

HE 10 / 7161

**LA-PPC/EPR Compliance Monitoring Of
The Spray Booth Releases**

at

Anglo ERI Limited

**Little End Road
Eaton Socon
St Neots
Cambridgeshire
PE19 8SN**

Study Period; - 9th February 2010

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ANGLO ERI LIMITED
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PE19 8SN

20th February 2010

FAO: Mr P Moore – Manufacturing Director

REPORT REF: - HE 10 / 7161

**LA-PPC/EPR COMPLIANCE MONITORING OF THE
SPRAY BOOTH RELEASES**

1.1 INTRODUCTION

This study was undertaken to determine data as detailed by Huntingdon District Council Local Authority personnel as part of the Anglo ERI Limited site's Local Authority – Pollution Prevention Control (LA-PPC/EPR) monitoring protocol.

This report relates to the determination of releases sourced from the extraction systems associated with the site's 2 off spray booths. ERI S1 identifies the extraction duct associated with the spray booth No. 1. ETR S2 identifies the extraction duct associated with the No. 2 spray finishing section. Both areas are extracted into 0.710m. dia. circular ducts.

These spraying operations and the use of the site's extraction systems was noted as most akin to batch finishing rather than continuous operation.

The site has progressively adopted the increasing use of water based primer and primer surfacer coatings, high solids single and two pack systems, however top coats are still mainly solvent based Pu systems encompassing compliant systems.

The releases from these "coatings" operations are encompassed by the provisions of the Pollution Prevention and Control (England and Wales) Regulations 2000, the Environmental Permitting Regulations 2007 and Process Guidance note PG 6/33 (2004) and are currently directed to the determination of volatile organic compounds (VOC as expressed as C) total isocyanate and total particulate matter.

Monitoring was undertaken over a continuous 3 hour period per stack to determine the results quoted and in accordance with the following Source Testing Association (STA) codes of practice; -



Document	Title
M 1054	STA Minimum Standards of testing and reporting.
M 1055	STA Code of Practice.
MIG001	Measurement of Specific Organic Compounds in Source Releases
QGN001	Guidance on Assessing Uncertainty in Stack Emission Monitoring.

The report relates to studies undertaken by Mr T Growcott BSc (Hons) MRSC C Sci. C.Chem MIMF and Mr K A Hall of Halcyon Environmental on February 9th 2010 as per the specification brief.

Halcyon is a member of the Source Testing Association. The author was formally trained in source testing via Clean Air Engineering (CAe) (1991), Casella (1992) and SGS (1991).

In terms of process activities the spraying operations undertaken during this study were based on an approx. blend of 50/50 water based and solvent based coatings. The site is progressing to water based and water bourn technologies to meet the provisions of the Solvent Emissions Directive (SED) and its Reduction Scheme target.

1.2 MONITORING RESULTS SUMMARY

The following analytical results were determined whilst normal production operations took place over specified sampling schedules; -

Stack ref	Location and shape	TPM mg/m ³	VOC as C mg/m ³	Isocyanate mg/m ³
1	ERI S1 Circular	1.86	8.2	< 0.01
2	ERI S2 Circular	1.04	4.27	< 0.01

1.3 EFFLUX VELOCITIES SUMMARY

The upgrading of the spray shop stack velocities, to comply with the specified minimum efflux velocity of 15 m/s has already been considered in ongoing site management upgrade initiatives. Stacks have already had their chinaman's hats removed during upgrading, and been elevated to have a discharge point 3m. above roof ridge height.

Both stacks exceed the minimum specified mean efflux velocity of 15 m/sec defined in the process guidance note.

1.4 ODOUR PERCEPTION SUMMARY

Odour from the site's 2 off permitted stacks was assessed and determined to be barely perceptable even by the sampling port.



1.5 FUTURE ACTIONS AND INITIATIVES

Future actions to achieve compliance are as follows; -

- (i) Annual submission of the site's VOC solvent inventory
- (ii) Continuance of use, wherever possible, of compliant and water borne coatings
- (iii) Continuance of annual compliance monitoring
- (iv) Compliance with the Solvent Releases Directive

A copy of this report (paper and electronic) should be sent to the Huntingdon District Council, Environment Services Dept. as per the site's LA-PPC/EPR authorisation.

Tim Growcott B Sc (Hons) MRSC C Chem C Sci MIMF
Senior Partner

ANGLO 7161LAPPC/EPR REP



SECTION 2

SAMPLING AND MONITORING PROCEDURES



2 SAMPLING AND MONITORING STRATEGY

2.1 SAMPLING STRATEGY

The sampling strategy adopted was based upon remote sampling using the procedure detailed in ISO 9096: 2003. The data was determined at sampling locations on each extraction system using the following instrumentation.

Mean efflux velocity data was determined using 2 off Airflow Developments model PVM100 electronic micro-manometers used in conjunction with 2 off Airflow Developments BS 1042 type 2.1A pitot systems, with in line thermocouples.

Calibrated Huger Sutronics temperature and pressure measurement devices were also used in these procedures.

All instrumentation used in this study carried calibration certification, traceable back to NPL standards

2.2 SAMPLING EQUIPMENT

Sampling was undertaken using calibrated, purpose built, instrumentation using, in this instance, Gilaire, BMS and Rothero & Mitchell high and low flow pumps used in conjunction with Aquaria sampling heads.

AGL gas monitoring instrumentation was used throughout the study.

All sampling and monitoring procedures were based on isokinetic sampling strategy, to assess process uniformity, with continuous on line assessment of flow rate and dynamic velocity measurements.

All flow rate and velocity measurement instrumentation was calibrated prior to, during and after each sampling run.

All sampling planes and points of determination were corrected in accordance with Ka coefficients as detailed in Source Testing Association protocols to within 100 % $\pm$ 10 % variance.

2.2.1 TOTAL PARTICULATE MATTER DETERMINATION

(i) TPM by ISO 9096: 2003 PROCEDURE

Periodic extractive sampling for Total Particulate Matter (TPM) was undertaken using 2 off Andersen sampling trains.

Sampling procedure was, within the limits of the sampling plane, in accordance with the main procedural requirements of ISO 9096: 2003.

The sampling train was leak tested before commencement of the study

Samples are collected with the whole sampling assembly located inside the stack, thereby producing a dry sample.

The sampling line includes a condensation trap, such that gas flow, gas volume, and gas temperature as measured at the pump all relate to dry gas.

The filters were submitted to a UKAS laboratory for post sampling reweighing.



2.2.2 BS 12619 VOC DETERMINATION

Both direct reading and post sampling laboratory-based procedures were used to produce the data reported herein.

Direct measurements were determined via a sampling train located adjacent to each stack.

Specialist procedures were involved in the determination of VOC analytes using portable Signal Instruments 3030 PM FID instruments, and also absorption and trapping media followed by two stage thermal desorption Gas Chromatography and Mass Spectroscopy to identify organic compounds and thermally degraded products sourced from stoving operations.

A certified 80 ppm propane in synthetic Air Products gas standard was supplied with the instrumentation.

This instrument sampled stack and duct air at its own predetermined rate, and air was passed through a Flame Ionisation detector within the unit. The electrical signal generated in a hydrogen-fuelled flame varies with VOC concentration. This variance is measured in the unit and read as methane equivalent by the instrument operator.

A correction coefficient is then applied from the equipment supplier's data tables.

2.2.3 ISOCYANATE DETERMINATIONS

Isocyanates were determined in accordance with US EPA method 207-1.

2.2.4 SAMPLING PROTOCOLS

The following stack sampling protocols were used to determine the data reported herein; -

Calculation of Velocity of Flow:

The basic formula for calculating velocity of flow from velocity pressure is:

$$\text{Velocity Pressure (Pv)} = \frac{1}{2} \rho V^2$$

Where:

Pv is Velocity Pressure in pascals.

ρ is the density of dry air (free of CO₂) at 1013mb, 273K in Kg/m³.

V is velocity in metres per second.

Dry air contains 78.1% Nitrogen (as N₂), 20.9% Oxygen (as O₂), 0.9% Argon (as Ar) and traces of CO₂ (0.03%), Ne, He, Kr, Xe, H₂, CH₄, N₂O, O₃, SO₂, NO₂, NH₃, CO, & I₂.

Atomic Weight of Nitrogen is 14, Oxygen is 16, and Argon is 40. Molecular Weight of Nitrogen (N₂) is 28, Oxygen (O₂) is 32 and Argon (Ar) is 40.

Molar Density of a complex gas mixture, such as air, can be calculated using the proportions of gas present, and the molecular weights of the component gases. Thus using the 3 principal components of dry air:



$$\begin{aligned}\text{Molar gas density} &= 0.781 \times 28 \text{ (for N}_2\text{)} + 0.209 \times 32 \text{ (for O}_2\text{)} + 0.009 \times 40 \text{ (for Ar)} \\ &= 28.916\end{aligned}$$

When the figures are made more accurate, and all the other trace gases added into the equation, **Molar Gas Density of Air** works out to be **28.9644**. This is normally approximated to 29.

The following calculations can be utilised (in most cases), where molar gas density is in the range of 28-30, (see note on determination of flue gas density).

In some combustion stacks the density can be found to be outside this range, in which case the calculations need to be modified by substituting the actual value into the basic equation, and following the calculation through.

One mole of gas occupies 22.4136 litres at 273 K, 1013mb. (Normally approximated to 22.4). One mole of air occupies the same volume and weighs 28.9644 g. Thus the **Density of Dry Air** at 273 K, 1013 mb works out at 1.292 Kg /m³. The precise figure is 1.2928 Kg/m³.

If this figure is entered into the initial equation

$$Pv = \frac{1}{2} \rho V^2$$

It calculates out to

$$\begin{aligned}\text{Velocity (metres per second)} &= 1.244 \sqrt{Pv} \quad (\text{at } 273 \text{ K, } 1013 \text{ mb}) \\ \text{or} \\ \text{Velocity (metres per second)} &= 1.280 \sqrt{Pv} \quad (\text{at ambient: } 289 \text{ K, } 1013\text{mb})\end{aligned}$$

This equation can be applied at or near standard conditions. Where conditions vary significantly from standard, corrections can be made according to the following formula:

$$V = 1.280 \sqrt{\frac{1013 \times T \times 101300}{Pa \times 289 \times (101300 + Ps)}} \times Pv$$

This equation corrects for atmospheric pressure (Pa), expressed in millibars, Temperature expressed in Kelvin (T), and static pressure in the stack (Ps) in pascals. It multiplies out to give:

$$V = 762.7 \sqrt{\frac{T \times Pv}{Pa (101300 + Ps)}} \times Pv$$

Where:

V	=	Velocity of Flow on metres per second	(ms ⁻¹)
T	=	Temperature in Kelvin (Kelvin = ° Celsius + 273)	(K)
Pv	=	Velocity Pressure in pascals	(Pa)
Ps	=	Static Pressure in pascals	(Pa)
Pa	=	Atmospheric Pressure in millibars (1 millibars = 100 pascals)	(mb)

To apply this equation, Pv should be entered as the root mean square of all velocity pressure readings. But where the majority of the readings do not vary by more than 25% from the mean figure, the mean provides a satisfactory answer.

The equation gives velocity of flow at temperature T, static pressure Ps, and atmospheric pressure Pa.



Measurements and Extractive Sampling:

Measurements are taken across the duct at points in the centre of a series of equal areas. In a square duct this is straightforward, but in a circular duct, it implies a series of points near to the edge of the stack, and very few measurements in the middle. ISO 9096: 2003 says that measurements may be taken at a series of 4 points evenly spaced across the duct.

Measurement of Air Flow in Stacks:

Correct isokinetic sampling is dependent on accurate assessment of air velocity in the duct or flue. Because of the potentially hot, acid conditions found in flues, the instrument of choice for measuring flow is one that measures differential pressure, and does not insert an instrument with electronic or moving parts into the duct. There are several other types of instrument available for measuring airflow, but these should not, as a general rule, be used in flue stacks.

Pressure in Ducts:

There are 4 factors that affect the perceived pressure in a duct:

1. Movement of air produces a measurable Velocity Pressure (also known as Dynamic Pressure).
2. Static Pressure, is exerted in all directions, by the compression, expansion, or heating process that is moving the air.
3. Atmospheric (Barometric) Pressure
4. Temperature.

Micro manometer & Pitot Tube:

The pitot tube is the differential pressure probe, it is designed to create minimal turbulence in the flow. The British Standard design has an ellipsoidal nose, which is inserted to face the flow. The tube is very directional and needs to be accurately aligned into the flow, to produce the best result. Unfortunately the pressure bearing on the nose of the instrument is velocity pressure, but with the addition of static pressure.

To eliminate this problem the pitot tube is made with a separate tapping to measure static pressure alone. The BS tube is made double, with tappings at right angles to the flow, whereas the American S type pitot consists of two separate tubes 180° opposed. The two types of pitot tube have different response factors (sometimes called the K factor), and this may require the use of a correction factor in calculating flow. The response factor for the BS type is 1.0 and for the S type is 0.85.

The original instrument for measuring air pressure is the U tube manometer. By attaching the two tappings of the pitot tube, one to each side of the manometer, Static pressure is applied to both sides, and its effect is eliminated, allowing a direct reading of Velocity pressure.

The inclined manometer is an improvement on the U tube, because it allows for more accurate readings of pressure. However it does require careful leveling before use, and an electronic micro manometer is more user friendly.

With either type of instrument it is important that it is connected up with the Velocity pressure tapping bearing on the positive side of the instrument.



Calculating & Presentation of Results (Measurements & Corrections):

Particulate sampling is always assessed gravimetrically (by weight). Filter material of all types is pre weighed, exposed in the sampling line and re-weighed.

This procedure may require drying of the filter medium before re-weighing, if the sampling was conducted at a temperature below the dew point. In all circumstances, filters require careful handling to avoid loss particulate, and also loss of original fibrous material. Weight of particulate collected is thus derived from the difference of the two weights and is normally expressed in milligrams (g^{-3}) or micrograms (g^{-6}). The balance should be calibrated against a traceable standard before and after each batch of filters is weighed / re-weighed.

Volume of gas collected is normally determined either by multiplying sampling flow rate (litres/minute) by time elapsed (minutes) to get a final volume in litres, or by utilising a direct reading from a gas meter.

In both cases, volume calculated is at ambient temperature and pressure and requires correcting to standard conditions. The gas meter or flow meter should be regularly re-calibrated against a traceable standard, and this may impose an extra calibration factor on the results to obtain correct ambient volume.

If the sampling line, does not include a silica gel trap, but only a condensate trap, (as in the BCURA or CEGB Mk111A) the air passing to the meters can be assumed to be water saturated at ambient conditions, and this too required compensation.

Schedule A & B processes require presentation of results in milligrams per cubic metre, and / or parts per million, as standardised to the following conditions:

Temperature	273K (0° Celsius)
Barometric Pressure	101.3KPa, (1013mb)
Humidity	Dry
Oxygen	3%, 6%, 8%, 11%, 15%, 18% depending on combustion process

The various calculations and conversions are explained in the subsequent paragraphs.

Determination of Isokinetic Sampling Rate:

To obtain correct samples of particulates, turbulence caused by sampling must be minimised. This is achieved by making the velocity of flow into the sampling probe equal to the velocity flow moving along the duct or stack. This sampling technique is called isokinetic sampling, and its use enables the collection of representative samples, by eliminating the distortion of sample reliability caused by variation in proportion of light particulates collected.

Velocity of flow is determined by the use of pitot tube and micro manometer. This is normally calculated at the stack temperature. The gas volume measuring equipment is normally functioning at about ambient temperature. (Gas moving along the sampling line rapidly cools to ambient).

To calculate isokinetic flow rate, first the gas velocity must be calculated as at ambient. This is done using the standard gas equation. (See Calculation of Results).

$$\frac{\text{Pressure} \times \text{Volume}}{\text{Temperature}} = \text{Constant}$$

Thus for a stack of uniform width volume is proportional to velocity, hence:



$$\text{Velocity}_{\text{ambient}} = \frac{\text{pressure}_{\text{stack}} \times \text{Velocity}_{\text{stack}} \times \text{Temperature}_{\text{ambient}}}{\text{Temperature}_{\text{stack}} \times \text{Pressure}_{\text{ambient}}}$$

As atmospheric pressure remains equal this item cancels out of the equation.

Sampling rate (litres per minute) is a function of stack velocity (metres per second) and probe tip area (square centimetres), derived from πr^2 . The rationale is as below:

$$\text{Metres per second (m/s)} \times \frac{100}{60} = \text{centimetres per minute (cm/min)}$$

$$\text{Centimetres per minute (cm/min)} \times \text{Square centimetres (cm}^2\text{)} = \text{Cubic Centimetres per minute (cm}^3\text{/min)}$$

$$\frac{\text{Cubic Centimetres per minute (cm}^3\text{/min)}}{1000} = \text{Litres per minute (l/min)}$$

Thus:

$$\text{Sampling Rate (l/min)} = \frac{\text{Ambient Stack Flow (m/s)} \times \text{Tip area (cm}^2\text{)}}{600}$$

Determination of Flue Gas Density:

Stack gas density is determined by measuring the concentration of Carbon Dioxide, Carbon Monoxide and Oxygen in the stack. This can be done using a combustion analyser, or if more accuracy is required, using an Infra Red Gas Analyser.

The residual dry atmospheric gas is assumed for the purpose of this calculation to be Nitrogen. Nitrogen concentration is calculated as follows:

$$\% \text{ N}_2 = 100 - (\% \text{ CO}_2 + \% \text{ O}_2 + \% \text{ CO})$$

The proportion of each gas in the dry mixture can then be utilised to calculate the dry molar gas density as shown previously:

$$\text{Molar Dry Gas Density (Dd)} = (\% \text{ CO}_2 \times \frac{44}{100}) + (\% \text{ O}_2 \times \frac{32}{100}) + (\% \text{ CO} + \% \text{ N}_2 \times \frac{28}{100})$$

Flue gases however also contain water. The water is condensed out of the sampling line, (to protect the sampling pump), and is weighted.

The volume of gas occupied by the collected condensate water can be calculated from the volume occupied by 1 mole of standard gas (ie. 22.4 litres at 273K, 1013mb).

$$\text{Gas Phase Volume of Water (litres)} = \text{Weight of Water (grams)} \times \frac{22.4}{28}$$

Dry gas volume of the sample is measured by the gas meter in the sampling line. Total gas volume (wet) collected is therefore the sum of the calculated water volume above and the dry gas volume measured.

$$\text{Total (Wet) Gas Volume} = \text{Dry Gas Volume} + \text{Gas phase Water Volume}$$



Using the above relationship, the proportion of dry gas in the total volume collected, (Mole Fraction of Dry Gas), can be calculated as follows:

$$\text{Mole Fraction of dry gas (Md)} = \frac{\text{Dry gas volume}}{\text{Total gas volume}}$$

Mole fraction of wet gas can be calculated similarly, or as

$$\text{Mole fraction of wet gas (Mw)} = 1 - \text{Mole fraction of dry gas (Md)}$$

Density of stack gas can then be calculated from the density of dry stack gas calculated above, and the Mole Fractions calculated.

Thus:

$$\text{Molar Density of dry gas (Dd)} \times \text{Mole fraction of dry gas (Md)} + 18 (1 - \text{Md}) = \text{Molar Stack gas density (Ds)}$$

This latter equation is identical in methodology to the earlier equation for deriving molar gas density of dry gas, but now includes an extra derived function for water

$$\text{Molar stack gas density (Ds)} = \text{Md} \left(\frac{\% \text{CO}_2 \times 46}{100} + \frac{\% \text{O}_2 \times 32}{100} + \frac{\% \text{N}_2 + \% \text{CO} \times 28}{100} \right) + \text{Mw} \left(\frac{\% \text{H}_2\text{O} \times 18}{100} \right)$$

In most cases the Molar stack gas density will work out as 29 ± 1 . In this case, the normal equation for stack flow will prove to be satisfactory.

Calculation of Volume Flow:

Volume flow is calculated from flow velocity and internal area of the stack or duct as follows:

$$\text{Volume flow (m}^3 \text{ min}^{-1}) = \text{Velocity (ms}^{-1}) \times \text{Internal Area of Duct (m}^2) \times 60$$

Internal area of duct is calculated as:

πr^2 for a circular duct,
or base x width for a rectangular or square duct.

To convert $\text{m}^3 \text{ min}^{-1}$ to cubic feet per minute (cfm) multiply by 35.315

Conversion Factors (mg/m^3 and ppm):

Final results of particulate concentrations in air are always presented as a weight by volume measure (e.g. milligrams per cubic metre).

Gases can be presented as a weight by volume, or as a volume measure (parts per million). Unfortunately, there is no standard methodology within the Process Guidance notes and both types of measure are used, often in the same note. It is thus, important to be able to change between the two methods of calculating gas concentration.

Hydrogen chloride will be used to illustrate the two methods as follows: Hydrogen chloride has molecular weight of 36.5. 1 mole of HCl occupies 22.4 litres at s.t.p. 1 millimole of HCl occupies 22.4 millilitres at s.t.p. 1 millimole weighs 36.5 milligrams. If 1 millimole of HCl is dispersed in 1 cubic metre of air then this is a concentration of 36.5 milligrams per cubic metre (mg/m^3) or 22.4 millilitres per cubic metre (parts per million) ppm.



This can be expressed to find an unknown as

$$V_1 = \frac{P_2 V_2}{T_2} \times \frac{T_1}{P_1}$$

The correction equation can therefore be expressed as:

Standardised Volume = $\frac{\text{Recorded Pressure} \times \text{Std Temperature (273)}}{\text{Std Pressure (1013)} \times \text{Recorded Temperature}}$ x Recorded Volume

For this correction to work, any unit of pressure can be utilised (inches of water, millimetres of mercury, millibars, kilopascals etc.) provided that the standard atmosphere is expressed in similar units. Temperature must however be worked in Absolute Units e.g. Kelvin ($K = ^\circ C + 273.15$) or Rankine ($^{\circ}R = ^\circ F + 459.67$)

2.2.5 INITIAL STACK PROFILE STUDY

As per the provisions of ISO 9096: 2003 a stack/duct profile study was addressed prior to monitoring and sampling.

This study was undertaken at ten points in two trans-axial assessments at the sampling points. Both temperature and velocity profiles were measured. The study determined that the temperature variance across the two measured planes was less than Tmax:Tmin and Vmax:Vmin variances defined within method tolerance specification.

There was no evidence of non-linear flow, spiralling or swirling flow, or of pulsed airflow in either of the tested extraction systems.

In this assessment the relative ratio of the cross sectional area of the stack and Anderson sampling head were determined.

The filter holder csa was noted as less than 10% of the stack csa, however, it was decided to maintain the filter body outside of the air streams to minimise sampling errors. The csa of the sample line was calculated on a 64 mm diameter.

2.2.6 MONITORING DIARY

All of the coatings used in the spray booths monitored during this study were based on conventional and catalysed air-drying/forced drying formulations.

The principle solvent and thinners associated with these paints were xylenes, toluol, n and iso butanol, aromatic and aliphatic hydrocarbons, aromatic naphthas, esters and glycols, methyl ethyl ketone and ethyl acetate.

All of the coatings which were applied in this study were considered to be typical of the ranges used in normal production schedules and operations. These were all purpose-formulated materials, produced to specific standards and performance specifications.

All of the areas which were monitored were subject to in house QA and QC procedures and controls, with a notably high level of supervision and management.



2.2.7 CLIMACTIC CONDITIONS

The following climactic conditions were noted during the study; -

Parameter	09.02.2010
Ambient Temp K	285
Atmospheric Pressure kPas	101.1
Wind Direction-	W
Visibility metres	> 1000
Relative Humidity %	46
Weather Conditions	Bright and sunny, no precipitation



SECTION 3
ANALYTICAL METHODS



3 ANALYTICAL METHODS

The following analytical methods were used to determine the data reported herein; -

Substance	Standard or Method
Volatile Organic Compounds	BS EN 12619 Flame Ionisation Detector
Total Particulate Matter	ISO 9096: 2003 Gravimetric

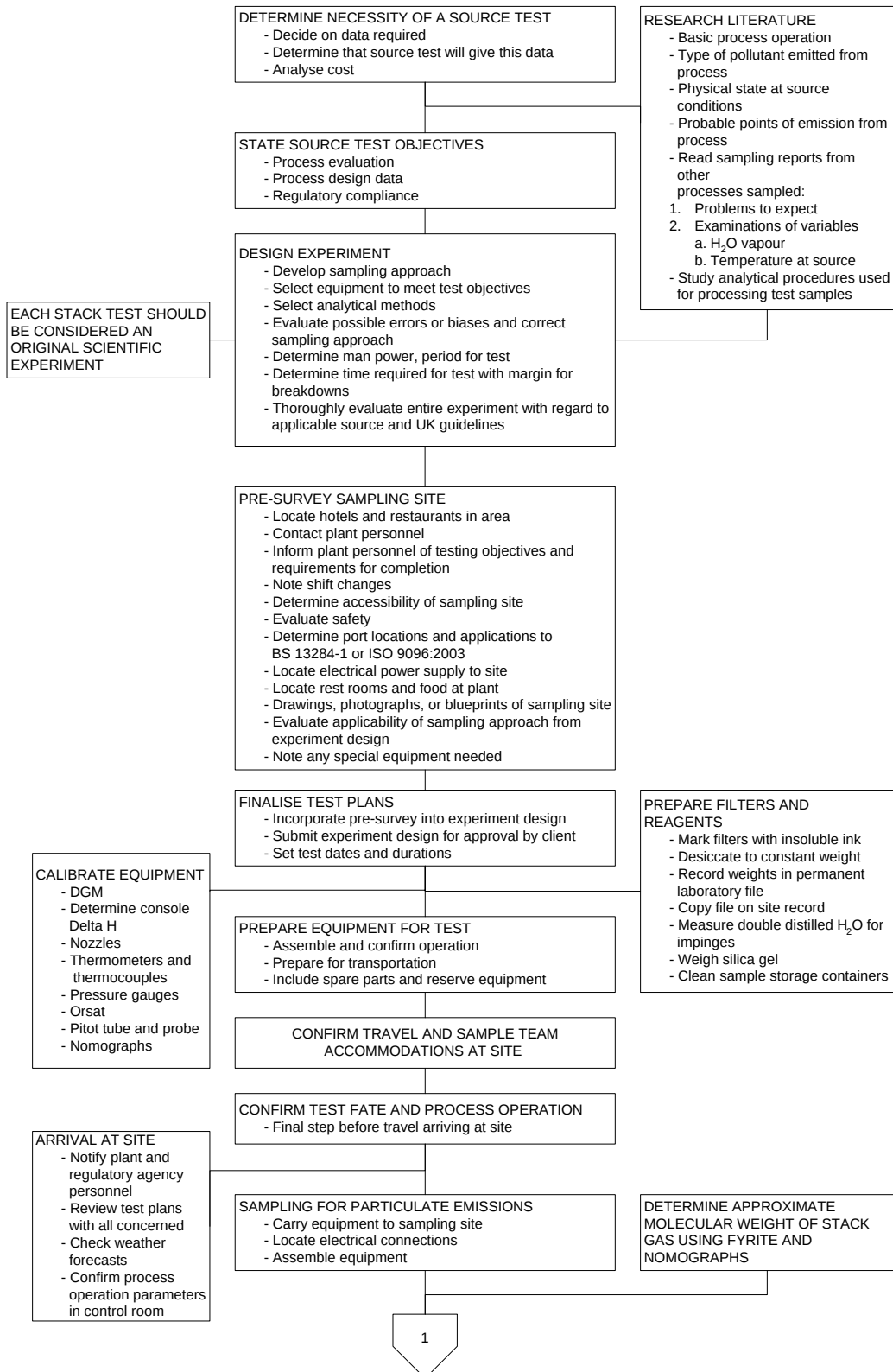
The data determined in this study may be utilised for further baseline comparisons against previous studies. all equipment which was hired in this study was sourced from an independent, UKAS accredited supply house.

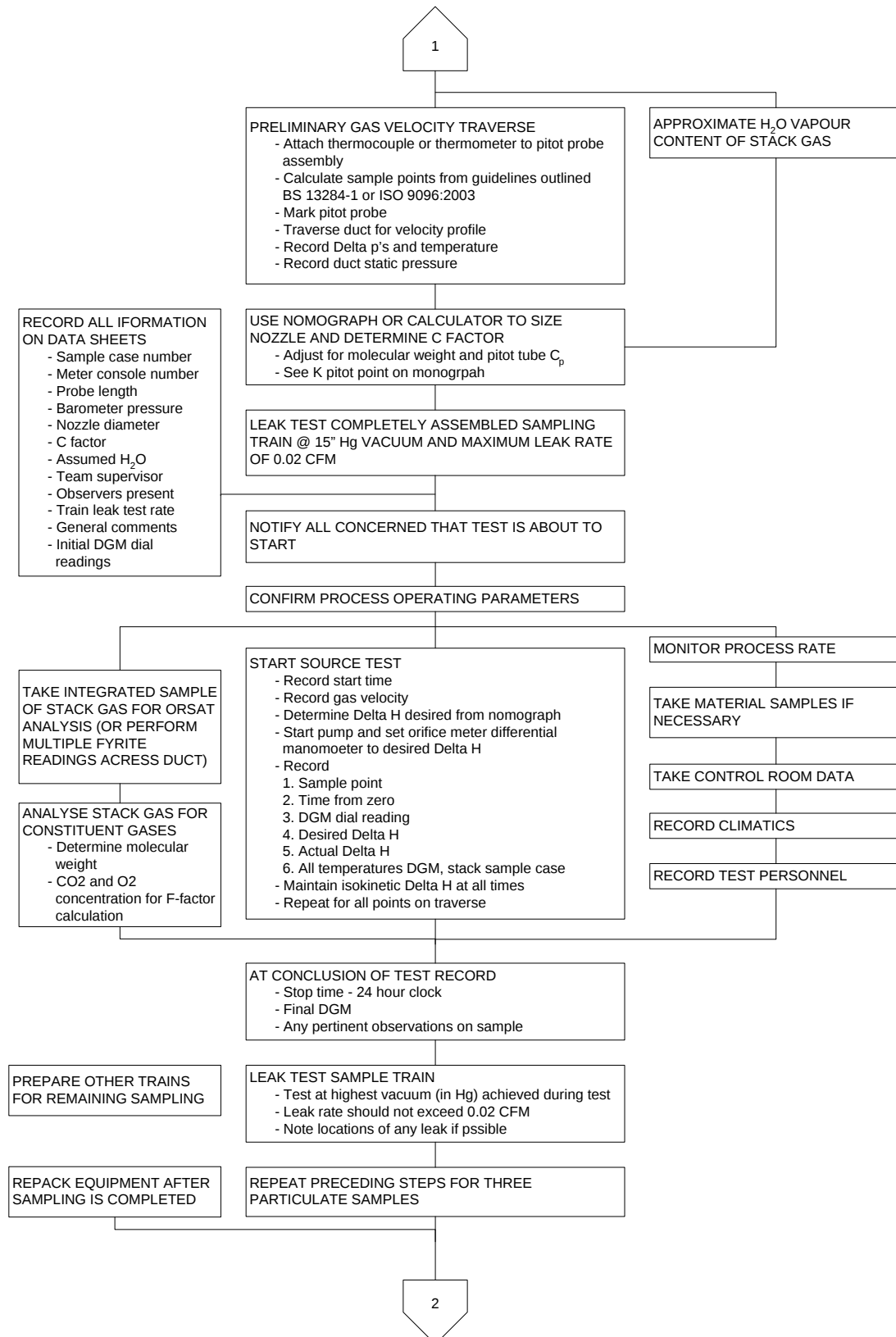
Uncertainty Data – Monitoring Test Methods.

Substance	Standard or Method	Uncertainty value
Particulate	ISO 9096: 2003	Uc =1.15 mg/m3 at a confidence of 95% or relative uncertainty of 23%
VOC (Total low range)	BS EN 12619	> 10 +/- 2 %



Planning and performing a stack test





2

SAMPLE CLEAN-UP AND RECOVERY

- Clean samples in laboratory or other clean area removed from site and protected from the outdoors
- Note sample conditions
- Store samples in quality assurance containers
- Mark and label all samples
- Pack carefully for shipping if analysis is not done on site

ANALYSE SAMPLES

- Follow BS 13284-1, ISO 9096:2003, HMIP A1, A2, M1, M2 guidelines
- Document procedures and any variations employed
- Prepare analytical Report Data

CALCULATE

- Moisture content of stack gas
- Molecular weight of gas
- Volume sampled at standard conditions
- Concentration / standard volume
- Control device efficiency
- Volumetric flow rate of stack gas
- Calculate pollutant mass rate

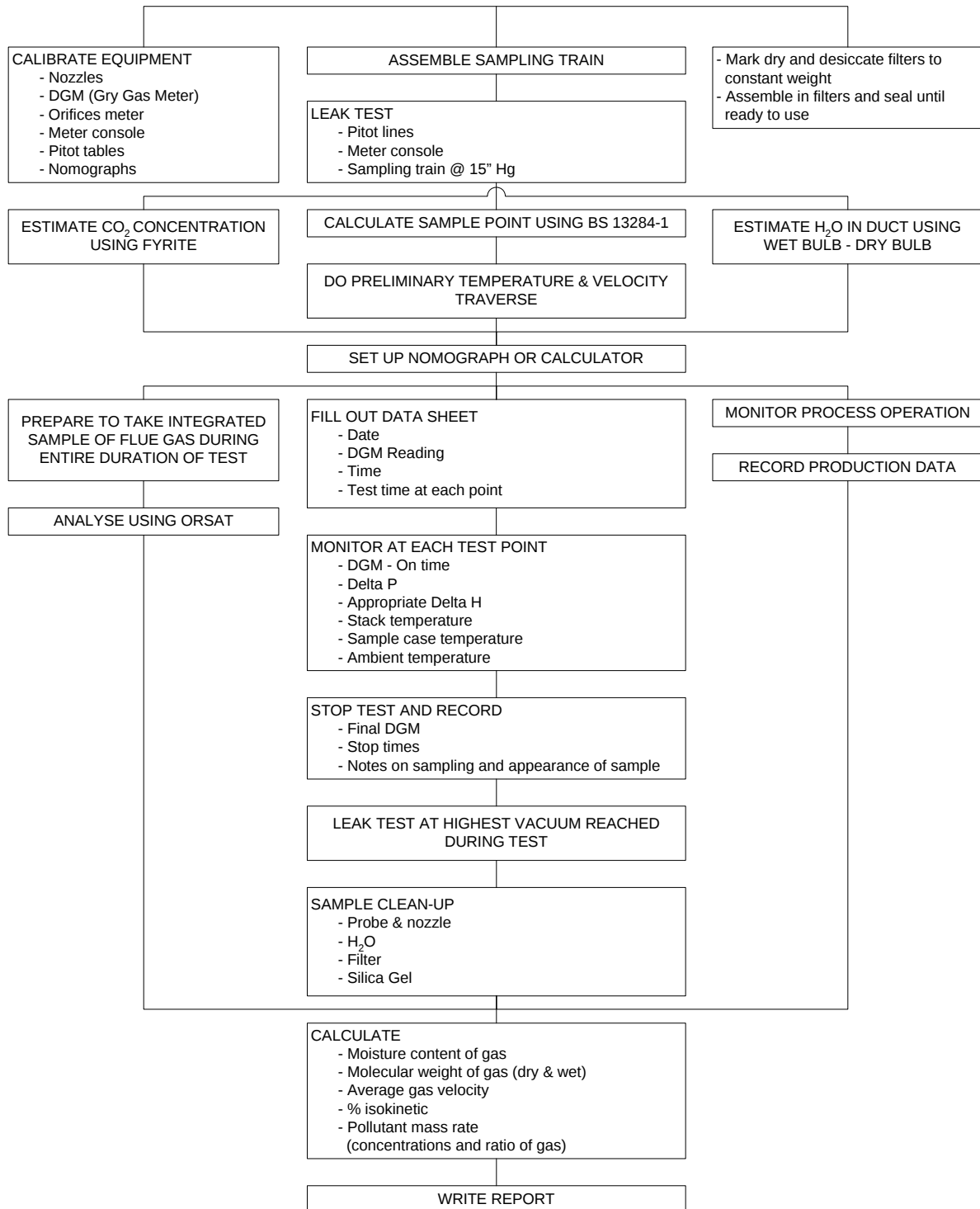
WRITE REPORT

- Prepare as possible legal document
- Summarise results
- Illustrate calculations
- Give calculated results
- Include all raw data (process & test)
- Attach descriptions of testing and analytical methods
- Signature of analytical and test personnel

SEND REPORT WITHIN MAXIMUM TIME TO INTERESTED PARTIES



Source Test Outline



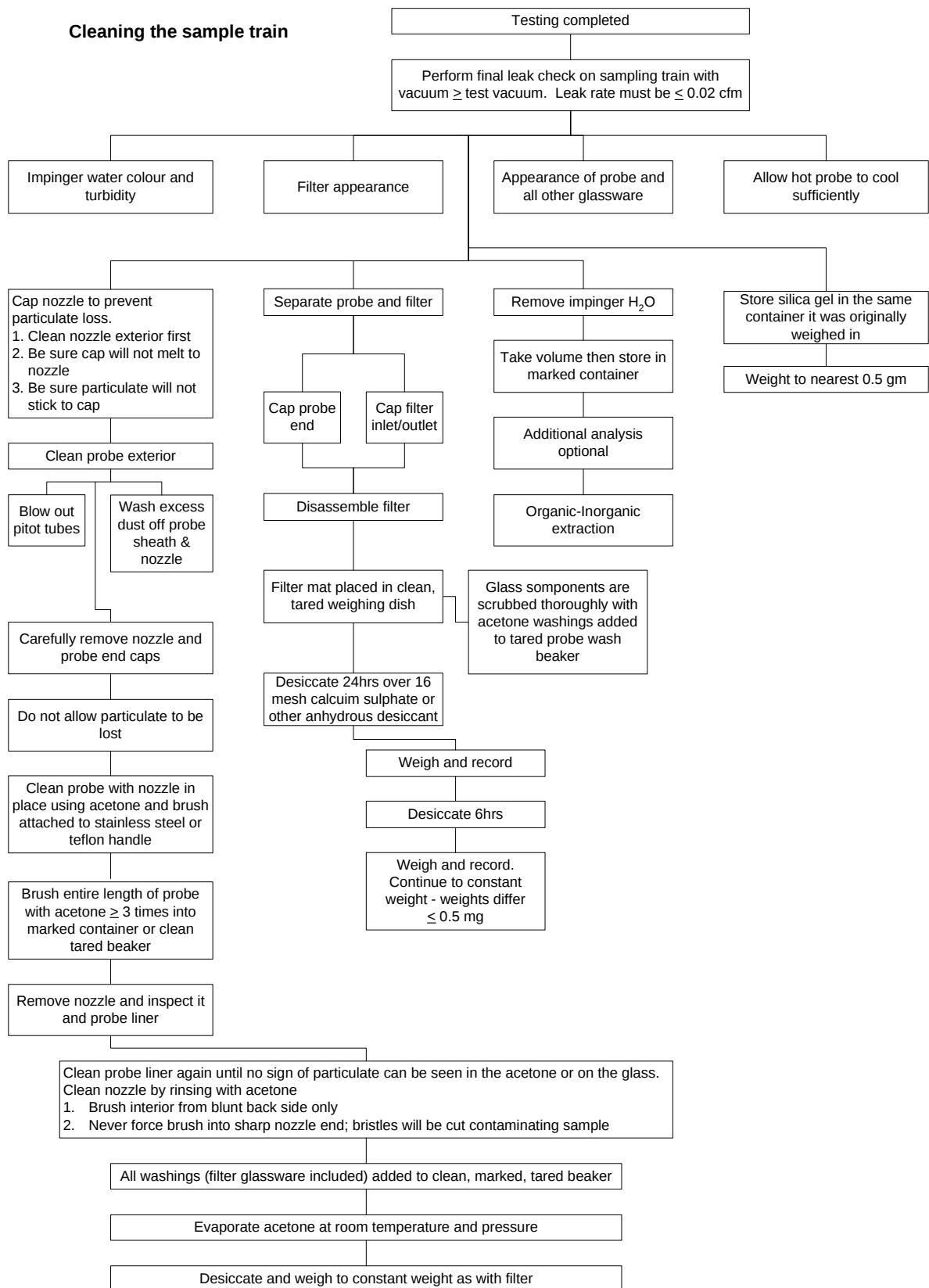


Table 1: Simple error analysis for particulate measurement, 4 Point Sampling (or 10 Point Sampling when Pitot Ratios >4:1≤9:1)

Type of Error	Source of Error	Quoted uncertainty	Estimate of component standard uncertainty (1SD)	Combined uncertainties (1SD)	Combined uncertainty (1SD)	Expanded uncertainty (95% confidence limits)
Precision-like Errors					±13.03%	±25.5%
Random	Errors in setting to isokinetic conditions	≤+1%	≤+0.58%	±4.66%		
	Minimum sampling time of 3 minutes	±8%	±4.62%			
Systematic						
Accuracy-like Errors						
Random	Measure flue dimensions to ±10mm/m	±2%	±1.15%	±1.15%	±13.03%	±25.5%
Systematic	Number of sampling points (see note below)	±13%	±6.63%	±7.22%		
	Minimum weight gain	assume ±2%	±1.5%			
	Pre=/Post-pitot reading within 10%	±2.5%	±1.44%			
	Temperature variations of 10% on 150°C	±1/5%	±0.87%			
	Gas flow axis deviates up to 30°	≤±3.5% velocity	≤+2.02% velocity			

Note: Type A component uncertainty, quoted at 95% confidence limits. All other component uncertainties assumed to be Type B.



Table 2: Simple error analysis for measurement of mass flow particulates when not all the requirements of ISO 9096: 2003 are met.

Deviation from standard: Only nearest 2 points of 4 on each of sampling lines can be reached (circular duct); pre/post sampling velocities differed by 20%; Highest to lowest pitot reading 15:1.

Type of Error	Source of Error	Quoted uncertainty	Estimate of component standard uncertainty (1SD)	Combined uncertainties (1SD)	Combined uncertainty (1SD)	Expanded uncertainty (95% confidence limits)
Precision-like Errors					±20.7%	±40.8%
Random	Errors in setting to isokinetic conditions	≤+1%	≤+0.58%	±4.66%		
	Minimum sampling time of 3 minutes	+8%	+4.62%			
Systematic						
Accuracy-like Errors						
Random	Measure flue dimensions to ±10mm/m	±2%	±1.15%	±1.15%		
Systematic	Number of sampling points, and highest:lowest pitot readings 15:1 (see note below)	±(13+12)%=25%	±12.78%	±14.88%		
	Bias due to non-symmetrical points	±7.5%	±4.33%			
	Minimum weight gain	assume ±2%	±1.5%			
	Pre/Post-pitot readings differ by 20%	±10%	±5.77%			
	Temperature variation of 10% on 150°C	±1.5%	±0.87%			
	Gas flow axis deviates up to 30°	≤+3.5% velocity	≤+2.02% velocity			

Note: Type A component uncertainty, quoted at 95% confidence limits. All other component uncertainties assumed to be Type B.



SECTION 4

VISUAL AND OLFACTORY ASSESSMENTS



4 VISUAL AND OLFACTORY ASSESSMENTS

4.1 VISUAL ASSESSMENT

In accordance with the provisions of LA-PPC/EPR an assessment of process-associated releases was undertaken.

The assessment was carried out with reference to the methods and procedures detailed in BS 2742C.1969.

The process related releases were evaluated: the discharge colour for all of the 2 off extraction systems were determined as colourless and less than Ringlemann shade 0.5.

4.2 OLFACTORY ASSESSMENT

In accordance with the provisions of LA-PPC/EPR an assessment of stack releases was undertaken at the adjacent upwind and downwind perimeter fence lines.

Perceptive odour evaluations were non quantitative and dependant upon the assessors, however an evaluation by subjective procedures was carried out by specialist personnel familiar with odour assessment techniques.

The site's releases were perceived as being of a low concentration odour, characteristic of "wet" and stoved paints and solvents, with a typically neutral, non-aggressive note determined only at the monitoring portals.

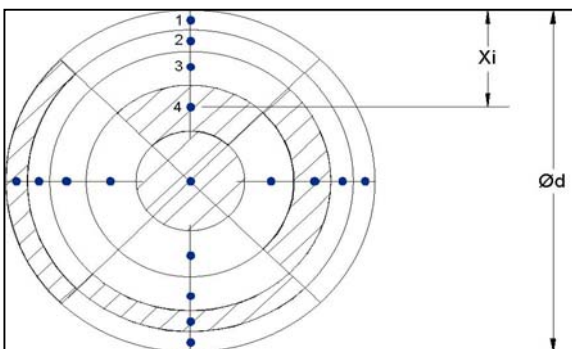


SECTION 5
MEAN EFFLUX VELOCITY MONITORING DATA



Pitot Measurements

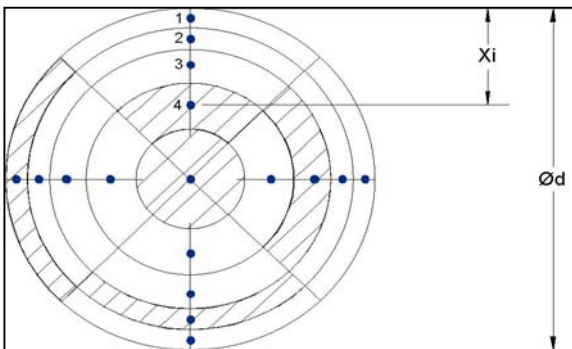
BS3405:		BS 9096:	Y
BS6069:		Please tick the relevant box	

Client:	Anglo ERI Limited		Date:	9th February 2010		
Address:	Little End Road		Operator:	T Growcott / K A Hall		
	Eaton Socon		Job Number:	HE 10 / 7161		
	St Neots		Location:	Roof Access, Main Building		
	Cambridgeshire		Instruments:	1m PITOT + PVM 100		
Details of Duct:	Spray Booth ERS 1			Atmos. P (pa)		Atmos. Temp K
Duct Shape:	Steel Circular		Initial:	100.9		279
Dimension / Dia.:	0.71m		Final:	101.3		283
Area:	0.3959m ²		Mean:	101.1		281
	Axis 1:		Axis 2:	Gas Homogeneity Check:		20 Gas Check
Traverse Point	Temp K	Temp K ²	Velocity kPa	v ²		
1	323	104329	74	5476		
2	323	104329	89	7921		
3	323	104329	102	10404		
4	323	104329	117	13689		
5	323	104329	86	7396		
6	323	104329	98	9604		
7	323	104329	94	8836	O2 reference	N/A
8	323	104329	97	9409	Humidity %	38% - 48%
9	323	104329	88	7744	Ambient K	279
10	323	104329	97	9409	Negative Pressure	Pass
11	323	104329	104	10816	Drift Angle	Pass
12	323	104329	123	15129	Dry Gas Correction	N/A
13	323	104329	117	13689	Pitot Correction	1
14	323	104329	119	14161	T Correction	
15	323	104329	124	15376	Vmax : Vmin	1.675
16	323	104329	112	12544	Tmax : Tmin	1
17	323	104329	110	12100	V _{rms}	103.9521949
Total	5491	1773593	1751	183703	Pitot Calibration	1
Average	323	104329	103	10806.05882	Static Pressure Pv (Pascals)	-1.29
RMS	323		103.9521949		Mean Stack Temperature K	323
					Moisture Content %	N/A



Pitot Measurements

BS3405:		BS 9096:	Y
BS6069:		Please tick the relevant box	

Client:	Anglo ERI Limited		Date:	9th February 2010		
Address:	Little End Road		Operator:	T Growcott / K A Hall		
	Eaton Socon		Job Number:	HE 10 / 7161		
	St Neots		Location:	Roof Access, Main Building		
	Cambridgeshire		Instruments:	1m PITOT + PVM 100		
Details of Duct:	Spray Booth ERS 1			Atmos. P (pa)		Atmos. Temp K
Duct Shape:	Steel Circular		Initial:	100.9		279
Dimension / Dia.:	0.71m		Final:	101.3		283
Area:	0.3959m ²		Mean:	101.1		281
	Axis 1:		Axis 2:	Gas Homogeneity Check:		20 Gas Check
Traverse Point	Temp K	Temp K ²	Velocity kPa	v ²		
1	319	101761	86	7396		
2	319	101761	98	9604		
3	319	101761	101	10201		
4	319	101761	107	11449		
5	319	101761	84	7056		
6	319	101761	94	8836		
7	319	101761	108	11664	O2 reference	N/A
8	319	101761	110	12100	Humidity %	38% - 48%
9	319	101761	74	5476	Ambient K	279
10	319	101761	86	7396	Negative Pressure	Pass
11	319	101761	102	10404	Drift Angle	Pass
12	319	101761	117	13689	Dry Gas Correction	N/A
13	319	101761	88	7744	Pitot Correction	1
14	319	101761	97	9409	T Correction	
15	319	101761	104	10816	Vmax : Vmin	1.581
16	319	101761	112	12544	Tmax : Tmin	1
17	319	101761	113	12769	V _{rms}	99.57350226
Total	5423	1729937	1681	168553	Pitot Calibration	1
Average	319	101761	98.88235294	9914.882353	Static Pressure Pv (Pascals)	0.87
RMS	319		99.57350226		Mean Stack Temperature K	319
					Moisture Content %	N/A



5 MEAN EFFLUX VELOCITY MONITORING RESULTS

The following parameters were determined for each defined extraction system; -

Stack ref.	Location and shape	Discharge Temp degrees K	Tmax:Tmin	Vmax:Vmin	Corrected Mean Efflux Velocity m/sec
1	ERI S1 Circular	287.9	1.001	1.675	12.68
2	ERI S2 Circular	286.4	1.001	1.581	12.41

Stack ref.	Location and shape	Droplet Test	Homogenous Mix	Flow Drift	Minimum Flow Provisions
1	ERI S1 Circular	Free from droplets	20 spot tests CO meter	Pass	Pass
2	ERI S2 Circular	Free from droplets	20 spot tests CO meter	Pass	Pass

These results are reported in accordance with sampling protocol, corrected to standard conditions as detailed in process specific PG 6/33 (2004) note provisions.

The field sheets are retained within Halcyon's IT systems for future reference.



SECTION 6
ANALYTICAL RESULTS



6 ANALYTICAL RESULTS

The following analytical results were determined whilst normal production operations took place over specified sampling schedules;-

Stack ref	Location and shape	TPM mg/m ³	VOC as C mg/m ³	Isocyanate mg/m ³
1	ERI S1 Circular	1.86	8.2	< 0.01
2	ERI S2 Circular	1.04	4.27	< 0.01

* denotes emission discharges above the current PG 6/33 maximum limits.

These results are reported in accordance with the protocol defined by PG 6/33 (2004) guidance note and are expressed at standard reference conditions of 273.15K and 101.3 kPa, without correction for water vapour.

The following tables define monitoring schedules and results.



Stack ERI S1 – Volatile Organic Compounds (VOC as C)

Job Number:	HE 10 / 7161
Client:	Anglo
Date:	9th February 2010
Release Point Stack Ref	ERI S1
Instrument Type	FID
Calibration Gas	Methane
Sample Number	7161VOC/001/380
Test Start (Ti)	09.25
Test Finish (Tf)	11.00
Test Duration (mins)	95
% Carbon	75
Sampling Rate Interval (secs)	15
No. of Samples	380
Maximum Reading (mgC/m ³)	14
Minimum Reading (mgC/m ³)	0
Mean Reading (mgC/m ³)	8.2

Stack ERI S2 Volatile Organic Compounds (VOC as C)

Job Number:	HE 10 / 7161
Client:	Anglo
Date:	9th February 2010
Release Point Stack Ref	ERI S2
Instrument Type	FID
Calibration Gas	Methane
Sample Number	7161VOC/001/400
Test Start (Ti)	09.20
Test Finish (Tf)	11.00
Test Duration (mins)	100
% Carbon	75
Sampling Rate Interval (secs)	15
No. of Samples	400
Maximum Reading (mgC/m ³)	8
Minimum Reading (mgC/m ³)	0
Mean Reading (mgC/m ³)	4.27



Stack ERI S1 – Isocyanates (as NCO)

Job Number:	HE 10 / 7161
Client:	Anglo
Date:	9th February 2010
Release Point Stack Ref	ERI S1
US EPA 207-1 Sampling Train	-
Sample Number	7161/NCO/001/2
Test Start (Ti)	09.25
Test Finish (Tf)	11.00
Test Duration (mins)	95
Sampling Rate Interval (mins)	30
No. of Samples	3 x 30 mins
Mean Reading (mg/m ³)	< 0.01

ERI Stack S2 – Isocyanates (as NCO)

Job Number:	HE 10 / 7161
Client:	Anglo
Date:	9th February 2010
Release Point Stack Ref	ERI S2
US EPA 207-1 Sampling Train	-
Sample Number	7161/NCO/001/2
Test Start (Ti)	09.20
Test Finish (Tf)	11.00
Test Duration (mins)	100
Sampling Rate Interval (mins)	30
No. of Samples	3 x 30 mins
Mean Reading (mg/m ³)	< 0.01



Stack ERI S1 – Total Particulate Matter

Job Number:	HE 10 / 7161
Client:	Anglo
Date:	9th February 2010
Release Point Stack Ref	ERI S1
Instrument Type	Anderson Portable
Sample Number	7161/TPM/001/2
Test Start (Ti)	09.35
Test Finish (Tf)	11.00
Test Duration (mins)	85
No. of Samples	2 x 150 mins
Maximum Reading (mg/m ³)	2.19
Minimum Reading (mg/m ³)	1.82
Mean Reading (mg/m ³)	1.96

Stack ERI S2 Total Particulate Matter

Job Number:	HE 10 / 7161
Client:	Anglo
Date:	9th February 2010
Release Point Stack Ref	ERI S2
Instrument Type	Anderson Portable
Sample Number	7161/TPM/001/2
Test Start (Ti)	09.35
Test Finish (Tf)	11.00
Test Duration (mins)	85
No. of Samples	2 x 150 mins
Maximum Reading (mg/m ³)	2.00
Minimum Reading (mg/m ³)	0.87
Mean Reading (mg/m ³)	1.04



APPENDIX 1

INSTRUMENTATION CALIBRATION LOG



HALCYON ENVIRONMENTAL CALIBRATION RECORD LOG

	Doc. Ref:	CL001
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No.	Equipment	Serial Number	Model	Date of Calibration	Certificate Number
01	Airflow Developments	114575	PVM 100	14.12.2009	IC1145P
02	Airflow Developments	N / A	BS1042 2A	14.12.2009	IC1145P
03	Testo Analyser	00724899	325-1	10.09.2009	20615
04	Testo Flue GHS Pro BE	N / A	060095 2A	10.09.2009	20615
05	Rothero and Mitchell	7173	Airflow 3	Calibrated Internally Against Standard	HE 09 / 22612
06	Rothero and Mitchell	6886	Airflow 3	"	HE 09 / 22613
07	Rothero and Mitchell	4130	Airflow 3	"	HE 09 / 22614
08	Rothero and Mitchell	5217	Airflow 3	"	HE 09 / 22616
09	Rothero and Mitchell	9413	Airflow 3	"	HE 09 / 22617
10	Rothero and Mitchell	9228	Airflow 3	"	HE 09 / 22618
11	Rothero and Mitchell	1927	Airflow 3	"	HE 09 / 22615
12	Rothero and Mitchell	1567	Airflow 3	"	HE 09 / 22610
13	SKC	22721	22549 Rotameter 0.300mls/min	10.09.2009	10712
14	Knauer Modular HPLC System	162217		Daily Using Supelco Standards	
15	Digitron with pitot and thermo micro anemometer	451097801	PM 80	10.09.2009	ATP
16	Signal Instruments 3030	IHS		Hire certification	
17	Bubble Meter	22806	Optiflow 420	10.10.2009	HE 09 / 22714
18	Perkin Elmer 8600 GC	1092	S410 9C	16.11.2009	HE 09 / 22617

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Approved:												<i>Halcyon Environmental</i>