



Resource & Environmental Consultants Ltd



## **MONITORING OF EMISSIONS FROM THE PAINT & LACQUER PRODUCTION PROCESS**

**28 NOVEMBER, 2014 (QUARTER 4)**

**Prepared for Valspar Corporation (UK) Ltd**

**REC Report 71779p3r0**

**Issued: 12 January, 2015**



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**1783**

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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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## 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 <sup>3</sup> ) | Mass Emission Rate | Permit Emission Rate Limit |
|------------------------|-------------|------------------------------------------------------|--------------------|----------------------------|
|                        |             | A5                                                   | A5                 |                            |
| Total VOCs (as carbon) | C           | 786.2                                                | 0.353              | 2.0 kg/hr                  |
| Ethyl acrylate         | B           | 0.4                                                  | 0.2                | 100 g/hr                   |
| Methyl acrylate        | B           | 0.4                                                  | 0.2                | 100 g/hr                   |

**NOTE 1:** All data are expressed in mg/Nm<sup>3</sup> 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 <sup>3</sup> ) |       |       |
|------------------------|-------------|------------------------------------------------------|-------|-------|
|                        |             | A1                                                   | A2    | A3    |
| Total VOCs (as carbon) | C           | 1964.3                                               | 104.3 | 337.2 |
| Ethyl acrylate         | B           | 0.4                                                  | 0.5   | 0.5   |
| Methyl acrylate        | B           | 0.4                                                  | 0.5   | 0.5   |

**NOTE 1:** All data are expressed in mg/Nm<sup>3</sup> 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           | 0.84               | 0.054 | 0.113 | 2.0 kg/hr                  |
| Ethyl acrylate (g/hr)        | B           | 0.2                | 0.3   | 0.2   | 100 g/hr                   |
| Methyl acrylate (g/hr)       | B           | 0.2                | 0.3   | 0.2   | 100 g/hr                   |

**NOTE 1:** All data are expressed in mg/Nm<sup>3</sup> 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 <sup>3</sup> ) |     | Permit Limit (mg/Nm <sup>3</sup> ) |
|--------------------|-------------|------------------------------------------------------|-----|------------------------------------|
|                    |             | A1                                                   | A6  |                                    |
| Particulate Matter | D           | 4.4                                                  | 6.6 | 20                                 |

**NOTE 1:** All data are expressed in mg/Nm<sup>3</sup> 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

## 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 <sup>3</sup>   |
| Methyl Acrylate + Ethyl Acrylate | B                    | In house method MM0011 based on BS EN 13649 | 30            | 0.1 mg/m <sup>3</sup> |
| Total VOCs                       | C                    | In house method MM0011 based on BS EN 13649 | 33 to 300     | 0.1 mg/m <sup>3</sup> |

**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:

11Q23EY, 28Q07AD, 32S02AD, 4000W56R/21BDIL, WE0251P, WE0912P.

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  $\frac{1}{3}$  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 | 10:30 – 11:20 (28/11/14) |
|       | Particulates        | 10:32 – 11:32 (28/11/14) |
| A2    | Total & Target VOCs | 12:30 – 13:30 (28/11/14) |
| A3    | Total & Target VOCs | 12:16 – 13:16 (28/11/14) |
| A5    | Total & Target VOCs | 10:53 – 11:53 (28/11/14) |
| A6    | Particulates        | 12:31 – 13:31 (28/11/14) |

## 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<sup>3</sup>/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<sup>3</sup> 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<sup>3</sup> 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/m<sup>3</sup> at the standard reference conditions of 273K, 101.3kPa without correction for water vapour or oxygen content.

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

## TABLES

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**TABLE 1****FLOW DATA**

| Stack Ref. | Stack Temp | Av Pitot $\Delta P$ | X-Sect. Area      | Velocity (actual) | Volume Flow (m <sup>3</sup> /hr) |         |
|------------|------------|---------------------|-------------------|-------------------|----------------------------------|---------|
|            | (°C)       | (Pa)                | (m <sup>2</sup> ) | (m/s)             | (actual)                         | (@ ntp) |
| A1         | 16         | 10                  | 0.031             | 4.0               | 451                              | 428     |
| A2         | 14         | 15                  | 0.031             | 5.0               | 557                              | 519     |
| A3         | 12         | 162                 | 0.006             | 16.2              | 351                              | 334     |
| A5         | 14         | 20                  | 0.023             | 5.7               | 473                              | 449     |
| A6         | 15         | 17                  | 0.168             | 5.2               | 3,160                            | 2,997   |

**TABLE 2****PARTICULATE EMISSION DATA**

| Sampling Data                                    | A1              | A6              |
|--------------------------------------------------|-----------------|-----------------|
| Start Time/Date                                  | 10:32, 28/11/14 | 12:31, 28/11/14 |
| End Time/Date                                    | 11:32, 28/11/14 | 13:31, 28/11/14 |
| Sampling Period (min)                            | 60              | 60              |
| DGM start (dry m <sup>3</sup> )                  | 83672.400       | 83982.400       |
| DGM end (dry m <sup>3</sup> )                    | 83970.400       | 84287.800       |
| Volume Sampled (dry m <sup>3</sup> )             | 0.298           | 0.305           |
| Ambient Temp (°C)                                | 12              | 11              |
| Ambient Press (kPa)                              | 101.2           | 101.2           |
| Volume Sampled, 273K, 101.3kPa (m <sup>3</sup> ) | 0.285           | 0.293           |
| Analytical Data                                  |                 |                 |
| Wt gain filter (mg)                              | 0.05            | 0.05            |
| Wt gain rinse (mg)                               | 1.20            | 1.90            |
| Total particulate matter (mg)                    | 1.25            | 1.95            |
| Emission Concentration Data                      |                 |                 |
| Particulates (mg/m <sup>3</sup> )                | 4.4             | 6.6             |

**TABLE 3****VOC EMISSION DATA**

| <b>Sampling Data</b>                       | <b>A1</b>           | <b>A2</b>           | <b>A3</b>           | <b>A5</b>           |
|--------------------------------------------|---------------------|---------------------|---------------------|---------------------|
| DGM Ref (AQ No.)                           | GM-44               | GM-44               | 203                 | 203                 |
| Start Time                                 | 28/11/2014<br>10:30 | 28/11/2014<br>12:30 | 28/11/2014<br>12:16 | 28/11/2014<br>10:53 |
| End Time                                   | 28/11/2014<br>11:20 | 28/11/2014<br>13:30 | 28/11/2014<br>13:16 | 28/11/2014<br>11:53 |
| DGM Start (m <sup>3</sup> )                | 7399.4              | 7426.4              | 766698.0            | 736241.0            |
| DGM End (m <sup>3</sup> )                  | 7426.0              | 7446.4              | 792687.0            | 766684.0            |
| Volume Sampled (litres)                    | 26.600              | 20.000              | 20.012              | 23.441              |
| Ambient Temp (°C)                          | 12                  | 11                  | 10                  | 10                  |
| Ambient Press (kPa)                        | 101.2               | 101.2               | 101.2               | 101.2               |
| Volume Sampled, 273K, 101.3kPa (litres)    | 25.455              | 19.206              | 19.285              | 22.590              |
| <b>Analytical Data</b>                     |                     |                     |                     |                     |
| 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)      | 40,000              | 2,002               | 6,502               | 17,760              |
| Total VOCs on tube rear section (µg)       | 10,000              | 1                   | 1                   | 1                   |
| Mass on Back-up Section (%)                | 20.0                | 0.0                 | 0.0                 | 0.0                 |
| <b>Emission Concentration Data</b>         |                     |                     |                     |                     |
| Ethyl Acrylate (mg/m <sup>3</sup> )        | 0.4                 | 0.5                 | 0.5                 | 0.4                 |
| Uncertainty (± mg/m <sup>3</sup> )         | 0.1                 | 0.2                 | 0.2                 | 0.1                 |
| Methyl Acrylate (mg/m <sup>3</sup> )       | 0.4                 | 0.5                 | 0.5                 | 0.4                 |
| Uncertainty (± mg/m <sup>3</sup> )         | 0.1                 | 0.2                 | 0.2                 | 0.1                 |
| Total VOCs(mg/m <sup>3</sup> )             | 1964.3              | 104.3               | 337.2               | 786.2               |
| Uncertainty (± mg/m <sup>3</sup> )         | 589.3   5893        | 31.3   312.9        | 101.2   1012        | 235.9   2359        |
| Volume Flowrate (m <sup>3</sup> /hr)       | 428                 | 519                 | 334                 | 449                 |
| Ethyl Acrylate (g/hr)                      | 0.2                 | 0.3                 | 0.2                 | 0.2                 |
| Methyl Acrylate (g/hr)                     | 0.2                 | 0.3                 | 0.2                 | 0.2                 |
| Total VOCs (kg/hr)                         | 0.840               | 0.054               | 0.113               | 0.353               |

# **APPENDIX 1**

## **Certificate of Analysis**

# Scientific Analysis Laboratories Ltd

## Certificate of Analysis

Hadfield House  
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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:** 440073-1

**Date of Report:** 15-Dec-2014

**Customer:** REC Environmental Monitoring Ltd  
Osprey House  
Pacific Quay  
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Salford  
M50 2UE

**Customer Contact:** Mr Rob Jones

**Customer Job Reference:** 71779

**Customer Site Reference:** 28/11/14

**Date Job Received at SAL:** 01-Dec-2014

**Date Analysis Started:** 02-Dec-2014

**Date Analysis Completed:** 15-Dec-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



Report checked  
and authorised by :  
Kayleigh McCann  
Project Manager

Issued by :  
Kayleigh McCann  
Project Manager

**Signature valid**

Digitally signed by Kayleigh  
McCann  
Date: 2014.12.15 16:39:38 GMT  
Reason: Issue  
Location: SAL

|                                                                                                                                                                                           |               |            |              |               |                   |                   |                   |                   |
|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------|------------|--------------|---------------|-------------------|-------------------|-------------------|-------------------|
| <b>SAL Reference:</b> 440073<br><b>Project Site:</b> 28/11/14<br><b>Customer Reference:</b> 71779<br><br><b>Filter Quartz 37mm</b> Analysed as Filter Quartz 37mm<br><b>Miscellaneous</b> |               |            |              |               |                   |                   |                   |                   |
| <b>SAL Reference</b>                                                                                                                                                                      |               |            |              |               | <b>440073 009</b> | <b>440073 010</b> | <b>440073 013</b> | <b>440073 014</b> |
| <b>Customer Sample Reference</b>                                                                                                                                                          |               |            |              |               | <b>71779/9</b>    | <b>71779/10</b>   | <b>71779/13</b>   | <b>71779/14</b>   |
| <b>Test Sample</b>                                                                                                                                                                        |               |            |              |               | <b>AR</b>         | <b>AR</b>         | <b>AR</b>         | <b>AR</b>         |
| <b>Determinand</b>                                                                                                                                                                        | <b>Method</b> | <b>LOD</b> | <b>Units</b> | <b>Symbol</b> |                   |                   |                   |                   |
| Particulates (Total)                                                                                                                                                                      | Grav (5 Dec)  | 0.05       | mg           | U             | <0.05             | <0.05             | <0.05             | <0.05             |

|                                                                                                                                                                                 |               |            |              |               |                   |                   |                   |                   |
|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------|------------|--------------|---------------|-------------------|-------------------|-------------------|-------------------|
| <b>SAL Reference:</b> 440073<br><b>Project Site:</b> 28/11/14<br><b>Customer Reference:</b> 71779<br><br><b>Wash(Acetone)</b> Analysed as Wash(Acetone)<br><b>Miscellaneous</b> |               |            |              |               |                   |                   |                   |                   |
| <b>SAL Reference</b>                                                                                                                                                            |               |            |              |               | <b>440073 011</b> | <b>440073 012</b> | <b>440073 015</b> | <b>440073 016</b> |
| <b>Customer Sample Reference</b>                                                                                                                                                |               |            |              |               | <b>71779/11</b>   | <b>71779/12</b>   | <b>71779/15</b>   | <b>71779/16</b>   |
| <b>Test Sample</b>                                                                                                                                                              |               |            |              |               | <b>AR</b>         | <b>AR</b>         | <b>AR</b>         | <b>AR</b>         |
| <b>Determinand</b>                                                                                                                                                              | <b>Method</b> | <b>LOD</b> | <b>Units</b> | <b>Symbol</b> |                   |                   |                   |                   |
| Particulates (Total)                                                                                                                                                            | Grav          | 0.3        | mg           | U             | 1.9               | 1.2               | <0.3              | 0.6               |

|                                                                                                                                                                                             |               |            |              |               |                      |                      |                      |                      |                      |  |
|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------|------------|--------------|---------------|----------------------|----------------------|----------------------|----------------------|----------------------|--|
| <b>SAL Reference:</b> 440073<br><b>Project Site:</b> 28/11/14<br><b>Customer Reference:</b> 71779<br><br><b>Tube (Charcoal 226-09)</b> Analysed as Tube (Charcoal 226-09)<br><b>Suite A</b> |               |            |              |               |                      |                      |                      |                      |                      |  |
| <b>SAL Reference</b>                                                                                                                                                                        |               |            |              |               | <b>440073 001</b>    | <b>440073 002</b>    | <b>440073 003</b>    | <b>440073 004</b>    | <b>440073 005</b>    |  |
| <b>Customer Sample Reference</b>                                                                                                                                                            |               |            |              |               | <b>71779/1 FRONT</b> | <b>71779/2 FRONT</b> | <b>71779/3 FRONT</b> | <b>71779/4 FRONT</b> | <b>71779/5 FRONT</b> |  |
| <b>Test Sample</b>                                                                                                                                                                          |               |            |              |               | <b>AR</b>            | <b>AR</b>            | <b>AR</b>            | <b>AR</b>            | <b>AR</b>            |  |
| <b>Determinand</b>                                                                                                                                                                          | <b>Method</b> | <b>LOD</b> | <b>Units</b> | <b>Symbol</b> |                      |                      |                      |                      |                      |  |
| 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             | 19000                | 10000                | 2000                 | <1                   | 6500                 |  |

|                                                                                                                                                                                             |               |            |              |               |                      |                      |                      |                   |                     |  |
|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------|------------|--------------|---------------|----------------------|----------------------|----------------------|-------------------|---------------------|--|
| <b>SAL Reference:</b> 440073<br><b>Project Site:</b> 28/11/14<br><b>Customer Reference:</b> 71779<br><br><b>Tube (Charcoal 226-09)</b> Analysed as Tube (Charcoal 226-09)<br><b>Suite A</b> |               |            |              |               |                      |                      |                      |                   |                     |  |
| <b>SAL Reference</b>                                                                                                                                                                        |               |            |              |               | <b>440073 006</b>    | <b>440073 007</b>    | <b>440073 008</b>    | <b>440073 017</b> | <b>440073 018</b>   |  |
| <b>Customer Sample Reference</b>                                                                                                                                                            |               |            |              |               | <b>71779/6 FRONT</b> | <b>71779/7 FRONT</b> | <b>71779/8 FRONT</b> | <b>71779/17</b>   | <b>71779/1 BACK</b> |  |
| <b>Test Sample</b>                                                                                                                                                                          |               |            |              |               | <b>AR</b>            | <b>AR</b>            | <b>AR</b>            | <b>AR</b>         | <b>AR</b>           |  |
| <b>Determinand</b>                                                                                                                                                                          | <b>Method</b> | <b>LOD</b> | <b>Units</b> | <b>Symbol</b> |                      |                      |                      |                   |                     |  |
| 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                   | 7700                 | 760                  | <1                | 11000               |  |

|                                                                                                   |               |            |              |               |                     |                     |                     |                     |                     |
|---------------------------------------------------------------------------------------------------|---------------|------------|--------------|---------------|---------------------|---------------------|---------------------|---------------------|---------------------|
| <b>SAL Reference:</b> 440073<br><b>Project Site:</b> 28/11/14<br><b>Customer Reference:</b> 71779 |               |            |              |               |                     |                     |                     |                     |                     |
| <b>Tube (Charcoal 226-09)</b> Analysed as Tube (Charcoal 226-09)<br><b>Suite A</b>                |               |            |              |               |                     |                     |                     |                     |                     |
| <b>SAL Reference</b>                                                                              |               |            |              |               | <b>440073 019</b>   | <b>440073 020</b>   | <b>440073 021</b>   | <b>440073 022</b>   | <b>440073 023</b>   |
| <b>Customer Sample Reference</b>                                                                  |               |            |              |               | <b>71779/2 BACK</b> | <b>71779/3 BACK</b> | <b>71779/4 BACK</b> | <b>71779/5 BACK</b> | <b>71779/6 BACK</b> |
| <b>Test Sample</b>                                                                                |               |            |              |               | <b>AR</b>           | <b>AR</b>           | <b>AR</b>           | <b>AR</b>           | <b>AR</b>           |
| <b>Determinand</b>                                                                                | <b>Method</b> | <b>LOD</b> | <b>Units</b> | <b>Symbol</b> |                     |                     |                     |                     |                     |
| 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             | <b>10000</b>        | <1                  | <1                  | <1                  | <1                  |

|                                                                                                   |               |            |                     |                     |             |    |
|---------------------------------------------------------------------------------------------------|---------------|------------|---------------------|---------------------|-------------|----|
| <b>SAL Reference:</b> 440073<br><b>Project Site:</b> 28/11/14<br><b>Customer Reference:</b> 71779 |               |            |                     |                     |             |    |
| <b>Tube (Charcoal 226-09)</b> Analysed as Tube (Charcoal 226-09)<br><b>Suite A</b>                |               |            |                     |                     |             |    |
| <b>SAL Reference</b>                                                                              |               |            | <b>440073 024</b>   | <b>440073 025</b>   |             |    |
| <b>Customer Sample Reference</b>                                                                  |               |            | <b>71779/7 BACK</b> | <b>71779/8 BACK</b> |             |    |
| <b>Test Sample</b>                                                                                |               |            | <b>AR</b>           | <b>AR</b>           |             |    |
| <b>Determinand</b>                                                                                | <b>Method</b> | <b>LOD</b> | <b>Units</b>        | <b>Symbol</b>       |             |    |
| Ethyl acrylate                                                                                    | GC/MS         | 5          | µg                  | U                   | <5          | <5 |
| Methyl acrylate                                                                                   | GC/MS         | 5          | µg                  | U                   | <5          | <5 |
| VOC (Total excluding targets)                                                                     | GC/MS         | 1          | µg                  | N                   | <b>9300</b> | <1 |

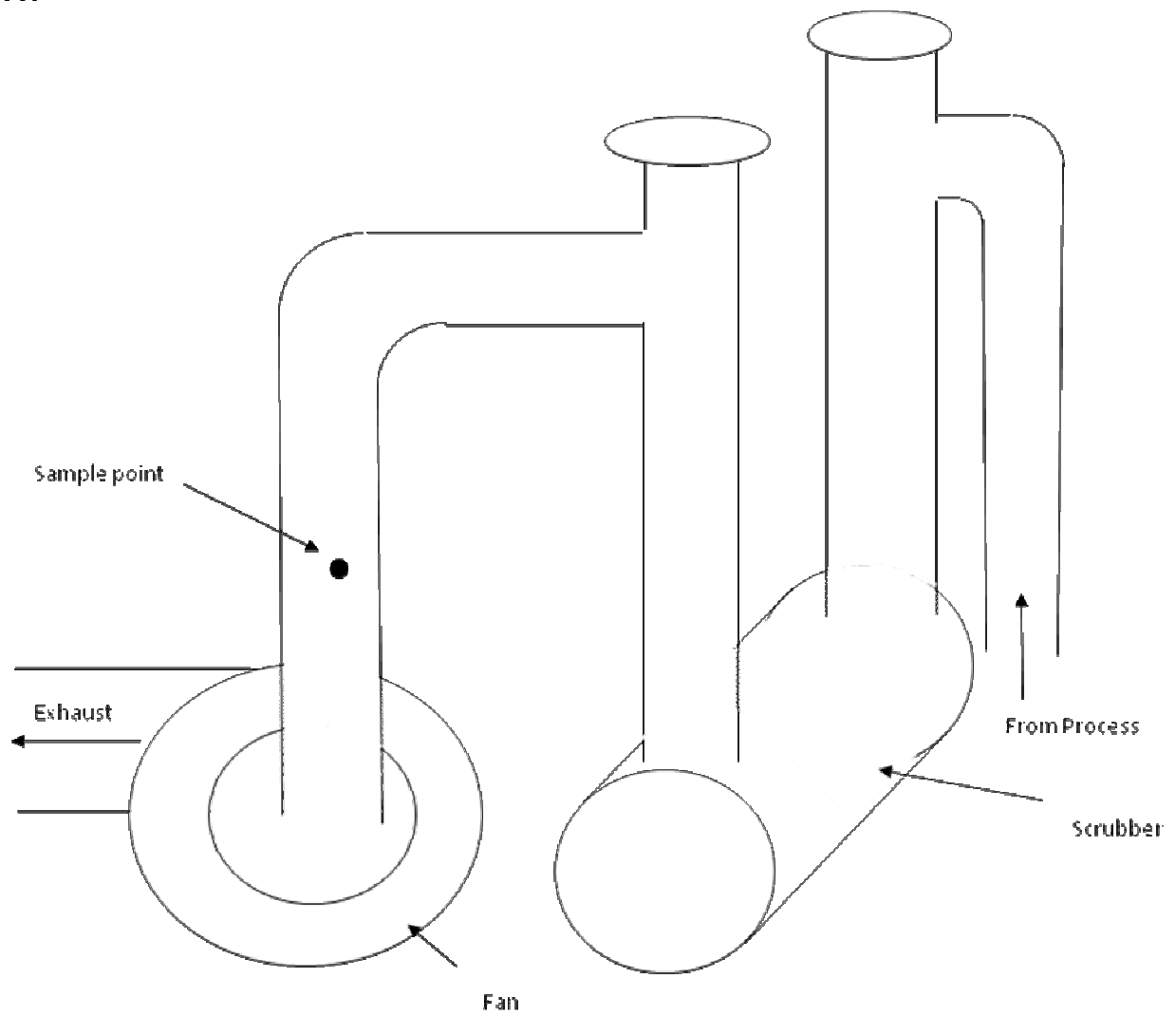
## Index to symbols used in 440073-1

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

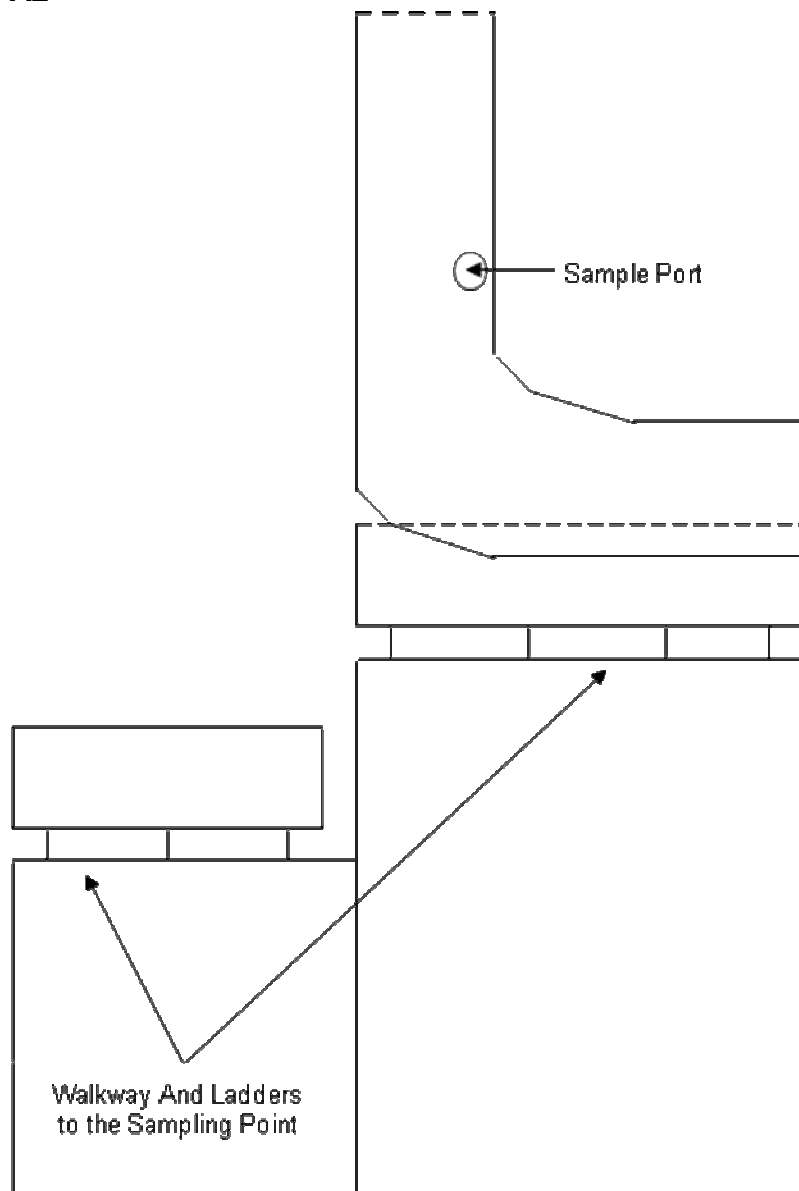
## **APPENDIX 2**

### **Diagrams of Sampling Points**

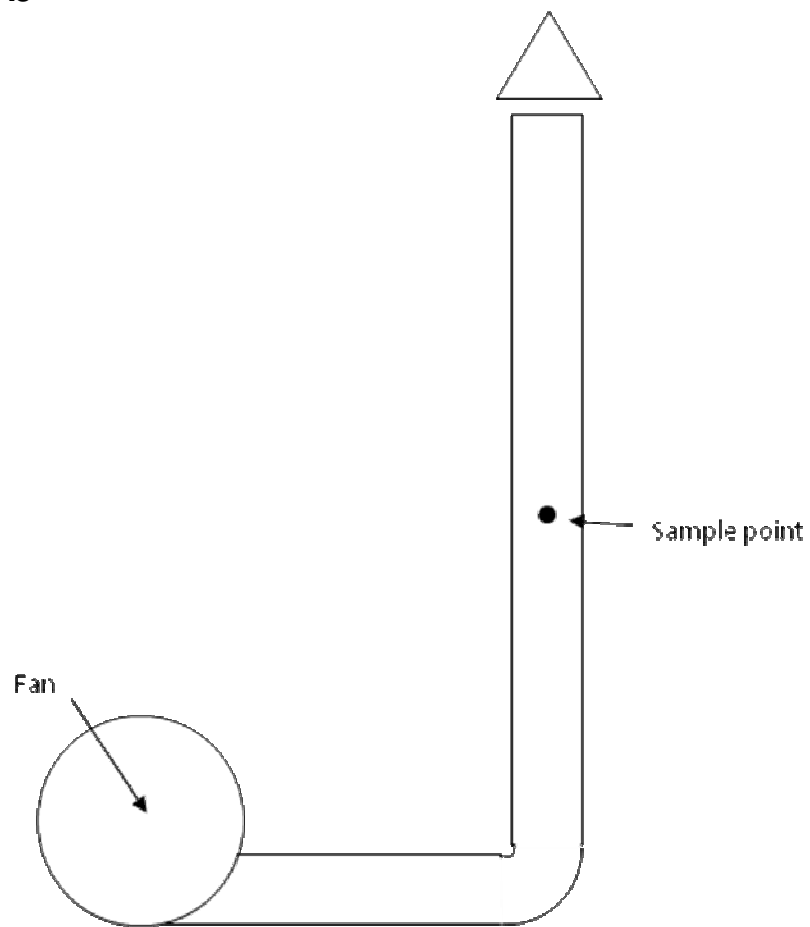
A1



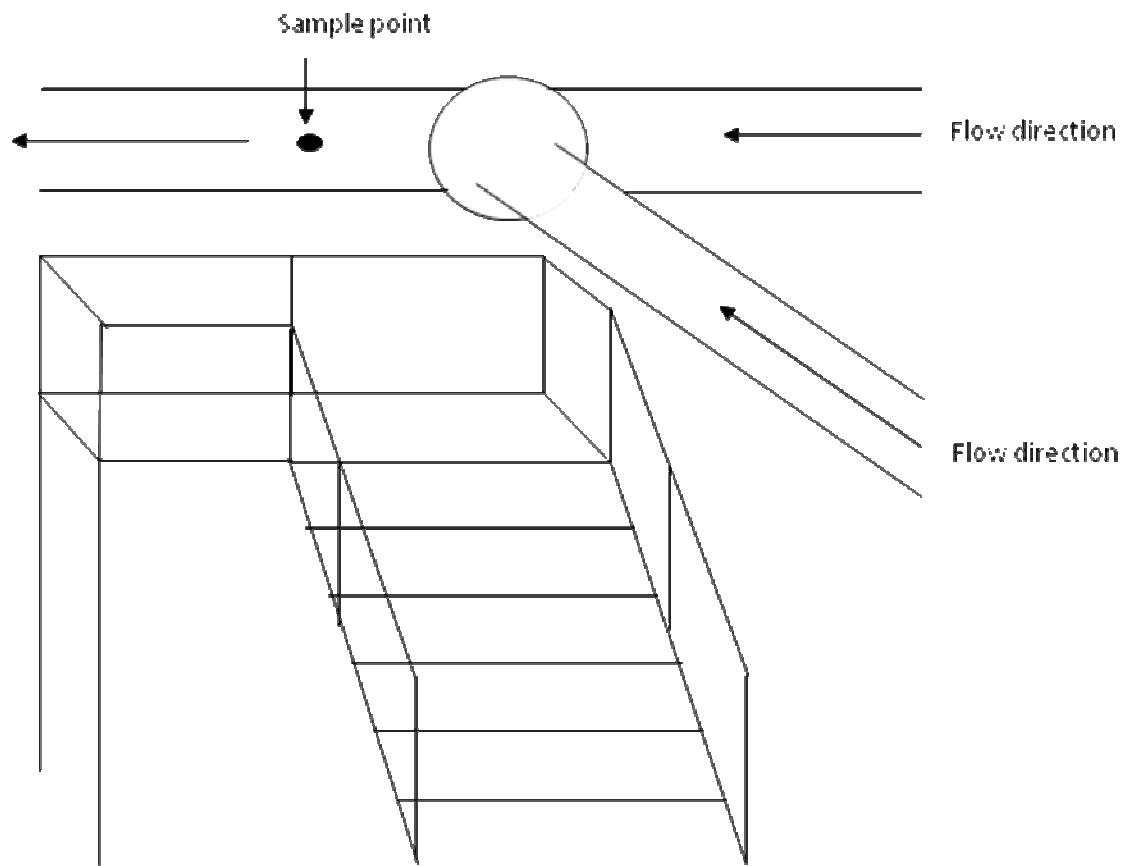
A2



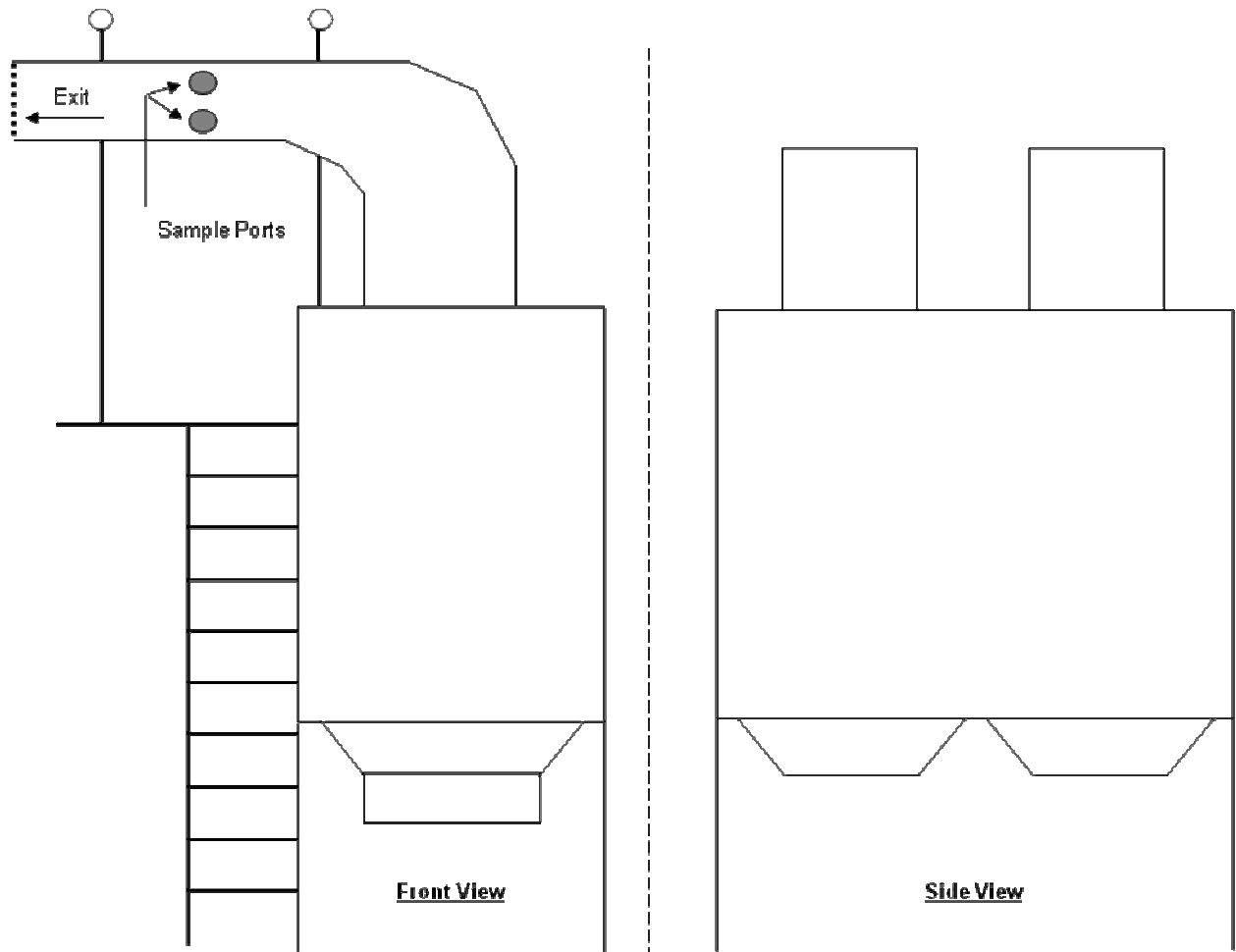
**A3**



A5



**A6**



## APPENDIX 3

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### Calculations

#### Conversion Factors

ppm @ mg/Nm<sup>3</sup> (at 273K, 101.3kPa: STP)

|                 |   |      |                                                                     |
|-----------------|---|------|---------------------------------------------------------------------|
| CO              | x | 1.25 |                                                                     |
| SO <sub>2</sub> | x | 2.86 |                                                                     |
| VOC's           | x | 1.61 | (ppm as C <sub>3</sub> H <sub>8</sub> to mg/Nm <sup>3</sup> as C)   |
| NO <sub>x</sub> | x | 2.05 | (ppm NO + NO <sub>2</sub> to mg/m <sup>3</sup> as NO <sub>2</sub> ) |

#### Oxygen Correction to Reference Value

Concentration at (STP) -> Concentration at 273K, 101.3kPa, reference O<sub>2</sub> and Dry Gas, i.e.

Concentration X ((20.9-O<sub>2</sub> ref)/(20.9-O<sub>2</sub> measured)) = Concentration at ref Oxygen state.

#### Example Calculation

|                                                                      |   |                                                                             |
|----------------------------------------------------------------------|---|-----------------------------------------------------------------------------|
| SO <sub>2</sub> concentration at STP                                 | = | 170.7 mg/Nm <sup>3</sup>                                                    |
| Oxygen percentage in gas stream                                      | = | 13.8%                                                                       |
| Reference Oxygen                                                     | = | 11%                                                                         |
| SO <sub>2</sub> concentration at reference O <sub>2</sub> conditions | = | 170.7 ((20.9-11)/(20.9-13.8))                                               |
|                                                                      | = | 238 mg/Nm <sup>3</sup> at 273K, 101.3kPa,<br>11% O <sub>2</sub> 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 <sup>3</sup> (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<sup>3</sup> = TCE ppm x 5.864 (Mol Wt/22.4)