMISSION DATA

Sampling Data	A1	A2	A3	A5
DGM Ref (AQ No.)	336	335	203	203
Start Time	26/03/2015 11:00	26/03/2015 10:40	26/03/2015 12:17	26/03/2015 12:11
End Time	26/03/2015 12:04	26/03/2015 11:42	26/03/2015 13:17	26/03/2015 13:11
DGM Start (m ³)	84744.0	6645.6	84776.0	6684.0
DGM End (m ³)	84775.0	6675.8	84799.5	6701.0
Volume Sampled (litres)	31.000	30.200	23.500	17.000
Ambient Temp (°C)	12	10	10	11
Ambient Press (kPa)	100.7	100.7	100.7	100.7
Volume Sampled, 273K, 101.3kPa (litres)	29.519	28.960	22.535	16.245
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 (%)	50.0	50.0	50.0	50.0
Methyl Acrylate on tube front section (µg)	5	5	5	5
Methyl Acrylate on tube rear section (µg)	5	5	5	5
Mass on Back-up Section (%)	50.0	50.0	50.0	50.0
Total VOCs on tube front section (µg)	1	10	250	20,000
Total VOCs on tube rear section (µg)	1	1	1	36
Mass on Back-up Section (%)	50.0	9.1	0.4	0.2
Emission Concentration Data				
Ethyl Acrylate (mg/m ³)	0.3	0.3	0.4	0.6
Uncertainty (± mg/m ³)	0.1	0.1	0.1	0.2
Methyl Acrylate (mg/m ³)	0.3	0.3	0.4	0.6
Uncertainty (± mg/m ³)	0.1	0.1	0.1	0.2
Total VOCs(mg/m ³)	0.1	0.4	11.1	1233.4
Uncertainty (± mg/m ³)	0.0 0.2	0.1 1.1	3.3 33.4	370.0 3700.1
Volume Flowrate (m ³ /hr)	462	565	357	470
Ethyl Acrylate (g/hr)	0.2	0.2	0.2	0.3
Methyl Acrylate (g/hr)	0.2	0.2	0.2	0.3
Total VOCs (kg/hr)	0.000	0.000	0.004	0.580

Bold type denotes a result above the limit of detection of the analysis method

APPENDIX 1

Certificate of Analysis



Scientific Analysis Laboratories Ltd

Certificate of Analysis

Hadfield House
Hadfield Street
Cornbrook
Manchester
M16 9FE
Tel : 0161 874 2400
Fax : 0161 874 2404

Scientific Analysis Laboratories is a
limited company registered in England and
Wales (No 2514788) whose address is at
Hadfield House, Hadfield Street, Manchester M16 9FE

Report Number: 466536-1

Date of Report: 02-Apr-2015

Customer: REC Environmental Monitoring Ltd
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Customer Contact: Mr Rob Jones

Customer Job Reference: 02840

Date Job Received at SAL: 27-Mar-2015

Date Analysis Started: 01-Apr-2015

Date Analysis Completed: 02-Apr-2015

The results reported relate to samples received in the laboratory
Opinions and interpretations expressed herein are outside the scope of UKAS accreditation
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Tests covered by this certificate were conducted in accordance with SAL SOPs
All results have been reviewed in accordance with QP22



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Report checked
and authorised by :
Michael Goodman
Project Management

Issued by :
Kayleigh McCann
Project Manager

SAL Reference: 466536 Customer Reference: 02840 Filter Quartz 37mm Analysed as Filter Quartz 37mm Miscellaneous						
SAL Reference		466536 005	466536 011			
Customer Sample Reference		02840/5	02840/11			
Test Sample		AR	AR			
Date Sampled		26-MAR-2015	26-MAR-2015			
Determinand	Method	LOD	Units	Symbol		
Particulates (Total)	Grav (5 Dec)	0.05	mg	U	(44) <0.05	(44) <0.05

SAL Reference: 466536 Customer Reference: 02840 Wash(Acetone) Analysed as Wash(Acetone) Miscellaneous						
SAL Reference		466536 006	466536 012			
Customer Sample Reference		02840/6	02840/12			
Test Sample		AR	AR			
Date Sampled		26-MAR-2015	26-MAR-2015			
Determinand	Method	LOD	Units	Symbol		
Particulates (Total)	Grav	0.3	mg	U	0.6	5.0

SAL Reference: 466536										
Customer Reference: 02840										
Tube (Charcoal 226-09) Analysed as Tube (Charcoal 226-09)										
Suite A										
SAL Reference				466536 001	466536 002	466536 003	466536 004	466536 007		
Customer Sample Reference				02840/1	02840/2	02840/3	02840/4	02840/7		
Test Sample				AR	AR	AR	AR	AR		
Date Sampled				26-MAR-2015	26-MAR-2015	26-MAR-2015	26-MAR-2015	26-MAR-2015		
Determinand		Method	LOD	Units	Symbol					
Ethyl acrylate	GC/MS	5	µg	U	<5	<5	<5	<5	<5	<5
Methyl acrylate	GC/MS	5	µg	U	<5	<5	<5	<5	<5	<5
VOC (Total excluding targets)	GC/MS	1	µg	N	<1	<1	10	<1		250

SAL Reference: 466536 Customer Reference: 02840 Tube (Charcoal 226-09) Analysed as Tube (Charcoal 226-09) Suite A									
SAL Reference		466536 008	466536 009	466536 010	466536 013				
Customer Sample Reference		02840/8	02840/9	02840/10	02840/13				
Test Sample		AR	AR	AR	AR				
Date Sampled		26-MAR-2015	26-MAR-2015	26-MAR-2015	26-MAR-2015				
Determinand	Method	LOD	Units	Symbol					
Ethyl acrylate	GC/MS	5	µg	U	<5	<5	<5	<5	
Methyl acrylate	GC/MS	5	µg	U	<5	<5	<5	<5	
VOC (Total excluding targets)	GC/MS	1	µg	N	<1	(37) 20000	36	<1	

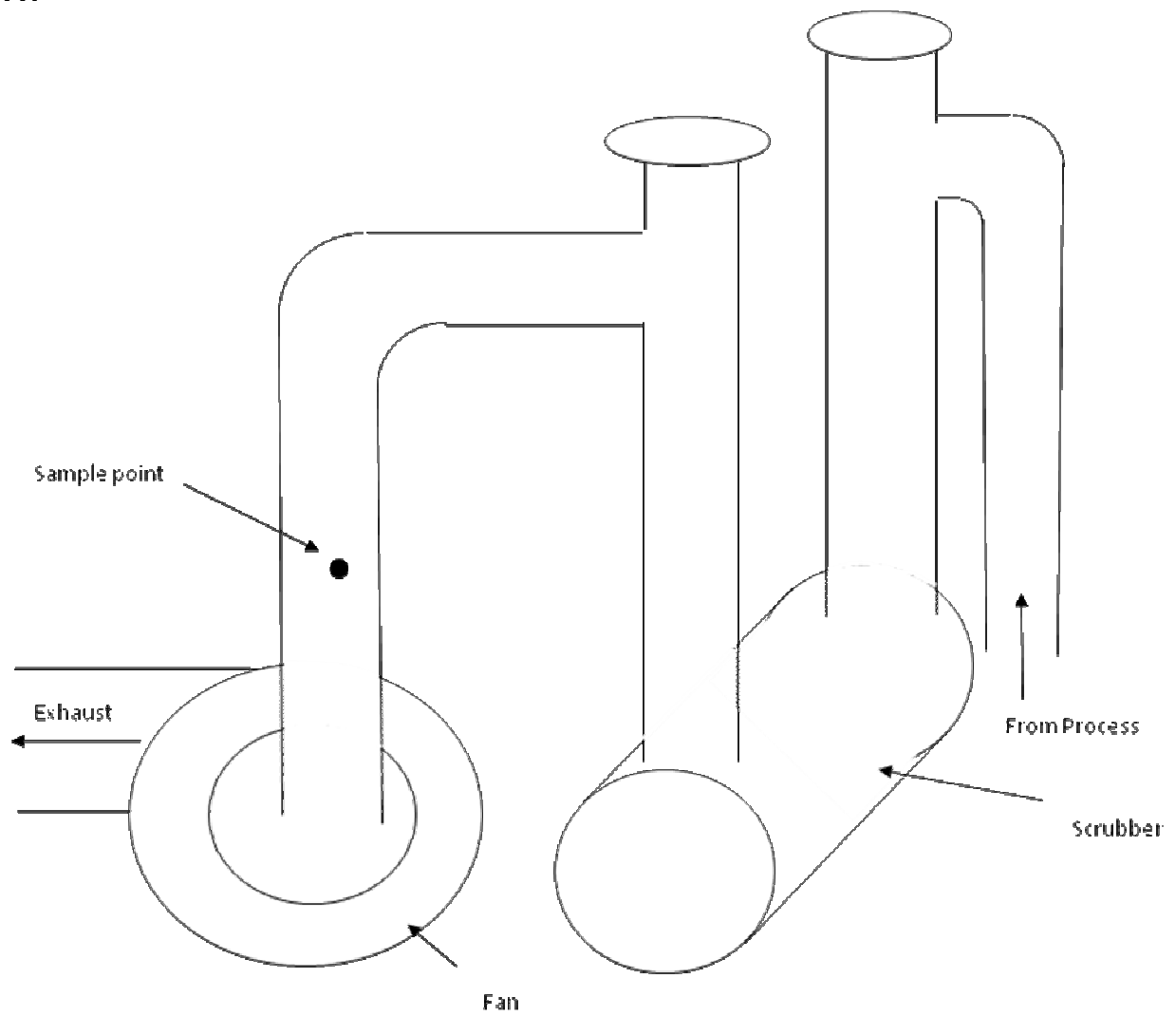
Index to symbols used in 466536-1

Value	Description
AR	As Received
44	Filter received damaged, may lead to erroneous results.
37	There was >10% found on the back section of the tube
U	Analysis is UKAS accredited
N	Analysis is not UKAS accredited

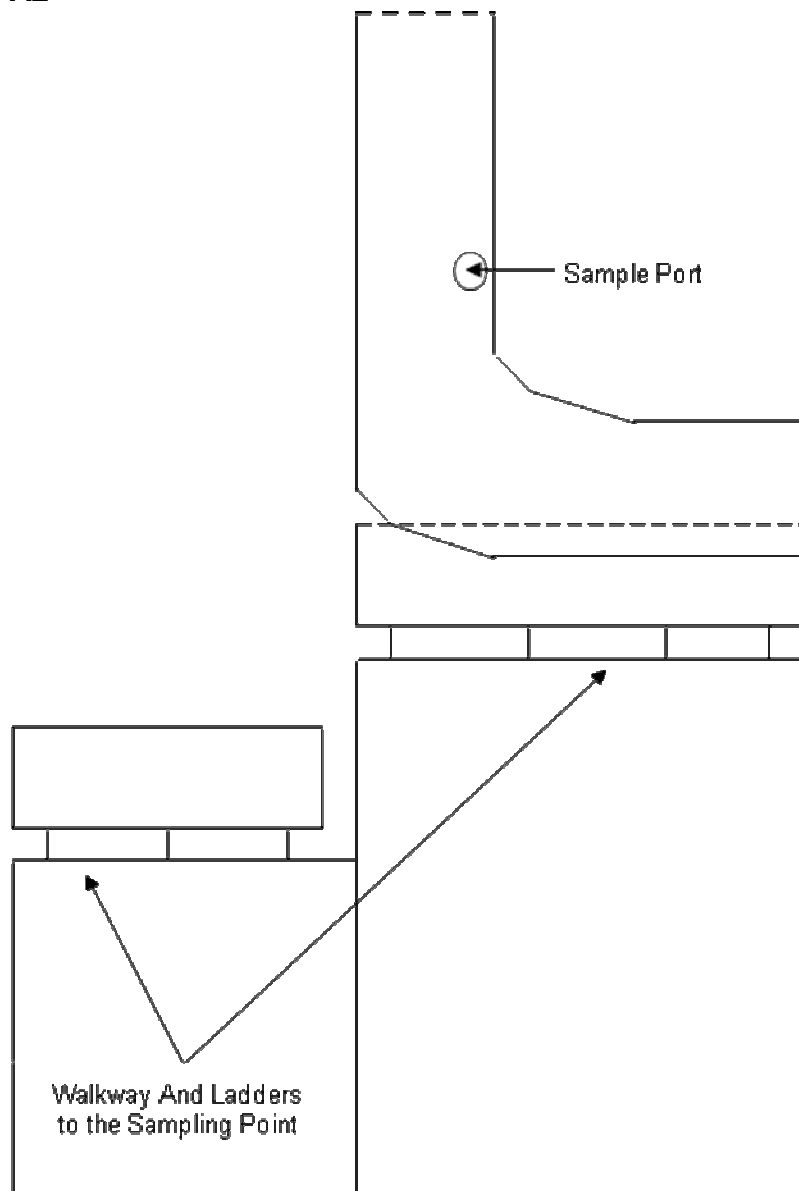
APPENDIX 2

Diagrams of Sampling Points

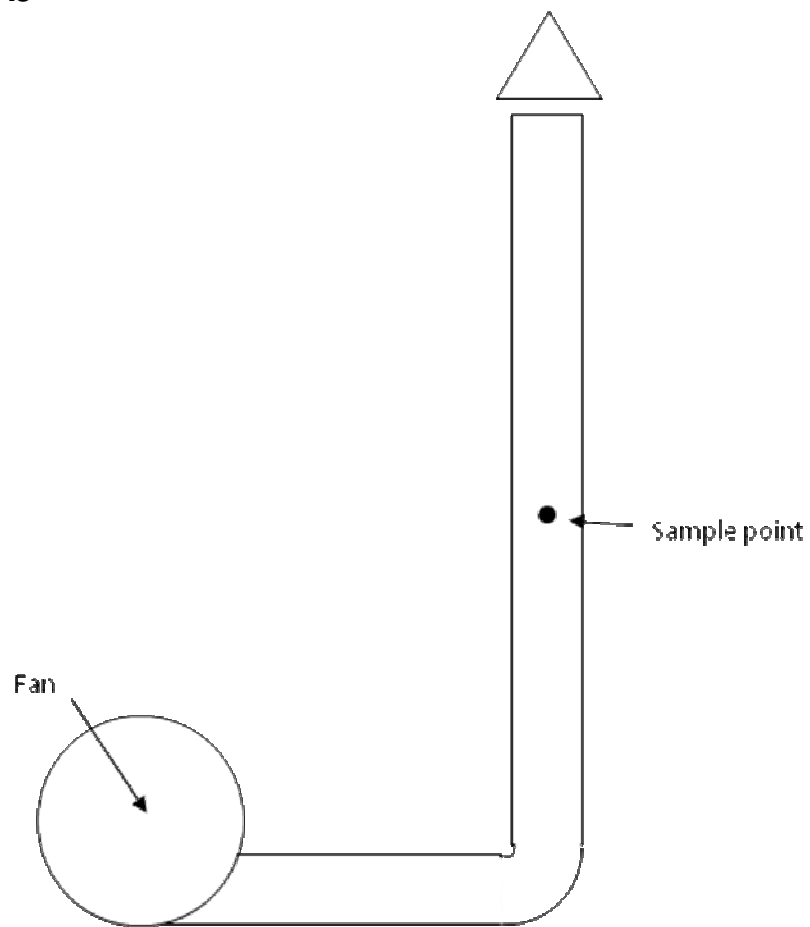
A1



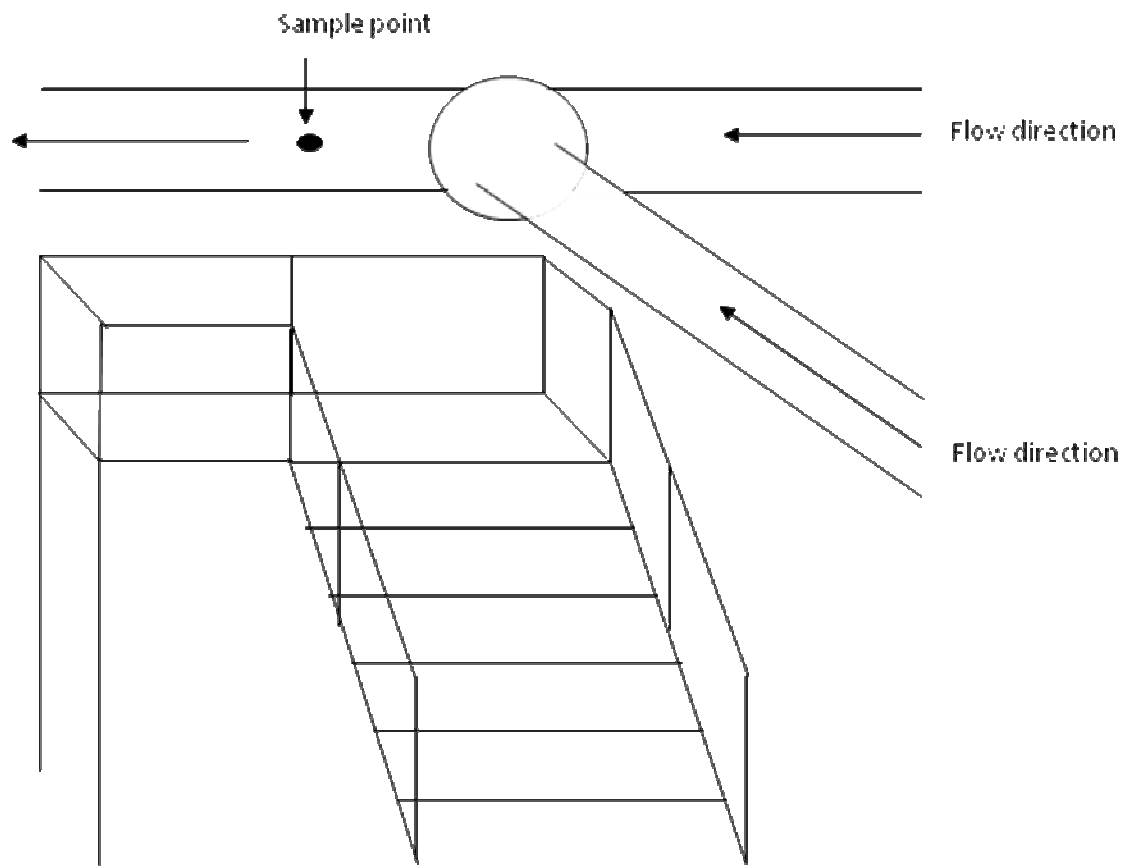
A2



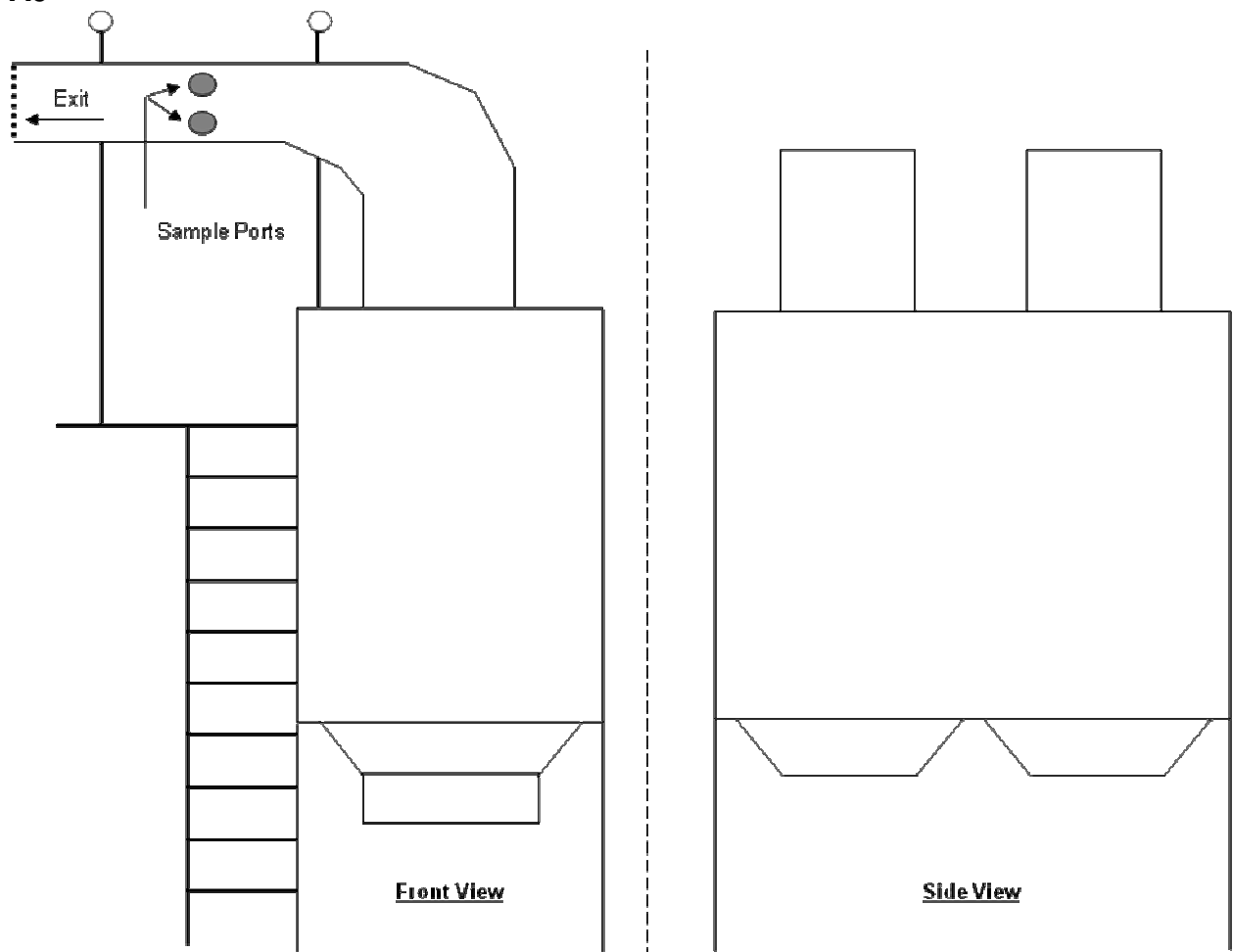
A3



A5



A6



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 ₃ H 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 O₂ and Dry Gas, i.e.

Concentration X ((20.9-O₂ ref)/(20.9-O₂ measured)) = Concentration at ref Oxygen state.

Example Calculation

SO ₂ concentration at STP	=	170.7 mg/Nm ³
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/Nm ³ 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/Nm ³ (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/m³ = TCE ppm x 5.864 (Mol Wt/22.4)