# Appendix A7.4 2016 VOC Emission Survey

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# KLRP-VOC/SURFACEEMISSIONS/2016/1 SURFACE EMISSIONS SURVEY AT KERDIFFSTOWN, NAAS, CO. KILDARE

**PERFORMED BY ODOUR MONITORING IRELAND ON BEHALF OF JACOBS**

| | |
|---|---|
| **PREPARED BY:** | Dr. John Casey & Dr. Brian Sheridan |
| **ATTENTION:** | Ms. Claire McLaughlin |
| **FACILITY NAME:** | Kerdiffstown |
| **DATE OF MONITORING VISIT:** | 26th July 2016 |
| **NAME AND ADDRESS OF CLIENT ORGANISATION:** | Kerdiffstown Landfill Remediation Project (KLRP), Naas, Co. Kildare |
| **NAME AND ADDRESS OF MONITORING ORGANISATION:** | Odour Monitoring Ireland, Unit 32 DeGranville Court, Dublin Road, Trim, Co. Meath |
| **DATE OF REPORTING:** | 29th Aug. 2016 |
| **NAME AND THE FUNCTION OF THE PERSON APPROVING THE REPORT:** | Dr. Brian Sheridan, Managing Partner, Odour Monitoring Ireland |
| **REPORT NUMBER:** | 2016351(1) |
| **REVIEWERS:** | |

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## DOCUMENT AMENDMENT RECORD

**Client:** ***Kildare County Council***

**Title:** KLRP-VOC/SurfaceEmissions/2016/1 Surface emissions Survey at Kerdiffstown Landfill Remediation Project, Naas, Co. Kildare

| **Project Number:**2016351 | | | **Document Reference:** KLRP-VOC/SurfaceEmissions/2016/1 | | |
|---|---|---|---|---|---|
| 2016351(1) | Document for review | JWC | BAS | JWC | 29/08/2016 |
| | | | | | |
| | | | | | |
| | | | | | |
| **Revision** | **Purpose/Description** | **Originated** | **Checked** | **Authorised** | **Date** |

## Executive Summary

Kildare County Council commissioned Odour Monitoring Ireland to perform a surface emissions survey at Kerdiffstown Landfill in order to ascertain any likely sources of facility gas surface emissions. The survey was carried out on the 26th July 2016.

During the surface emissions survey, the following tasks were performed on site:

1. Identification of the key mechanisms that lead to the release of facility gas surface emissions from the site.
2. Identify geographically on a site map, the locations of facility gas surface emissions in order to perform remediation of the identified surface emissions areas.

The following conclusions were drawn from the survey:

- Twelve zones of surface emissions were identified within the facility that exceeded recommended trigger levels. These zones are identified geographically on a site map contained in *Appendix I* of this report.
- Currently none of the facility area is permanently capped. Therefore the surface emission criterion averaged over the capped area does not apply. There were three surface emissions zones greater than or equal to 500 ppm around identified features. There were nine surface emissions zones greater than or equal to 100 ppm instantaneous reading on open surfaces within the facility footprint.
- Nine zones of surface emissions were identified within the facility on 14th October 2015.

# 1. Introduction

## 1.1. Background to work

Odour Monitoring Ireland was commissioned by Kildare County Council to perform a specified independent Volatile organic compound surface emissions survey at the Kerdiffstown facility. The assessment involved a volatile organic compound (VOC) surface emissions survey of the facility in order to ascertain the VOC emission points and mark them upon a map for remediation. This report presents a summary of the findings of a VOC surface emissions survey at Kerdiffstown Landfill Remediation Project (KLRP), Naas, Co. Kildare. The report is based on scientific measurements and observations made during a site visit conducted on the 26th July 2016.

## 1.2. Scope of work

The main aims of the survey included:

- Surface emissions monitoring in accordance with AG6 requirements carried out by Dr. John Casey,
- Discussion meeting with facility manager once survey was complete in order to communicate main surface emissions areas for immediate remediation, where necessary

# 2. Techniques used

This section describes the techniques used throughout the study. The surface emissions surveying and reporting was performed by Dr. John Casey, Odour Monitoring Ireland. Dr. John Casey has preformed surface emissions monitoring survey's on behalf of Odour Monitoring Ireland for regulatory bodies in Ireland and Northern Ireland, local authorities in Ireland, private waste operators in Ireland and borough councils in Northern Ireland. A full documented list of previous survey are available upon request.

## 2.1. "Odour hog" monitoring within the facility

The "odour hog" (i.e. Version 2, 4 years old with less than 3.5 second response time for the flame ionisation detector (FID) VOC analyser is a portable, intrinsically safe, survey VOC dual monitor, which provides fast and accurate readings of organic and inorganic vapours. A photo ionisation detector (PID) uses an ultraviolet (UV) light source (*photo*) to ionise a gas sample and detect its concentration. Ionisation occurs when a molecule absorbs the high energy UV light, ejecting a negatively charged electron and forming of positively charged molecular ion. The gas becomes electrically charged. These charged particles produce a current that is easily measured at the sensor electrodes. Only a small fraction of the VOC molecules are ionised. A PID does not respond to methane. A FID is similar to a flame thermocouple detector, but measures the ions from the flame instead of the heat generated. The FID detects the methane fraction, which provides greater sensitivity in terms of methane surface emissions detection but not necessarily odour hence why the PID data is also interpreted. The FID/PID analyser was calibrated with certified reference material isobutylene and methane before commencement of the survey, (see calibration certificates for gases used in Appendix II). The calibration readings were rechecked in accordance with AG6 requirements.

Using the continuous kinematic "odour hog" with integrated GPS (i.e Magellan Professional with sub centimetre accuracy post processed), the capping of the facility was surveyed for potential surface emissions areas. Those areas identified were geo-referenced and highlighted for remediation. This technique is useful for comparison in surface emissions area within the same facility on different surveys. The surface emissions maps generated for the particular facility can be used to assess the effectiveness of implemented mitigation techniques and to qualitatively assess the nature of surface emissions from the facility. All surface emissions surveying was carried out in accordance with Air Guidance Note 6.

Efforts should be made to attain surface emissions <100 ppm from open surfaces and <500 ppm around features such as vertical wells, leachate collection sumps, leachate slope risers and other projections out of the waste body (Casey et al., 2008). These are minimum standards, which should lead to greater facility collection efficiencies thus reducing the impact on the general environment.

## 2.2. Meteorological conditions

*Table 2.1* illustrates the predominant wind direction during the monitoring exercise. The meteorological conditions were characterised for the day of monitoring and were as follows:

**Table 2.1.** Meteorological conditions during Kerdiffstown facility TVOC survey.

| **26th Jul. 2016** | |
|---|---|
| Average wind speed 13 km/hr | Wind direction southerly |
| Temperature 19$^0$C | 1019 mbar |
| Dry weather | -- |

During the VOC and gas field survey, wind deviated from a southerly direction.

## 2.3 Current facility gas collection infrastructure on the facility

The current collection system consists of vertical wells, there are gravity condensate removal devices on the landfill gas abstraction system within the facility. Vertical facility gas abstraction is employed in the facility. There are two operational installed facility gas enclosed flares (500 $m^3$/hr & 250 $m^3$/hr) capacity enclosed flares. At the time of the survey one flare was in operation.

# 3. Results

## 3.1. Volatile organic compound surface emissions locations identified within KLRP

*Figure 6.2 and Table 3.1* illustrates the results obtained for the capping surface emissions survey. A total of twelve individual surface emissions zones were identified. Each surface emissions zone is discussed separately in this manner in order to allow for the development of remediation strategies to mitigate the individual surface emissions areas.

**Table 3.1.** Capping VOC surface emission locations results with source identities correlating with *Figure 6.2 (see Appendix I)*.

| Location ID | Easting (m) | Northing (m) | Max VOC conc. (ppm) | Identification and Mitigation | Recommended trigger levels |
|---|---|---|---|---|---|
| K1 | 291395 | 222205 | 557 | Discrete Feature: Intermediate Cap, Vertical Well G35. Investigate and remediate the cause of the surface emissions. | <500ppm |
| K2 | 291407 | 222233 | 594 | Discrete Feature: Intermediate Cap, Vertical Well G31. Investigate and remediate the cause of the surface emissions. | <500ppm |
| K3 | 291374 | 222272 | 3,847 | Discrete Location: Intermediate Cap, Surface area. Investigate and remediate the cause of the surface emissions. | <100ppm |
| K4 | 291326 | 222261 | 387 | Discrete Location: Intermediate Cap, Surface area. Investigate and remediate the cause of the surface emissions. | <100ppm |
| K5 | 291380 | 222296 | 184 | Discrete Location: Intermediate Cap, Surface area. Investigate and remediate the cause of the surface emissions. | <100ppm |
| K6 | 291369 | 222337 | 398 | Discrete Location: Intermediate Cap, Surface area. Investigate and remediate the cause of the surface emissions. | <100ppm |
| K7 | 291291 | 222310 | 6,947 | Discrete Feature: Intermediate Cap, Vertical Well. Investigate and remediate the cause of the surface emissions. | <500ppm |
| K8 | 291220 | 222295 | 154 | Discrete Location: Intermediate Cap, Surface area. Investigate and remediate the cause of the surface emissions. | <100ppm |
| K9 | 291215 | 222327 | 384 | Discrete Location: Intermediate Cap, Surface area. Investigate and remediate the cause of the surface emissions. | <100ppm |
| K10 | 291238 | 222333 | 3,954 | Discrete Location: Intermediate Cap, Surface areas. Investigate and remediate the cause of the surface emissions. | <100ppm |
| K11 | 291246 | 222369 | 4,178 | Discrete Location: Intermediate Cap, Surface area. Investigate and remediate the cause of the surface emissions. | <100ppm |
| K12 | 291263 | 222324 | 3,749 | Discrete Location: Intermediate Cap, Surface areas. Investigate and remediate the cause of the surface emissions. | <100ppm |

Twelve sources of facility gas surface emissions were identified (*see Figures 6.2 and Table 3.1*) within the facility.

Currently none of the facility area is permanently capped. Therefore the surface emission criterion averaged over the capped area does not apply. There were three surface emissions zones greater than or equal to 500 ppm around identified features. There were nine surface emissions zones greater than or equal to 100 ppm instantaneous reading on open surfaces within the facility footprint.

### 3.2. Close out meeting with facility manager

Following completion of the surface emissions survey, the surface emissions team and the facility manager discussed all aspects and general conclusions of the survey. The facility manager was informed of the potential areas of surface emissions (see section 2.4 and section 3 of the report for details).

## 4. Conclusions

The following conclusions were drawn from the survey of Kerdiffstown Facility:

- The surface emissions contour map generated from the kinematic Volatile organic compound (VOC) survey illustrated surface areas of facility gas surface emissions.
- Currently none of the facility area is permanently capped. Therefore the surface emission criterion averaged over the capped area does not apply. There was three surface emissions zones greater than or equal to 500 ppm around identified features. There were nine surface emissions zones greater than or equal to 100 ppm instantaneous reading on open surfaces within the facility footprint.

## 5. References

- Casey, J.W., Sheridan, B.A., Henry, M., Reynolds, K., (2008). Effective tools for managing odours from facility facilities. International Conference on Environmental Odour Monitoring and Control**,** Rome, Italy**,** July 6-8, 2008**.**

# 6. *Appendix I*- Volatile organic compound surface emissions contour map & Cell capping outline & LFG infrastructure map

**Figure 6.1.** Cell capping outline & LFG infrastructure on the facility.

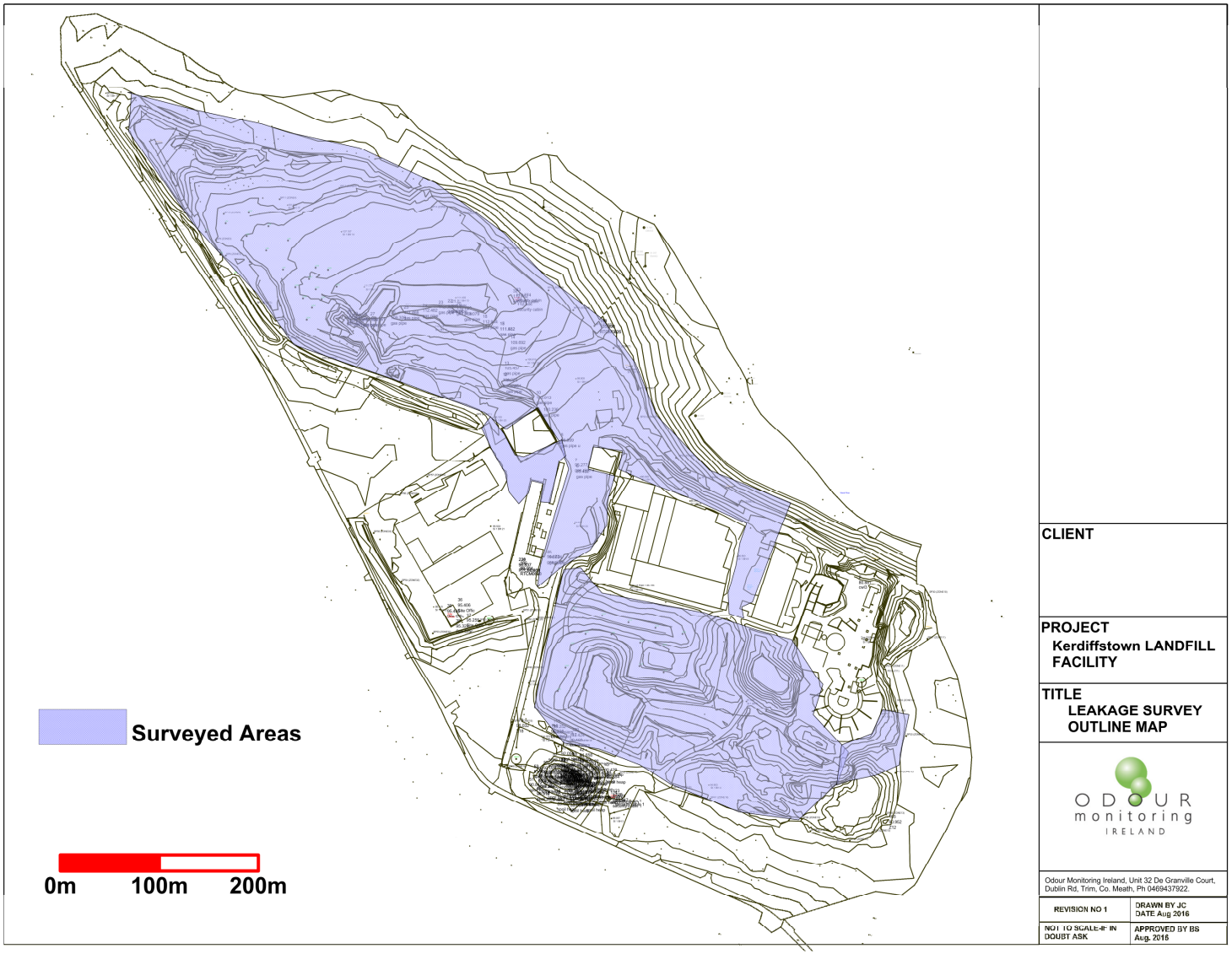
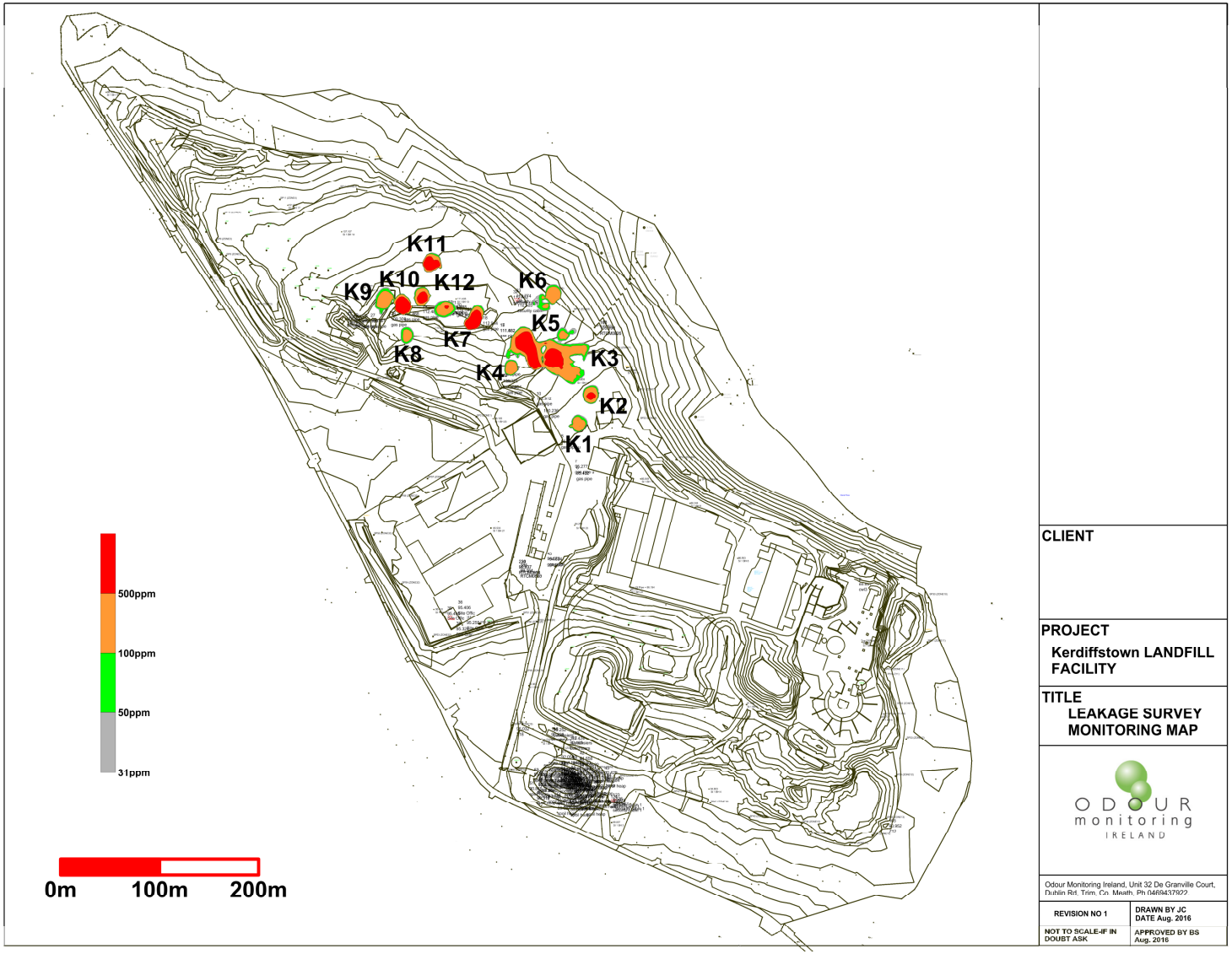

Surveyed Areas
0m
100m
200m
CLIENT
PROJECT
Kerdiffstown LANDFILL FACILITY
TITLE
LEAKAGE SURVEY OUTLINE MAP
ODOUR monitoring IRELAND
Odour Monitoring Ireland, Unit 32 De Granville Court, Dublin Rd, Trim, Co. Meath, Ph 0469437922.
REVISION NO 1
DRAWN BY JC
DATE Aug 2016
NOT TO SCALE-IF IN DOUBT ASK
APPROVED BY BB
Aug. 2016

**Figure 6.2.** Facility gas surface emissions monitoring within the facility (colour scale area indicating TVOC gas colour scale).


K11
K10
K12
K9
K6
K5
K7
K8
K3
K4
K2
K1
500ppm
100ppm
50ppm
31ppm
0m
100m
200m
CLIENT
PROJECT
Kerdiffstown LANDFILL FACILITY
TITLE
LEAKAGE SURVEY MONITORING MAP
ODOUR monitoring IRELAND
Odour Monitoring Ireland, Unit 32 De Granville Court, Dublin Rd, Trim, Co. Meath. Ph 0469437922
REVISION NO 1
DRAWN BY JC
DATE Aug. 2016
NOT TO SCALE-IF IN DOUBT ASK
APPROVED BY BS
Aug. 2016

# *7. Appendix II*-Calibration certificates and procedures.

## 7.1 Span & Calibration procedure

Necessary Calibration gases: Zero gas (0ppm), 98.8ppm and 988ppm methane (Calibration certificates below).

Calibration is carried out in accordance with manufacturers guidelines.

Location: Zero span instrument onsite.

Frequency: Before, midway through, and after the surface emissions survey, typically therefore at 3-4 hour intervals. If the survey only last 2 to 3 hours the instrument is checked before and after the event.

Instrument settling: The FID is switched on and left to settle for a period of 30 minutes minimum.

Span Procedure: The zero and span gases shall be introduced under the same flow and pressure conditions using the sample probe at the end of the sample line. The adjustment procedure shall be as follows:

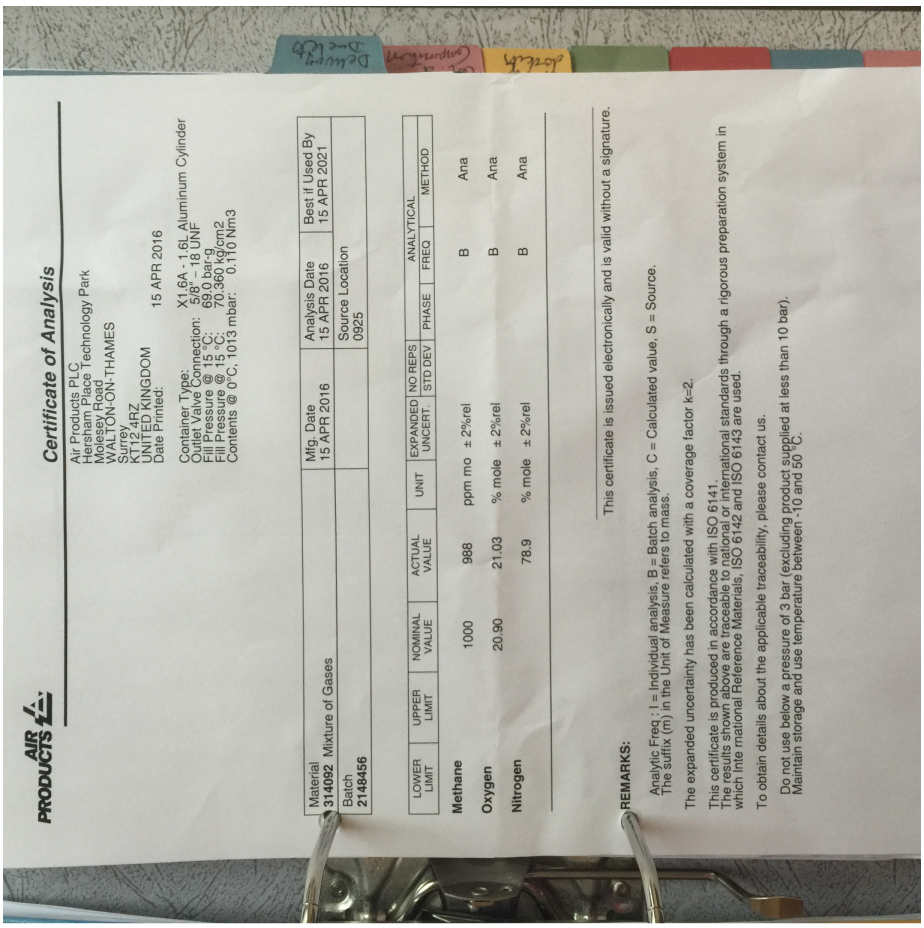
a) Feed the zero gas (0ppm) into the FID and set the zero;

b) Feed the span gas (98.8ppm) and adjust the instrument accordingly;

c) Feed the zero gas into the FID once more and check that the reading returns to zero; if not repeat steps a) to c).

d) repeat procedure A to C to verify

Equipment is maintained and operated as specified by the manufacturer.



AIR PRODUCTS

## Certificate of Analysis

Air Products PLC
Hersham Place Technology Park
Molesey Road
WALTON-ON-THAMES
Surrey
KT12 4RZ
UNITED KINGDOM
Date Printed: 15 APR 2016

Container Type: X1.6A - 1.6L Aluminum Cylinder
Outlet Valve Connection: 5/8" – 18 UNF
Fill Pressure @ 15 °C: 69.0 bar-g
Fill Pressure @ 15 °C: 70.360 kg/cm2
Contents @ 0°C, 1013 mbar: 0.110 Nm3

| Material | Mfg. Date | Analysis Date | Best if Used By |
|---|---|---|---|
| 314092 Mixture of Gases | 15 APR 2016 | 15 APR 2016 | 15 APR 2021 |
| Batch 2148456 | | Source Location 0925 | |

| | LOWER LIMIT | UPPER LIMIT | NOMINAL VALUE | ACTUAL VALUE | UNIT | EXPANDED UNCERT. | NO REPS STD DEV | PHASE | ANALYTICAL FREQ | METHOD |
|---|---|---|---|---|---|---|---|---|---|---|
| **Methane** | | | 1000 | 988 | ppm mo | ± 2%rel | | | B | Ana |
| **Oxygen** | | | 20.90 | 21.03 | % mole | ± 2%rel | | | B | Ana |
| **Nitrogen** | | | | 78.9 | % mole | ± 2%rel | | | B | Ana |

This certificate is issued electronically and is valid without a signature.

**REMARKS:**

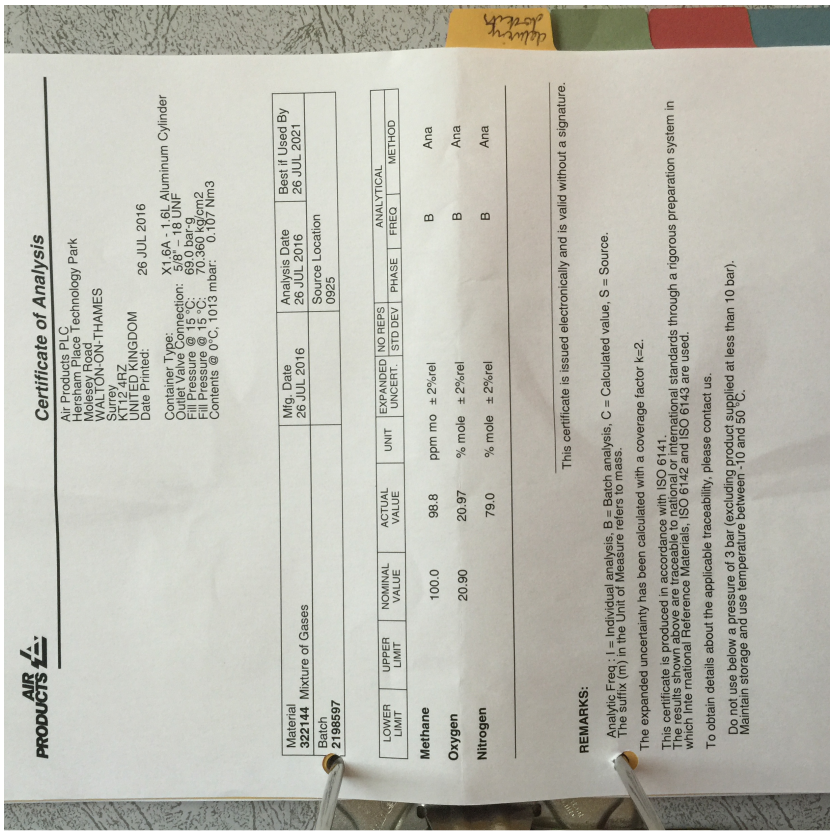
Analytic Freq : I = Individual analysis, B = Batch analysis, C = Calculated value, S = Source.
The suffix (m) in the Unit of Measure refers to mass.

The expanded uncertainty has been calculated with a coverage factor k=2.

This certificate is produced in accordance with ISO 6141.
The results shown above are traceable to national or international standards through a rigorous preparation system in which inte rnational Reference Materials, ISO 6142 and ISO 6143 are used.

To obtain details about the applicable traceability, please contact us.

Do not use below a pressure of 3 bar (excluding product supplied at less than 10 bar).
Maintain storage and use temperature between -10 and 50 °C.



AIR PRODUCTS

## Certificate of Analysis

Air Products PLC
Hersham Place Technology Park
Molesey Road
WALTON-ON-THAMES
Surrey
KT12 4RZ
UNITED KINGDOM
Date Printed: 26 JUL 2016

Container Type: X1.6A - 1.6L Aluminum Cylinder
Outlet Valve Connection: 5/8" – 18 UNF
Fill Pressure @ 15 °C: 69.0 bar-g
Fill Pressure @ 15 °C: 70.360 kg/cm2
Contents @ 0°C, 1013 mbar: 0.107 Nm3

| Material | Mfg. Date | Analysis Date | Best if Used By |
|---|---|---|---|
| 322144 Mixture of Gases | 26 JUL 2016 | 26 JUL 2016 | 26 JUL 2021 |
| Batch 2198597 | | Source Location 0925 | |

| | LOWER LIMIT | UPPER LIMIT | NOMINAL VALUE | ACTUAL VALUE | UNIT | EXPANDED UNCERT. | NO REPS STD DEV | PHASE | ANALYTICAL FREQ | METHOD |
|---|---|---|---|---|---|---|---|---|---|---|
| **Methane** | | | 100.0 | 98.8 | ppm mo | ± 2%rel | | | B | Ana |
| **Oxygen** | | | 20.90 | 20.97 | % mole | ± 2%rel | | | B | Ana |
| **Nitrogen** | | | | 79.0 | % mole | ± 2%rel | | | B | Ana |

This certificate is issued electronically and is valid without a signature.

**REMARKS:**

Analytic Freq : I = Individual analysis, B = Batch analysis, C = Calculated value, S = Source.
The suffix (m) in the Unit of Measure refers to mass.

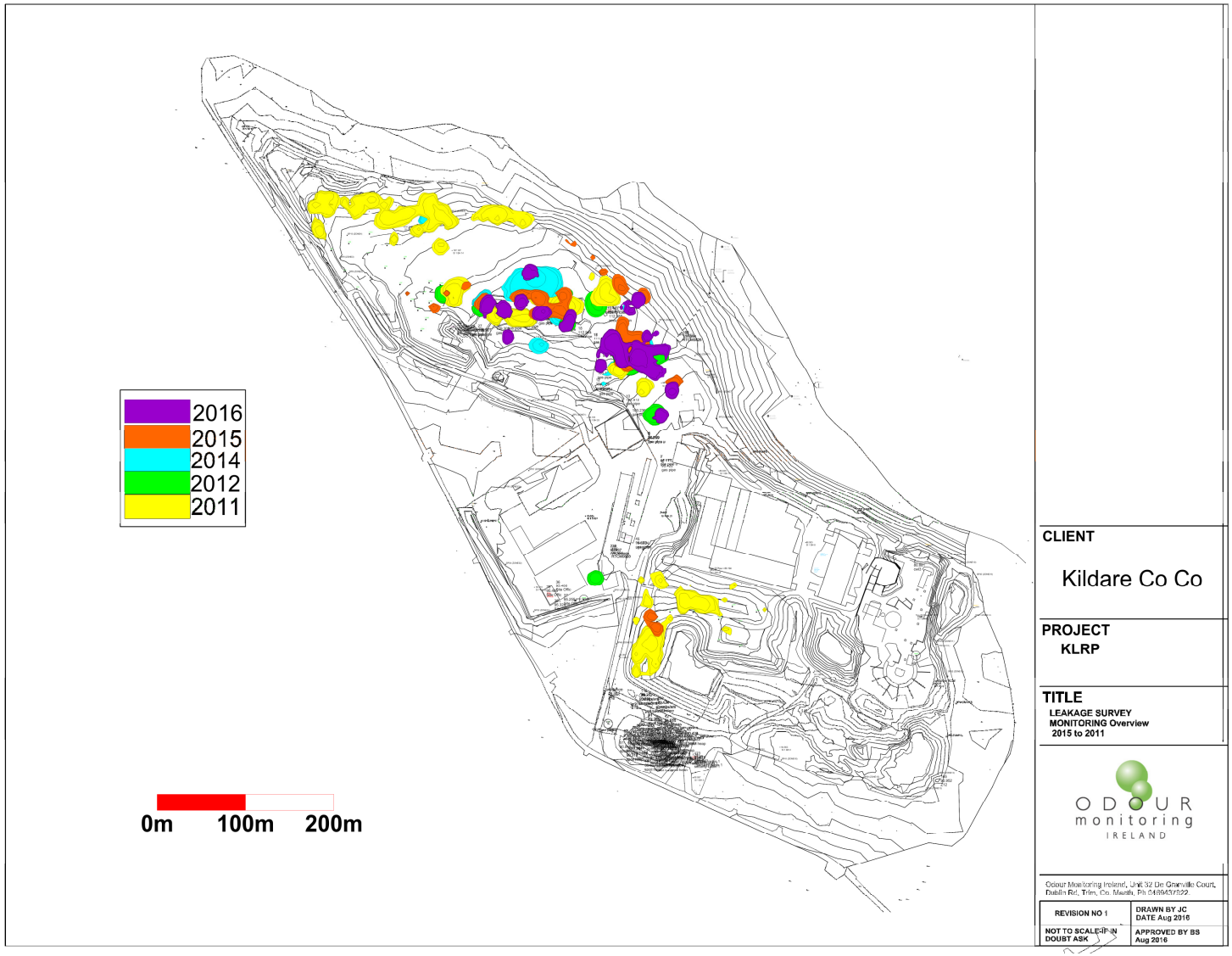
The expanded uncertainty has been calculated with a coverage factor k=2.

This certificate is produced in accordance with ISO 6141.
The results shown above are traceable to national or international standards through a rigorous preparation system in which inte rnational Reference Materials, ISO 6142 and ISO 6143 are used.

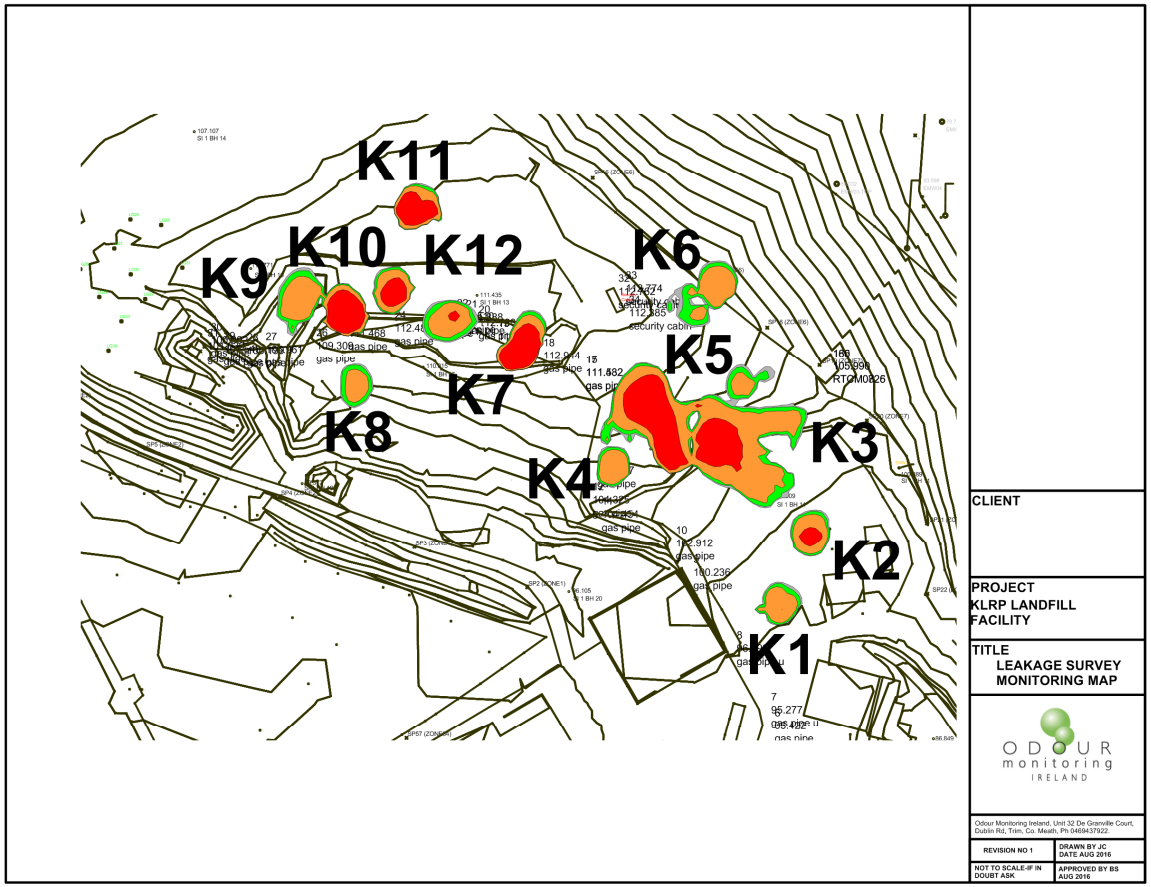
To obtain details about the applicable traceability, please contact us.

Do not use below a pressure of 3 bar (excluding product supplied at less than 10 bar).
Maintain storage and use temperature between -10 and 50 °C.

## 8. Appendix III Surface emissions mapping from 2011 to 2016.



## Surface emissions mapping from Northern part of the facility 26/08/2016



# Appendix A7.5 October 2016 Dust and Odour Report

Analysing
Testing
Consulting
Calibrating

# TEST REPORT 131062

**Client:**
**Priority Construction**
**162 Clontarf Road**
**Clontarf**
**Dublin 3**

**FAO: Mr. Paraic Madden**

**BHP Ref No.: 16/10/1380**
**Order No.:**
**Date Received: 21st October 2016**
**Date Tested: 27th 21st October 2016**
**Test Specification: Nil**

**BHP**
New Road
Thomondgate
Limerick
Ireland
Tel +353 61 455399
Fax + 353 61 455447
E Mail
dervlapurcell@bhp.ie

**Item: Monitoring of emissions to air at locations O1, O2, O3 & O4 at the at the Kerdiffstown Landfill located near Naas, Co Kildare.**

**For and on behalf of BHP Ltd.**

**Dervla Purcell**
**Date Issued: 1st November 2016**
***Supplement to report No. N/A***

# Contents

## 1.0 SCOPE OF SURVEY

At the request of Paraic Madden of Priority Construction, BHP Laboratories Ltd undertook to perform gas monitoring and odour observations at 4 nominated locations in Kerdiffstown Landfill, Co Kildare.

## 2.0 SURVEY APPROACH

All locations were assessed for ammonia, hydrogen sulphide and mercaptans by Drager tube. On site odour observations were also noted at each location

The locations are named D1-D4. They are the same locations as the noise monitoring locations and the dust gauges. A site map showing the monitoring locations is presented in Appendix A. Photographs of the sampling locations are presented in appendix B.

## 3.0 DATE OF SURVEY

Sampling was carried on the 21st October 2016 by Aidan Daffy.

## 4.0 RESULTS

Results of the gas monitoring and odour observations survey are presented in the following table:

**Table 1**
**Kerdiffstown Landfill - Monitoring Locations 21st October 2016**

| Sample No. | Location | Wind Speed m/s | Wind Direction | Drager Tube | Colour Change | Result (ppm) | Sampling Observations |
|---|---|---|---|---|---|---|---|
| **1** | D1 | 0-1 | E | Ammonia | None | <0.25 | No odour observed. |
| | | | | Mercaptans | None | <0.5 | |
| | | | | Hydrogen Sulphide | None | <0.2 | |
| **2** | D2 | 0-1 | E | Ammonia | None | <0.25 | No odour observed. |
| | | | | Mercaptans | None | <0.5 | |
| | | | | Hydrogen Sulphide | None | <0.2 | |
| **3** | D3 | 0-1 | E | Ammonia | None | <0.25 | No odour observed. |
| | | | | Mercaptans | None | <0.5 | |
| | | | | Hydrogen Sulphide | None | <0.2 | |
| **4** | D4 | 0-1 | E | Ammonia | None | <0.25 | No odour observed. |
| | | | | Mercaptans | None | <0.5 | |
| | | | | Hydrogen Sulphide | None | <0.2 | |

## 5.0 CONCLUSIONS

There was no Ammonia, Mercaptan or Hydrogen Sulphide detected above the limit of detection at all monitoring locations as can be seen in Table 1.

# Appendix A

## Map indicating odour-monitoring locations

# Appendix B

## Photographs of odour monitoring locations on-site

### Odour monitoring Location D1

### Odour monitoring Location D2

## Odour monitoring Location D3


## Odour monitoring Location D4

# Appendix A7.6 2016 Flare Emissions Monitoring Report

| | |
|---|---|
| **Report Title** | Air Emissions Compliance Monitoring Emissions Report |
| **Company address** | Air Scientific Ltd., 32 DeGranville Court, Dublin road, Trim, Co. Meath |
| **Stack Emissions Testing Report Commissioned by** | Kildare County Council |
| **Facility Name** | Kerdiffstown Landfill |
| **Contact Person** | Ms. Claire McLoughlin |
| **EPA Licence Number** | WL0047-02 |
| **Licence Holder** | Kerdiffstown Landfill, F1 |
| **Stack Reference Number** | F1 |
| **Dates of the Monitoring Campaign** | 28/07/2016 |
| **Job Reference Number** | KELATL1280716 / 2016390 |
| **Report Written By** | Dr. John Casey |
| **Report Approved by** | Dr. Brian Sheridan |
| **Stack Testing Team** | Dr. John Casey |
| **Report Date** | 13/09/2016 |
| **Report Type** | Test Report Compliance Monitoring |
| **Version** | 1 |
| **Signature of Approver** | Brian Sheridan<br>Technical Manager |

**Contents**

# 1. Executive Summary

## *I. Monitoring Objectives*

### Overall Aim of the monitoring Campaign

The aim of the monitoring campaign was to demonstrate compliance with a set of emission limit values as specified in the site licence.

### Special Requirements

There were no special requirements.

### Target Parameters

| |
|---|
| Carbon Monoxide (CO) |
| Oxides of Nitrogen (NOx) as $NO_2$ |
| Total Volatile Organic Carbon (TOC) |
| Hydrogen Chloride (HCL) |
| Hydrogen Fluoride (HF) |
| Sulphur Dioxide ($SO_2$) |
| Stack Gas Temperature |
| Volume ($m^3.h^{-1}$) |

### Emission Limit Values

| Emission Limit Values / Mass Emissions Limit Values | $mg.m^{-3}$ | $kg.h^{-1}$ |
|---|---|---|
| CO | - | - |
| NOx as $NO_2$ | - | - |
| TOC | - | - |
| HCL | - | - |
| HF | - | - |
| $SO_2$ | - | - |
| Stack Gas Temperature | - | - |
| Volume ($m^3.h^{-1}$) | - | - |

### Reference Conditions

| Reference Conditions | Value |
|---|---|
| Oxygen Reference % | 3 |
| Temperature $^oC$ | 273.15 |
| Total Pressure kPa | 101.3 |
| Moisture % | Yes |

## Executive Summary

### Overall Results

| | Concentration | | | | |
|---|---|---|---|---|---|
| **Parameter** | **Units** | **Result** | **MU +/-** | **Limit** | **Compliant** |
| Carbon Monoxide (CO) | $mg.m^{-3}$ | 19.13 | 2.99 | - | N/A |
| Oxides of Nitrogen (NOx) as $NO_2$ | $mg.m^{-3}$ | 17.74 | 2.39 | - | N/A |
| Total Volatile Organic Carbon (VOC) | $mgC.m^{-3}$ | 4.23 | 0.60 | - | N/A |
| Hydrogen Chloride (HCL) | $mg.m^{-3}$ | 0.82 | 0.003 | - | N/A |
| Hydrogen Fluoride (HF) | $mg.m^{-3}$ | <0.28 | 0.01 | - | N/A |
| Sulphur Dioxide ($SO_2$) | $mg.m^{-3}$ | 929.98 | 58.76 | - | N/A |
| Oxygen (%) | % v/v | 8.13 | 0.15 | - | N/A |
| Stack Gas Temperature | K | 1288.15 | - | - | N/A |

### Accreditation details

| | |
|---|---|
| Air Scientific Limited | INAB319T |
| External Analytical Laboratory | UKAS1549 |
| Other | - |

**Executive Summary**

**Monitoring Dates & Times**

| Parameter | Run | Location ID | Sampling Dates | Sampling Time On | Sampling Time Off | Duration (mins.) |
|---|---|---|---|---|---|---|
| Carbon Monoxide (CO) | Run 1 | F1 | 28/07/2016 | 10:33:00 | 11:04:00 | 00:31:00 |
| | Run 2 | - | - | - | - | - |
| | Run 3 | - | - | - | - | - |
| Oxides of Nitrogen (NOx) as $NO_2$ | Run 1 | F1 | 28/07/2016 | 10:33:00 | 11:04:00 | 00:31:00 |
| | Run 2 | - | - | - | - | - |
| | Run 3 | - | - | - | - | - |
| Total Volatile Organic Carbon (VOC) | Run 1 | F1 | 28/07/2016 | 10:36:08 | 11:04:08 | 00:30:00 |
| | Run 2 | - | - | - | - | - |
| | Run 3 | - | - | - | - | - |
| Hydrogen Chloride (HCL) | Run 1 | F1 | 28/07/2016 | 09:05:00 | 09:37:00 | 00:32:00 |
| | Run 2 | - | - | - | - | - |
| | Run 3 | - | - | - | - | - |
| Hydrogen Fluoride (HF) | Run 1 | F1 | 28/07/2016 | 09:50:00 | 10:21:00 | 00:31:00 |
| | Run 2 | - | - | - | - | - |
| | Run 3 | - | - | - | - | - |
| Sulphur Dioxide ($SO_2$) | Run 1 | F1 | 28/07/2016 | 10:33:00 | 11:04:00 | 00:31:00 |
| | Run 2 | - | - | - | - | - |
| | Run 3 | - | - | - | - | - |
| Oxygen (%) | | F1 | 28/07/2016 | 10:33:00 | 11:04:00 | 00:31:00 |

**Executive Summary**

**Process details**

| Parameter | |
|---|---|
| **Process status** | Normal |
| **Capacity (per/hour) (if applicable)** | 69m3/hr |
| **Continuous or Batch Process** | Continuous |
| **Feedstock** | LFG |
| **Abatement System** | No |
| **Abatement Systems Running Status** | N/A |
| **Fuel** | LFG |
| **Plume Appearance** | Yes |
| **Other information** | None |

**Monitoring, Equipment & Analytical Methods**

| | Monitoring | | | | Analysis | |
|---|---|---|---|---|---|---|
| **Parameter** | **Standard** | **Technical Procedure** | **Accredited Testing** | **Testing Lab** | **Analytical Technique** | **Analysis Lab** |
| Carbon Monoxide (CO) | EN15058:2006 | SOP 2004 | Yes | AirSci | NCIR By Horiba PG-250 | AirSci |
| Oxides of Nitrogen (NOx) | EN14792:2006 | SOP 2002 | Yes | AirSci | Chemiluminescence | AirSci |
| Total Volatile Organic Carbon (TOC) | EN12619:2013 | SOP 2009 | Yes | AirSci | Flame Ionisation Detection | AirSci |
| Hydrogen Chloride (HCL) | EN1911:2010 | SOP 2014 | Yes | AirSci | Ion Chromatography | SAL |
| Hydrogen Fluoride (HF) | EN15713:2006 | SOP 2024 | No | AirSci | Ion Chromatography | SAL |
| Sulphur Dioxide (SO2) | TGN 21 | SOP 2012 | Yes | AirSci | NDIR Absorption | AirSci |
| Oxygen (%) | EN14789:2005 | SOP 2008 | Yes | AirSci | Paramagnetic | AirSci |
| Stack Gas Temperature | EN16911:2013 | SOP 2005 | No | AirSci | Thermocouple | AirSci |

**List of Equipment**

| ID | Item of Equipment | Manufacturer | Serial No. |
|---|---|---|---|
| ASLTM12EQ509 | 3010 MinfiFID | Signal Instruments | 16764 |
| ASLTM12EQ517 | Testo 400 Gas Pressure Vacumn and Flow | Testo | 00828828/305 |
| ASLTM12EQ520 | Buhler Sample Gas Cooler | Buhler Technologies | 100063602044367-001 |
| ASLTM13EQ504 | Horiba PG2500 Portable Flue Gas Analzer | Horiba | 41432840053 |
| ASLTM13EQ509 | 10 metre industrial heated sample line (Temp controller box 1 & 2) | Neptech | 13B088 |
| ASLTM15EQ505 | Mass flow meter | Siargo | A1K05286 |

**Sampling Deviations**

| Parameter | Deviation |
|---|---|
| **Standard ID** | EN1911 & EN15713 - absorption efficiency <95% |
| **Standard ID** | - |
| **Standard ID** | - |
| **Standard ID** | - |

**Reference Documents**

| | |
|---|---|
| Risk Assessment (RA) | SOP1011 |
| Site Review (SR) | SOP1015 |
| Site Specific Protocol (SSP) | SOP1015 |

**Executive Summary**

**Suitability of sampling location**

| General Information | Value |
|---|---|
| Permanent/Temporary | Temporary |
| Inside/ Outside | Outside |

| Platform Details | | |
|---|---|---|
| **Irish EPA Technical Guidance Note AG1 / BS EN 15259 Platform Requirements** | **Value** | **Comment** |
| Sufficient Working area to manipulate probe and measuring instruments | Yes | - |
| Platform has 2 handrails (approx. 0.5m & 1.0 m high) | Yes | - |
| Platform has vertical base boards (approx. 0.25 m high) | Yes | - |
| Platform has chains / self closing gates at top of ladders | Yes | - |
| There are no obstructions present which hamper insertion of sampling equipment | No | - |
| Safe Access Available | Yes | - |
| Easy Access Available | Yes | - |

| Sampling Location / Platform Improvement Recommendations |
|---|
| None |

| BSEN 15259 Homogeneity Test Requirements |
|---|
| 1: There is no requirement to perform a BSEN15259 Homogenity Test on this stack |
| **E.g. Select Option**<br>**1: There is no requirement to perform a BSEN15259 Homogenity Test on this stack**<br>**2: Test results were obtained from previous Homogeneity test carried out by ASL**<br>**3: Test results were obtained from previous Homogeneity test carried out by Alternative contractor**<br>**4: Other: Enter Description** |

**Stack diagram**

**APPENDICES**

## *II. Appendix I Monitoring Personnel & Equipment*

**Stack Emissions Monitoring Personnel**

| | | |
|---|---|---|
| **Team Leader** | **Name** | John Casey |
| | **Qualifications** | PhD. (Eng.), MSc. (Agr.), B. Agr. Sc. |
| | **System approval** | Air Scientific Limited Approved |
| | | - |

### *III. Appendix II Stack Details & flow characteristics*

**Preliminary stack survey calculations**

| **General Stack Details** | | |
|---|---|---|
| **Stack details** | **Units** | **Value** |
| Date of survey | | 28/07/2016 |
| Time of survey | | - |
| Type | | Circular |
| Stack Diameter / Depth, D | m | - |
| Stack Width, W | m | - |
| Average Stack Gas Temp., Ta | C | 1015 |
| Average Static Pressure, P static | kPa | - |
| Average Barometric Pressure, Pb | kPa | - |
| Type of Pitot | | - |
| Are Water Droplets Present ? | | - |
| Average Pitot Tube Calibration Coeff, Cp | | - |
| Negative flow | | - |
| Highly homogeneous flow stream/gas velocity | | Yes |

| | | |
|---|---|---|
| Sample Port Size | mm | - |
| Initial Pitot Leak Check | Pa | - |
| Final Pitot Leak Check | Pa | - |
| Orientation of Duct | | Vertical |
| Pitot Tube Cp | | 0.998 |
| Number of Lines Available | | 1 |
| Number of Lines Used | | 1 |

| **Sampling Line A** | | | | | | |
|---|---|---|---|---|---|---|
| **Point** | **Distance to duct (m)** | **Pa** | **Temp °C** | **Velocity (m/s)** | **Oxygen (%)** | **Angle of Swirl** |
| 1 | - | - | - | - | - | - |
| 2 | - | - | - | - | - | - |
| 3 | - | - | - | - | - | - |
| 4 | - | - | - | - | - | - |
| 5 | - | - | - | - | - | - |
| 6 | - | - | - | - | - | - |
| 7 | - | - | - | - | - | - |
| 8 | - | - | - | - | - | - |
| 9 | - | - | - | - | - | - |
| 10 | - | - | - | - | - | - |
| Average | - | - | - | - | - | - |
| Min | - | - | - | - | - | - |
| Max | - | - | - | - | - | - |

| Sampling Line B | | | | | | |
|---|---|---|---|---|---|---|
| **Point** | **Distance to duct (m)** | **Pa** | **Temp °C** | **Velocity (m/s)** | **Oxygen (%)** | **Angle of Swirl** |
| 1 | - | - | - | - | - | - |
| 2 | - | - | - | - | - | - |
| 3 | - | - | - | - | - | - |
| 4 | - | - | - | - | - | - |
| 5 | - | - | - | - | - | - |
| 6 | - | - | - | - | - | - |
| 7 | - | - | - | - | - | - |
| 8 | - | - | - | - | - | - |
| 9 | - | - | - | - | - | - |
| 10 | - | - | - | - | - | - |
| Average | - | - | - | - | - | - |
| Min | - | - | - | - | - | - |
| Max | - | - | - | - | - | - |

| Component | Conc. ppm | Conc. Dry % v/v | Conc. Wet % v/v | Molar Mass |
|---|---|---|---|---|
| Carbon Dioxide $CO_2$ | - | 10.31 | - | 44.01 |
| Oxygen $O_2$ | - | 8.12 | - | 32 |
| Nitrogen $N_2$ | - | 81.57 | - | 28.1 |
| Moisture ($H_2O$) | - | - | 9 | 18.02 |

| Reference Conditions | Units | Numbers |
|---|---|---|
| Temperature | °C | 273.15 |
| Total Pressure | kPa | 101.3 |
| Moisture | % | - |
| Oxygen (Dry) | % | 3 |

| **Stack Gas Composition & Molecular Weights** | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | | | | | | | |
| **Component** | **Molar Mass M** | **Density Kg/m$^3$ p** | **Conc. Dry % v/v** | **Dry Volume Fraction r** | **Dry Conc. kg/m$^3$ pi** | **Conc. wet % v/v** | **Wet Volume Fraction r** | **Wet Conc.kg/m$^3$ pi** |
| Carbon Dioxide $CO_2$ | 44.01 | 1.96 | 10.31 | 0.1031 | 0.20 | 9.38 | 0.09 | 0.18 |
| Oxygen $O_2$ | 32 | 1.43 | 8.12 | 0.0812 | 0.12 | 7.39 | 0.07 | 0.11 |
| Nitrogen $N_2$ | 28.1 | 1.25 | 81.57 | 0.8157 | 1.02 | 74.23 | 0.74 | 0.93 |
| Moisture ($H_2O$) | 18.02 | 0.80 | - | - | - | 9 | 0.09 | 0.07 |
| | - | - | - | - | - | - | - | - |
| where p=M/22.41 | - | - | - | - | - | - | - | - |
| pi = r x p | - | - | - | - | - | - | - | - |

| **Calculation of Stack Gas Densities** | | |
|---|---|---|
| | | |
| **Determinand** | **Units** | **Result** |
| Dry Density (STP), P STD | $kg.m^{-3}$ | 1.341 |
| Wet Density (STP), P STW | $kg.m^{-3}$ | 1.297 |
| Dry Density (Actual), P Actual | $kg.m^{-3}$ | - |
| Average wet Density (Actual), P ActualW | $kg.m^{-3}$ | - |
| | | |
| | | |
| **Where** | | |
| P STD = sum of component concentrations, kg/m3 (excluding water vapour) | - | - |
| P STW = (P STD + pi of H2O) / ( 1 + (pi of H2O / 0.8036)) | - | - |
| P actual = P STD x (T STP / (P STP)) x (Pa / Ta) | - | - |
| P actual W (at each sampling point) = P STW x (Ts / Ps) x (Pa / Ta) | - | - |

| Sampling Plane Validation Criteria | Value | Units | Requirement | Compliance | Method |
|---|---|---|---|---|---|
| Lowest Differential Pressure | - | Pa | >5 Pa | N/A | EN16911:2013 |
| Lowest Gas Velocity | - | m/s | - | N/A | - |
| Highest Gas Velocity | - | m/s | - | N/A | - |
| Ratio of Above | - | :1 | <3:1 | N/A | EN16911:2013 |
| Mean Velocity | - | m/s | - | N/A | - |
| Angle of flow with regard to duct axis | - | degrees | < 15 | N/A | EN16911:2013 |
| No local negative flow | - | - | - | N/A | - |
| Homogeneous flow stream/gas velocity | - | - | - | N/A | - |

| | |
|---|---|
| **Calculation of stack Gas Velocity, V** | |
| Velocity at Traverse Point, V = Kcp * Sqroot ((2 * DP ) / Density) | - |
| | |
| **Where** | |
| Kpt = Pitot tube calibration coefficient | - |
| Compressibility correction factor, assumed at a constant 0.998 | 0.998 |

| Gas Volumetric Flowrate | Units | Result |
|---|---|---|
| Gas Volumetric Flow Rate (Actual) | $m^3.h^{-1}$ | - |
| Gas Volumetric Flow Rate (STP, Wet) | $m^3. h^{-1}$ | - |
| Gas Volumetric Flowrate (STP, Dry) | $m^3. h^{-1}$ | - |
| Gas Volumetric Flowrate REF to Oxygen | $m^3. h^{-1}$ | - |

### *IV. Appendix III Individual parameter sampling details and results*

**Carbon Monoxide Quality Assurance**

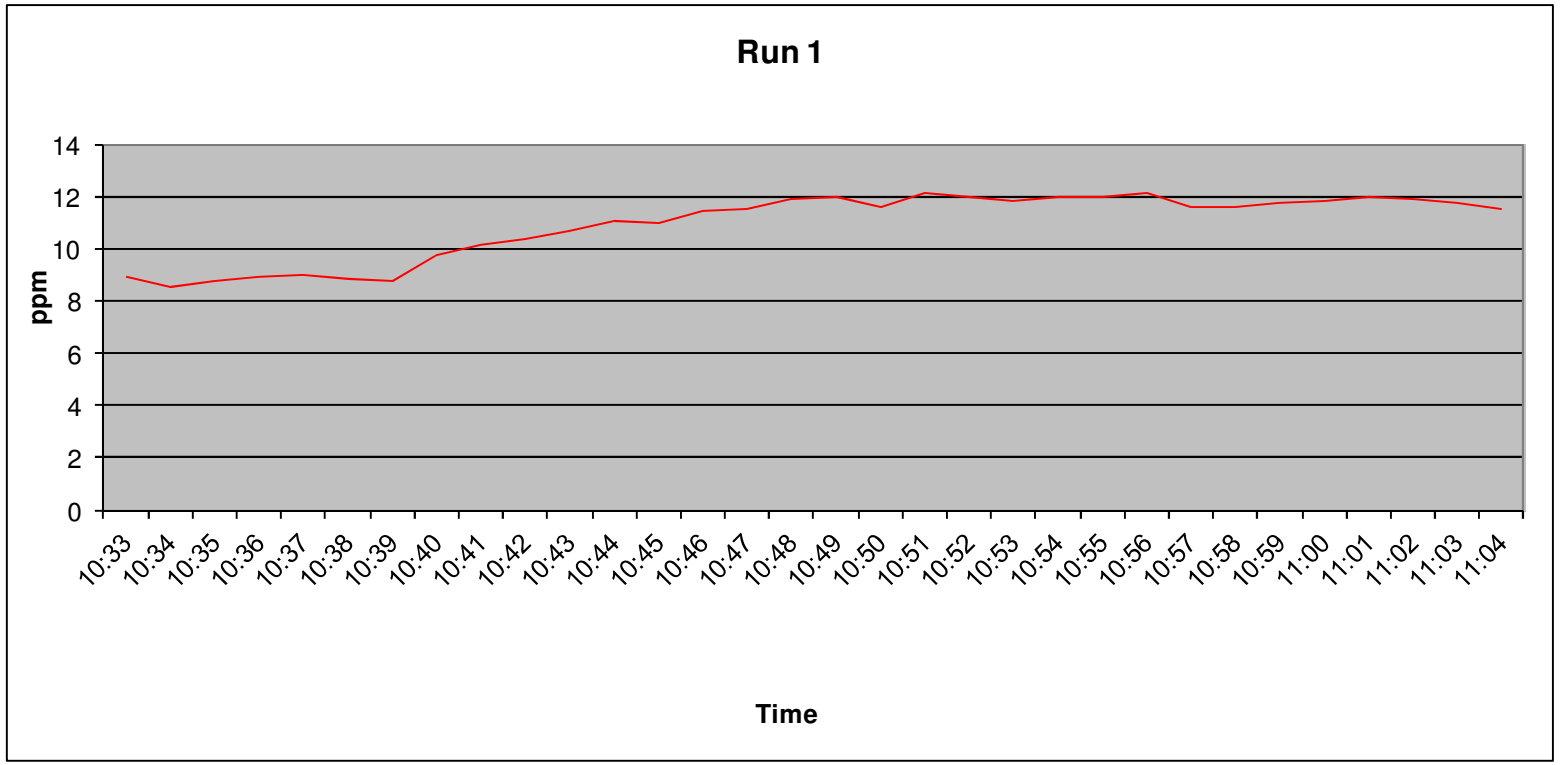
| **Sampling Details** | | |
|---|---|---|
| **Stack ID** | F1 | - |
| | **Units** | **Run 1** |
| ***Parameter*** | | |
| **Sampling Times** | - | 10:32 |
| **Sampling Dates** | - | 28/07/2016 |
| **Instrument Range** | ppm | 200 |
| **Span Gas Value** | ppm | 149 |
| **Acceptable Gas Range** | - | Yes |
| | | |
| ***Quality Assurance*** | **Units** | **Run 1** |
| **Conditioning Unit Temperature** | C | 2 |
| **Average Temperature** | < C | 2 |
| **Allowable Temperature** | - | 4 |
| **Temperature Acceptable** | - | Yes |
| **Pump flow rate** | l/min. | 0.5 |
| | | |
| ***Zero Drift*** | Units | **Run 1** |
| **Zero Down Sampling Line (Pre)** | ppm | 0.2 |
| **Zero Down Sampling Line (Post)** | ppm | 0.4 |
| **Zero drift** | ppm | 0.2 |
| **Allowable Zero Drift** | ppm | 2.97 |
| **Zero Drift Acceptable** | - | Yes |
| | | |
| ***Span Drift*** | Units | **Run 1** |
| **Span Down Sampling Line (Pre)** | ppm | 148.8 |
| **Span Down Sampling Line (Post)** | ppm | 150.4 |
| **Span Drift** | ppm | 1.6 |
| **Allowable Span Drift** | ppm | 2.97 |
| **Span Drift Acceptable (Y/N)** | - | Yes |
| | | |
| ***Leak Check*** | | |
| **Span Gas Conc.** | ppm | 149 |
| **Recorded Conc. down Line** | ppm | 148.8 |
| **Leak check acceptable (< 2%)** | (Y/N) | Yes |
| | | |
| **Test Conditions** | **Units** | **Run 1** |
| **Run Ambient Temperature Range** | C | 15 |

**Carbon Monoxide Results & Sampling details**

| Parameter | Units | Run 1 |
|---|---|---|
| Concentration | $mg.m^{-3}$ | 13.65 |
| Uncertainty | $mg.m^{-3}$ | 2.99 |
| Mass Emission | kg.h | - |

| General Sampling Information | |
|---|---|
| | |
| **Parameter** | **Value** |
| Standard | EN15058 |
| Technical Procedure | SOP2004 |
| | |
| Probe material | SS |
| Filtration Type/Size | PTFE |
| Heated Head Filter Used | Yes |
| Heated Line Temperature | 190 |
| | |
| Span Gas Reference Number | ASLTM15ING508 |
| Span Gas Expiry Date | Nov-17 |
| Span Gas Start Pressure (bar) | 20 |
| Gas Cylinder Concentration (ppm) | 149 |
| Span Gas Uncertainty (%) | <2 |
| Zero Gas Type | Nitrogen |
| | |
| Number of Sampling Lines Used | 1 |
| Number of Sampling Points Used | 1 |
| Sample Point I.D's | F1 |
| | |
| **Reference Conditions** | |
| Temperature (K) | 273.15 |
| Pressure (kPa) | 101.3 |
| Gas (Wet or Dry) | Dry |
| Oxygen | 3 |

**Carbon Monoxide Trend**



**Carbon Monoxide Measurement Uncertainty**

| | Units | Run 1 |
|---|---|---|
| Measured Quantities | | |
| Certified Range of Analyser | ppm | 1.36 to 1000 |
| Operational Range of Analyser | ppm | 200 |
| Measured Reading | ppm | 10.92 |
| | | |
| Measured Quantities | **Units** | **Run 1** |
| Nonlinearity | % | 0.9 |
| Temperature Dependent Zero drift | % | 0.14 |
| Temperature Dependent Span drift | % | -0.12 |
| Cross-sensitivity | % | 0.08 |
| Leak | % | 0 |
| Calibration Gas Uncertainty | % | <2 |
| | | |
| **Parameter** | **Units** | **Run 1** |
| Combined uncertainty | $mg.m^{-3}$ | 0.99 |
| Expanded uncertainty | $mg.m^{-3}$ | 1.98 |
| | | |
| **Uncertainty corrected to std conds.** | $mg.m^{-3}$ | 2.99 |
| | | |
| **Expanded uncertainty expressed with a level of confidence of 95%** | % of ELV | - |
| **Expanded uncertainty expressed with a level of confidence of 95%** | $mg.m^{-3}$ | 2.99 |
| | | |
| **Expanded uncertainty expressed with a level of confidence of 95%** | % of value | 21.90 |
| | | |
| **Requirement in standard is for uncertainty to be < 10% at ELV at standard conditions** | | |

**Oxides of Nitrogen Quality Assurance**

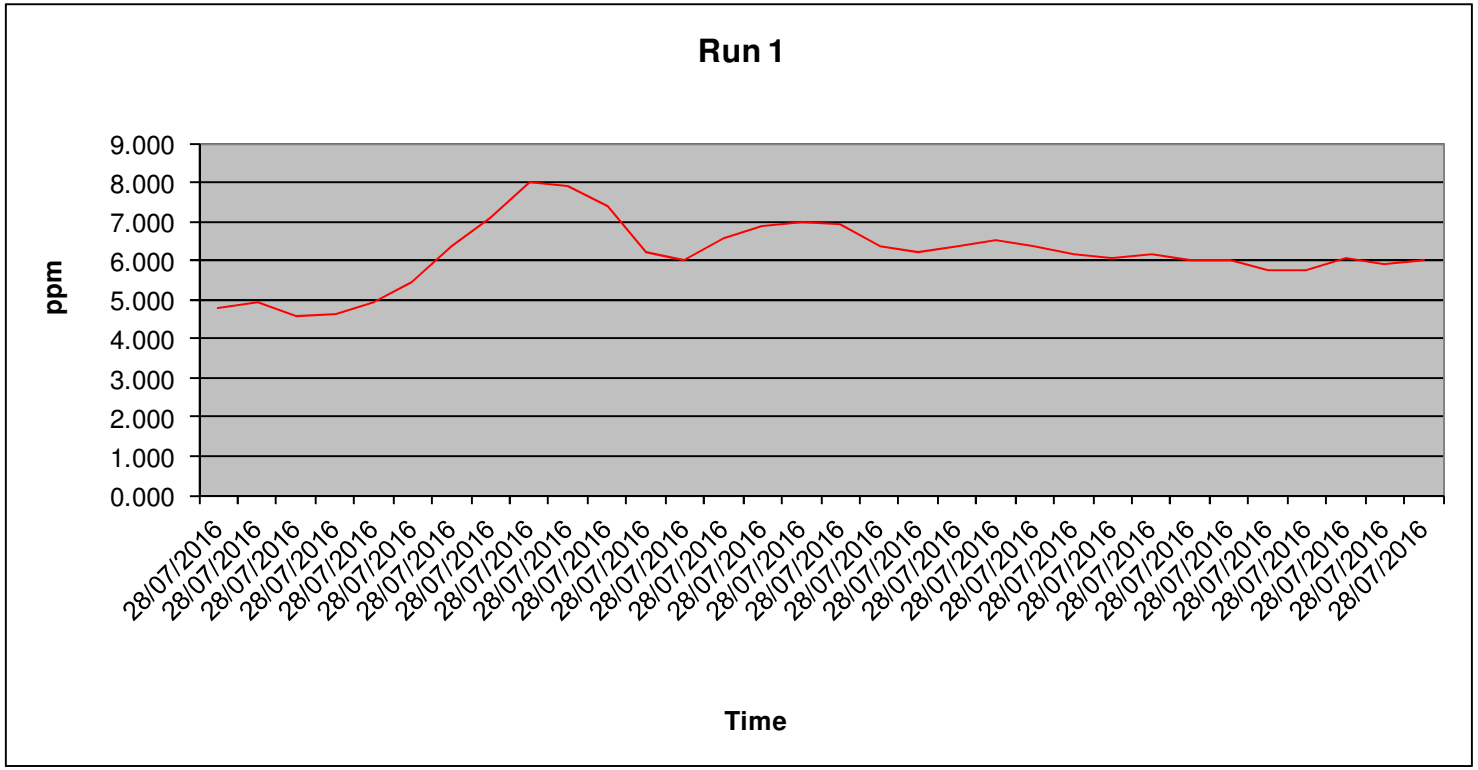
| **Sampling Details** | | |
|---|---|---|
| **Stack ID** | F1 | - |
| | **Units** | **Run 1** |
| ***Parameter*** | | |
| **Sampling Times** | - | 10:32 |
| **Sampling Dates** | - | 28/07/2016 |
| **Instrument Range** | ppm | 250 |
| **Span Gas Value** | ppm | 158 |
| **Acceptable Gas Range** | - | Yes |
| | | |
| ***Quality Assurance*** | **Units** | **Run 1** |
| **Conditioning Unit Temperature** | C | 2 |
| **Average Temperature** | < C | 2 |
| **Allowable Temperature** | - | 4 |
| **Temperature Acceptable** | - | Yes |
| **Pump flow rate** | l/min. | 0.5 |
| | | |
| ***Zero Drift*** | Units | **Run 1** |
| **Zero Down Sampling Line (Pre)** | ppm | 0.1 |
| **Zero Down Sampling Line (Post)** | ppm | 0 |
| **Zero drift** | ppm | 0.1 |
| **Allowable Zero Drift** | ppm | 3.16 |
| **Zero Drift Acceptable** | - | Yes |
| | | |
| ***Span Drift*** | Units | **Run 1** |
| **Span Down Sampling Line (Pre)** | ppm | 158.4 |
| **Span Down Sampling Line (Post)** | ppm | 156.3 |
| **Span Drift** | ppm | 2.1 |
| **Allowable Span Drift** | ppm | 3.16 |
| **Span Drift Acceptable (Y/N)** | - | Yes |
| | | |
| ***Leak Check*** | | |
| **Span Gas Conc.** | ppm | 158 |
| **Recorded Conc. down Line** | ppm | 158.4 |
| **Leak check acceptable (< 2%)** | (Y/N) | Yes |
| | | |
| **Test Conditions** | **Units** | **Run 1** |
| **Run Ambient Temperature Range** | C | 15 |
| **NOx Converter Efficiency** | % | 95.3 |

**Oxides of Nitrogen Results & Sampling details**

| Parameter | Units | Run 1 |
|---|---|---|
| Concentration | $mg.m^{-3}$ | 12.66 |
| Uncertainty | $mg.m^{-3}$ | 2.39 |
| Mass Emission | $kg.h^{-1}$ | - |

| General Sampling Information | |
|---|---|
| | |
| **Parameter** | **Value** |
| Standard | EN14792 |
| Technical Procedure | SOP2002 |
| | |
| Probe material | SS |
| Filtration Type/Size | PTFE |
| Heated Head Filter Used | Yes |
| Heated Line Temperature | 190 |
| Date & Result of last converter check | 95.3 18/12/2015 |
| | |
| Span Gas Reference Number | ASLTM15ING533 |
| Span Gas Expiry Date | Dec-16 |
| Span Gas Start Pressure (bar) | 40 |
| Gas Cylinder Concentration (ppm) | 158 |
| Span Gas Uncertainty (%) | <2 |
| Zero Gas Type | Nitrogen |
| | |
| Number of Sampling Lines Used | 1 |
| Number of Sampling Points Used | 1 |
| Sample Point I.D's | F1 |
| | |
| Reference Conditions | |
| Temperature (K) | 273.15 |
| Pressure (kPa) | 101.3 |
| Gas (Wet or Dry) | Dry |
| Oxygen | 3 |

**Oxides of Nitrogen Trend**



**Oxides of Nitrogen Measurement Uncertainty**

| | | |
|---|---|---|
| Measured Quantities | **Units** | **Run 1** |
| Nonlinearity | % | 1.4 |
| Temperature Dependent Zero drift | % | -0.04 |
| Temperature Dependent Span drift | % | -0.25 |
| Cross-sensitivity | % | 0.5 |
| Leak | % | 0 |
| Calibration Gas Uncertainty | % | <2 |
| Mass Flow Controllers (Dilution) Uncertainty | % | <1 |
| NOx Converter Efficiency | % | 95.3 |
| | | |
| **Parameter** | **Units** | **Run 1** |
| Combined uncertainty | $mg.m^{-3}$ | 0.77 |
| Expanded uncertainty | $mg.m^{-3}$ | 1.55 |
| | | |
| **Uncertainty corrected to std conds.** | $mg.m^{-3}$ | 2.39 |
| | | |
| **Expanded uncertainty expressed with a level of confidence of 95%** | % of ELV | - |
| **Expanded uncertainty expressed with a level of confidence of 95%** | $mg.m^{-3}$ | 2.39 |
| | | |
| **Expanded uncertainty expressed with a level of confidence of 95%** | % of value | 18.84 |
| | | |
| **Requirement in standard is for uncertainty to be < 10% at ELV at standard conditions** | | |

**Total Volatile Organic Carbon Quality Assurance**

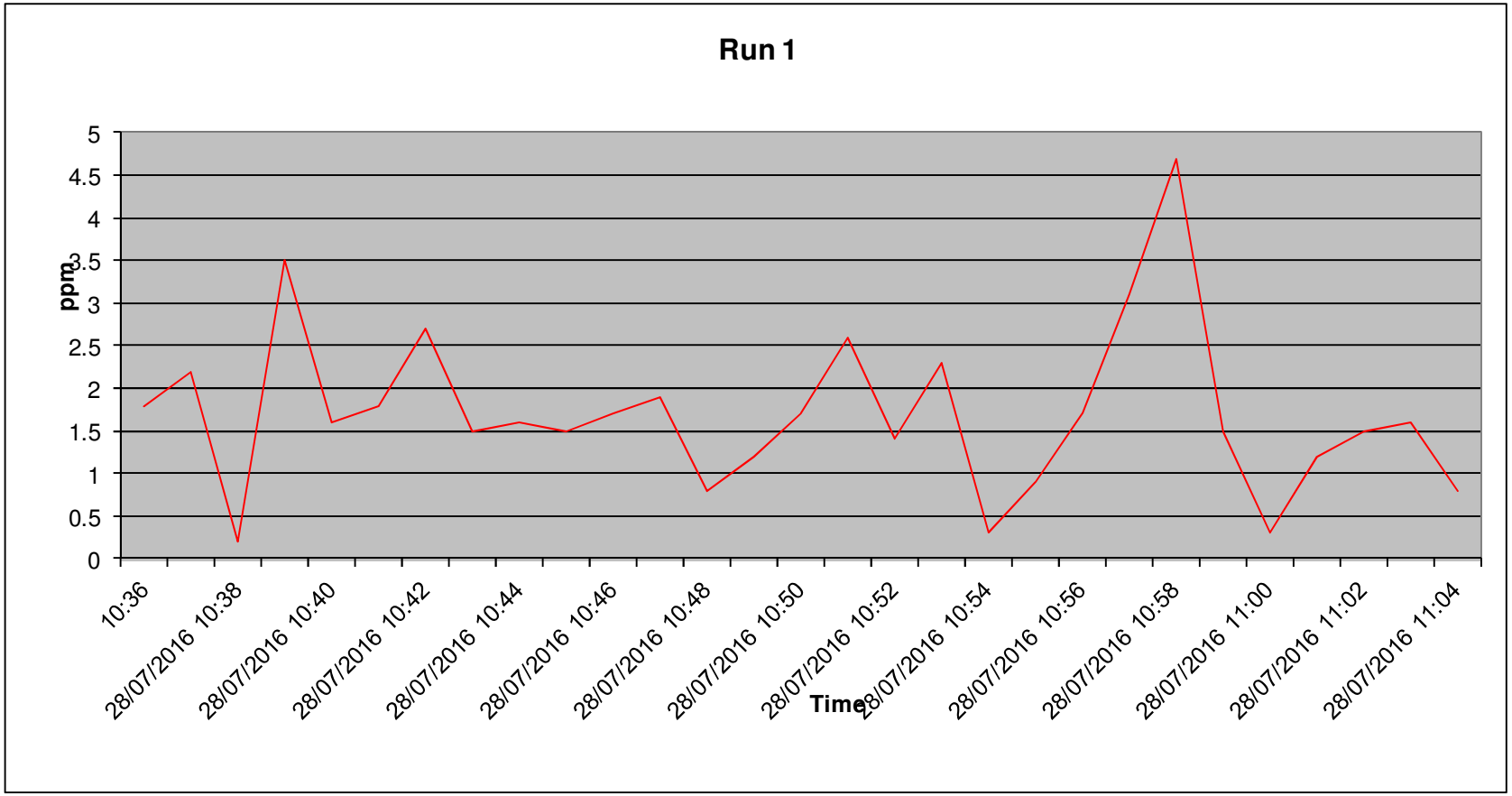
| **Sampling Details** | | |
|---|---|---|
| **Stack ID** | F1 | - |
| | **Units** | **Run 1** |
| ***Parameter*** | | |
| **Sampling Times** | - | 10:36 |
| **Sampling Dates** | - | 28/07/2016 |
| **Instrument Range** | ppm | 100 |
| **Span Gas Value** | ppm | 79 |
| **Acceptable Gas Range** | - | Yes |
| | | |
| ***Quality Assurance*** | **Units** | **Run 1** |
| **Oven Temperature** | C | 193 |
| **Average Temperature** | < C | 193 |
| **Temperature Acceptable** | - | Yes |
| **Sample line temperature** | C | 190 |
| | | |
| ***Zero Drift*** | Units | **Run 1** |
| **Zero Down Sampling Line (Pre)** | ppm | 0.1 |
| **Zero Down Sampling Line (Post)** | ppm | 0.4 |
| **Zero drift** | ppm | 0.3 |
| **Allowable Zero Drift** | ppm | 1.5 |
| **Zero Drift Acceptable** | - | Yes |
| | | |
| ***Span Drift*** | Units | **Run 1** |
| **Span Down Sampling Line (Pre)** | ppm | 78.9 |
| **Span Down Sampling Line (Post)** | ppm | 77.8 |
| **Span Drift** | ppm | 1.1 |
| **Allowable Span Drift** | ppm | 1.5 |
| **Span Drift Acceptable (Y/N)** | - | Yes |
| | | |
| ***Leak Check*** | | |
| **Span Gas Conc.** | ppm | 79 |
| **Recorded Conc. down Line** | ppm | 78.9 |
| **Leak check acceptable (< 2%)** | (Y/N) | Yes |

**Total Volatile Organic Carbon Results and Sampling Details**

| Parameter | Units | Run 1 |
|---|---|---|
| Concentration | $mgC.m^{-3}$ | 3.02 |
| Uncertainty | $mgC.m^{-3}$ | 0.60 |
| Mass Emission | $kg.h^{-1}$ | - |

| General Sampling Information | |
|---|---|
| | |
| **Parameter** | **Value** |
| Standard | EN12619 |
| Technical Procedure | SOP2009 |
| | |
| Probe material | SS |
| Filtration Type/Size | PTFE |
| Heated Head Filter Used | Yes |
| Heated Line Temperature | 190 |
| | |
| Span Gas Reference Number | ASLTM15ING532 |
| Span Gas Expiry Date | 01/12/2018 |
| Span Gas Start Pressure (bar) | 30 |
| Gas Cylinder Concentration (ppm) | 79 |
| Span Gas Uncertainty (%) | <2 |
| Zero Gas Type | Ambient |
| | |
| Number of Sampling Lines Used | 1 |
| Number of Sampling Points Used | 1 |
| Sample Point I.D's | F1 |
| | |
| Reference Conditions | - |
| Temperature (K) | 273.15 |
| Pressure (kPa) | 101.3 |
| Gas (Wet or Dry) | Dry |
| Oxygen | 3 |

**Total Volatile Organic Carbon Trend**



**Total Volatile Organic Carbon Measurement Uncertainty**

| | **Units** | **Run 1** |
|---|---|---|
| **Measured Quantities** | | |
| Certified Range of Analyser | ppm | 0.5 to 1000 |
| Operational Range of Analyser | ppm | 100 |
| Measured Reading | ppm | 1.71 |
| | | |
| **Measured Quantities** | Units | **Run 1** |
| Nonlinearity | % | 0.068 |
| Temperature Dependent Zero drift | % | 0.3 |
| Temperature Dependent Span drift | % | 0.3 |
| Cross-sensitivity | % | - |
| Leak | % | <2 |
| Calibration Gas uncertainty | % | <2 |
| | | |
| **Parameter** | Units | **Run 1** |
| Combined uncertainty | $mg.m^{-3}$ | 0.30 |
| Expanded uncertainty | $mg.m^{-3}$ | 0.60 |
| | | |
| **Expanded uncertainty expressed with a level of confidence of 95%** | % of ELV | - |
| | | |
| **Expanded uncertainty expressed with a level of confidence of 95%** | % of value | 19.75 |
| **Expanded uncertainty expressed with a level of confidence of 95%** | $mg.m^{-3}$ | 0.60 |
| | | |
| **Requirement in standard is for uncertainty to be < 10% at ELV at standard conditions** | | |

**Hydrogen Chloride Sampling Details & Results**

| | | |
|---|---|---|
| **Stack ID** | F1 | **Run 1** |
| **Sample ID** | F1HCL1 | **mls** |
| ***Impinger 1 ID*** | F1HCL1+2 | 130 |
| ***Impinger 2 ID*** | - | - |
| ***Impinger 3 ID*** | F1HCL3 | 130 |
| **Time on** | 09:05 | |
| **Time off** | 09:37 | |
| ***Leak Check Results*** | | |
| Prior to test: | 0.03 | l/min |
| Post Test: | 0.02 | l/min |
| Sample Volume Flow Rate: | 1.8 | l/min |
| Standard Requirement: | <2 | % |
| Test Result: | 0 | % |
| Test Status | Pass | |
| | | |
| ***Calibration Details*** | | |
| Pump Number: | - | |
| Calibration Unit: | ASLTM15EQ505 | |
| Calibration Rate Before Test: | 1.8 | litres per minute |
| Calibration Rate After Test: | 1.900 | litres per minute |
| Average sample Volume: | 1.8 | litres per minute |
| Sample Test Time: | 32 | minutes |
| Pump Gas Temperature: | 0 | $^{O}C$ |
| Pump Sample Pressure: | 101.3 | kPa |
| Actual Sample Volume: | 0.05760 | $m^3$ |
| Normalised Gas Volume: | 0.05760 | $Nm^3$ |

**Hydrogen Chloride Quality Assurance**

| | | |
|---|---|---|
| **Stack ID** | F1 | - |
| **Date** | 28/07/2016 | - |
| **Start time** | - | 09:05:00 |
| **Finish Time** | - | 09:37:00 |
| | | |
| | **Units** | **Run 1** |
| ***Leak test results*** | | |
| Mean Sampling Rate | l/min | 1.8 |
| Pre-sampling leak rate | l/min | 0.03 |
| Post-sampling leak rate | l/min | 0.02 |
| Leak rate | l/min | 0 |
| Acceptable leak rate (<2%) | Y/N | Yes |
| | | |
| ***Filtration*** | | |
| Filter Material | - | N/A |
| Filter Size | mm | N/A |
| Max. Filter Temp | degrees | N/A |
| Absorbers Type | Glass/PTFE/ Other | PTFE |
| Absorption Solution | - | Di H2O |
| | | |
| ***Absorption Efficiency*** | | |
| Total Imp1 + Imp 2 + Imp 3 | ug | 33.8 |
| Impinger 3 | ug | 6.5 |
| Absorption efficiency | % | 81 |
| Acceptable Absorption Eff. | >95% (Y/N) | N |
| | | |
| ***Blank sample*** | | |
| Blank sample ID | - | F1HCLB |
| Blank result | $mg/m^3$ | <0.11 |
| Acceptable Blank | <10% ELV (Y/N) | Y |
| | | |
| ***Testing laboratory*** | | |
| Laboratory Name | - | UKAS1549 |
| Test certificate Number | - | 589741 |

**Hydrogen Chloride Results & Measurement Uncertainty**

| **Stack ID** | F1 | **Run 1** |
|---|---|---|
| **Date** | - | |
| **Start time** | 09:05 | |
| **Finish Time** | 09:37 | |
| | | |
| **Results** | | |
| | | |
| Laboratory Result | 33.8 | µg/ml |
| Impinger final Volume | 260 | ml |
| Concentration | 0.03 | mg |
| Sample Volume | 0.058 | $Nm^3$ |
| Emissions Concentration | 0.59 | $mg.m^{-3}$ |
| Mass Emissions | - | $kg.h^{-1}$ |

| | **Units** | **Run 1** |
|---|---|---|
| | Units | Run 1 |
| **Parameter** | | |
| Combined Uncertainty | $mg.m^{-3}$ | 0.001 |
| Expanded uncertainty as percentage of measured value | % of measured value | 4.80 |
| Expanded uncertainty in units of measurement | $mg.m^{-3}$ | 0.003 |
| Expanded uncertainty as percentage of limit value | % Of ELV | - |

**Hydrogen Fluoride Sampling Details & Results**

| **Sampling Details** | | **Run 1** |
|---|---|---|
| **Stack ID** | F1 | |
| **Start time** | 09:50 | |
| **Finish Time** | 10:21 | |
| ***Leak Check Results*** | | |
| Prior to test: | 0.02 | l/min |
| Post Test: | 0.02 | l/min |
| Sample Volume Flow Rate: | 1.9 | l/min |
| Standard Requirement: | <2 | % |
| Test Result: | 0 | % |
| Test Status | Pass | |
| | | |
| ***Calibration Details*** | | |
| Pump Number: | - | |
| Calibration Unit: | ASLTM15EQ505 | |
| Calibration Rate Before Test: | 1.9 | l/min |
| Calibration Rate After Test: | 1.9 | l/min |
| Average sample Volume: | 1.9 | l/min |
| Sample Test Time: | 31 | min |
| Pump Gas Temperature: | 0 | $^{O}C$ |
| Pump Sample Pressure: | 101.3 | kPa |
| Actual Sample Volume: | 0.05890 | $m^3$ |
| Normalised Gas Volume: | 0.06473 | $Nm^3$ |

**Hydrogen fluoride Quality Assurance**

| | | |
|---|---|---|
| **Start time** | - | 09:50:00 |
| **Finish Time** | - | 10:21:00 |
| | | |
| | **Units** | **Run 1** |
| ***Leak test results*** | | |
| Mean Sampling Rate | l/min | 1.9 |
| Pre-sampling leak rate | l/min | 0.02 |
| Post-sampling leak rate | l/min | 0.02 |
| Leak rate | l/min | 0.00 |
| Acceptable leak rate (<2%) | Y/N | Yes |
| | | |
| ***Filtration*** | | |
| Filter Material | - | N/A |
| Filter Size | mm | N/A |
| Max. Filter Temp | degrees | N/A |
| Absorbers Type | Glass/PTFE/ Other | Glass |
| Absorption Solution | - | 0.1m NaOH |
| | | |
| ***Absorption Efficiency*** | | |
| Total Imp 1 + Imp2 + Imp3 | ug | 13 |
| Impinger 3 | ug | 6.5 |
| Absorption efficiency | % | 50 |
| Acceptable Absorption Eff. | >95% (Y/N) | N |
| | | |
| ***Blank sample*** | | |
| Blank sample ID | - | F1HFB |
| Blank result | $mg/m^3$ | <0.08 |
| Acceptable Blank | <10% ELV (Y/N) | Y |

**Hydrogen Fluoride Results & Measurement Uncertainty**

| **Sampling Details** | | **Run 1** |
|---|---|---|
| **Stack ID** | F1 | |
| **Date** | - | |
| **Start time** | 09:50:00 | |
| **Finish Time** | 10:21:00 | |
| | | |
| **Results** | | |
| | | |
| Laboratory Result | 13 | µg/ml |
| Impinger final Volume | 260 | ml |
| Concentration | 0.01 | mg |
| Sample Volume | 0.06 | $Nm^3$ |
| Emissions Concentration | <0.20 | $mg.m^{-3}$ |
| Mass Emissions | - | $kg.h^{-1}$ |

| | **Units** | **Run 1** |
|---|---|---|
| | Units | Run 1 |
| **Parameter** | | |
| Combined Uncertainty | $mg.m^{-3}$ | 0.005 |
| Expanded uncertainty as percentage of measured value | % of measured value | 4.742 |
| Expanded uncertainty in units of measurement | $mg.m^{-3}$ | 0.010 |
| Expanded uncertainty as percentage of limit value | % Of ELV | - |

**Sulphur Dioxide Quality Assurance**

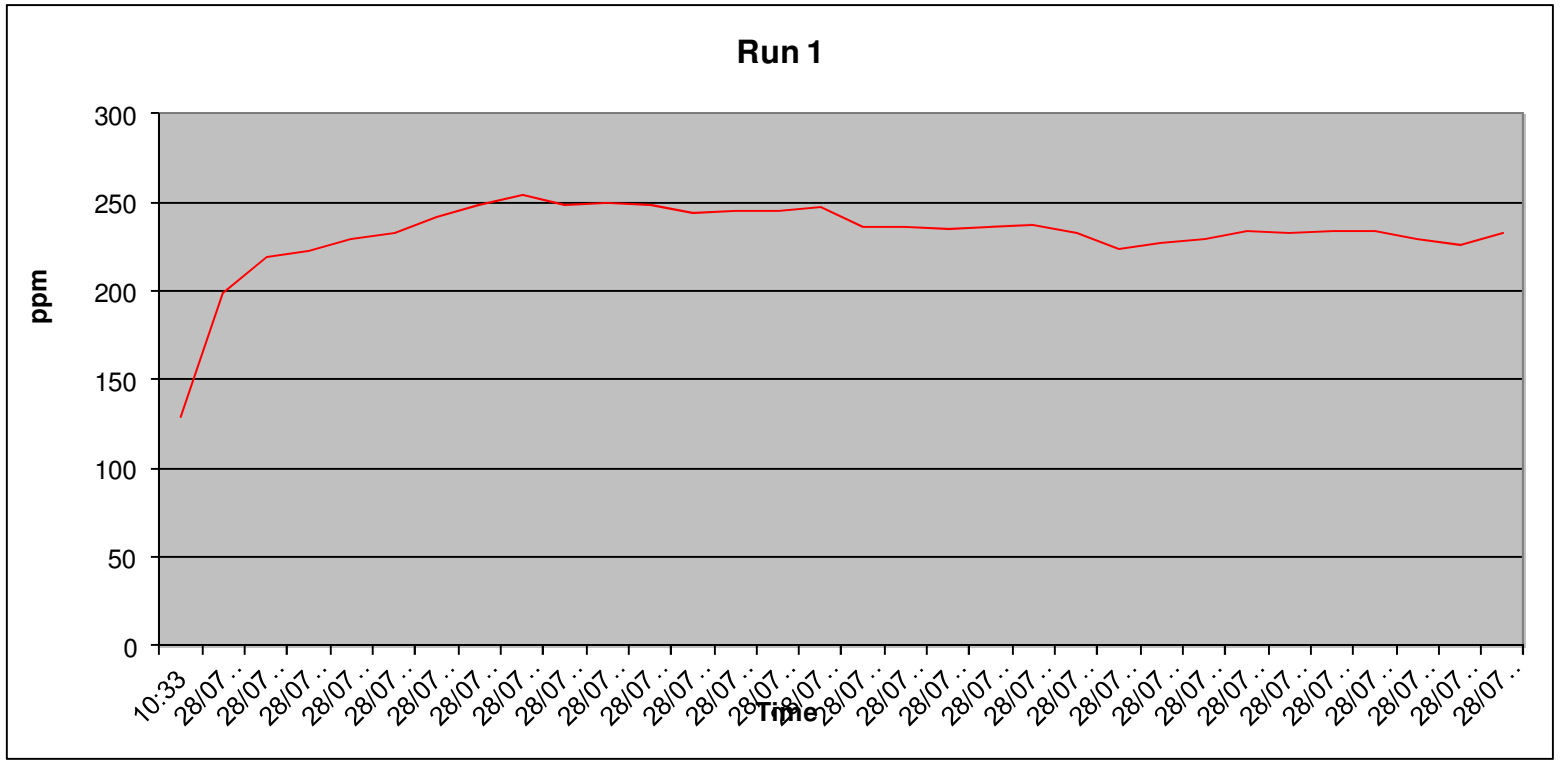
| **Sampling Details** | | |
|---|---|---|
| **Stack ID** | F1 | - |
| | **Units** | **Run 1** |
| ***Parameter*** | | |
| **Sampling Times** | - | 10:32 |
| **Sampling Dates** | - | 28/07/2016 |
| **Instrument Range** | ppm | 1000 |
| **Span Gas Value** | ppm | 506 |
| **Acceptable Gas Range** | - | Yes |
| | - | - |
| ***Quality Assurance*** | **Units** | **Run 1** |
| **Conditioning Unit Temperature** | C | 2 |
| **Average Temperature** | < C | 2 |
| **Allowable Temperature** | - | 4 |
| **Temperature Acceptable** | - | Yes |
| **Pump flow rate** | l/min. | 0.5 |
| | - | - |
| ***Zero Drift*** | Units | **Run 1** |
| **Zero Down Sampling Line (Pre)** | ppm | 0 |
| **Zero Down Sampling Line (Post)** | ppm | 6 |
| **Zero drift** | ppm | 6 |
| **Allowable Zero Drift** | ppm | 25 |
| **Zero Drift Acceptable** | - | Yes |
| | - | - |
| ***Span Drift*** | Units | **Run 1** |
| **Span Down Sampling Line (Pre)** | ppm | 510 |
| **Span Down Sampling Line (Post)** | ppm | 488 |
| **Span Drift** | ppm | 22 |
| **Allowable Span Drift** | ppm | 25 |
| **Span Drift Acceptable (Y/N)** | - | Yes |
| | - | - |
| ***Leak Check*** | | |
| **Span Gas Conc.** | ppm | 506 |
| **Recorded Conc. down Line** | ppm | 510 |
| **Leak check acceptable (< 2%)** | (Y/N) | Yes |
| | - | - |
| **Test Conditions** | **Units** | **Run 1** |
| **Run Ambient Temperature Range** | C | 15 |

**Sulphur Dioxide Results & Sampling details**

| Parameter | Units | Run 1 |
|---|---|---|
| Concentration | $mg.m^{-3}$ | 663.52 |
| Uncertainty | $mg.m^{-3}$ | 58.76 |
| Mass Emission | kg.h | - |

| General Sampling Information | |
|---|---|
| | |
| **Parameter** | **Value** |
| Standard | TGN 21 |
| Technical Procedure | 2012 |
| | |
| Probe material | SS |
| Filtration Type/Size | PTFE |
| Heated Head Filter Used | Yes |
| Heated Line Temperature | 190 |
| Date & Result of last converter check | - |
| | |
| Span Gas Reference Number | ASLTM15ING507 |
| Span Gas Expiry Date | Nov-16 |
| Span Gas Start Pressure (bar) | 30 |
| Gas Cylinder Concentration (ppm) | 506 |
| Span Gas Uncertainty (%) | <2 |
| Zero Gas Type | N |
| | |
| Number of Sampling Lines Used | 1 |
| Number of Sampling Points Used | 1 |
| Sample Point I.D's | F1 |
| | |
| **Reference Conditions** | |
| Temperature (K) | 273.15 |
| Pressure (kPa) | 101.3 |
| Gas (Wet or Dry) | Dry |
| Oxygen | 3 |

**Sulphur Dioxide Trend**



**Sulphur Dioxide Measurement Uncertainty**

| | **Units** | **Run 1** |
|---|---|---|
| Measured Quantities | | |
| Certified Range of Analyser | ppm | 2.14 to 1000 |
| Operational Range of Analyser | ppm | 1000 |
| Measured Reading | ppm | 232.00 |
| | | |
| Measured Quantities | **Units** | **Run 1** |
| Nonlinearity | % | 0.8 |
| Temperature Dependent Zero drift | % | 0.8 |
| Temperature Dependent Span drift | % | 2 |
| Cross-sensitivity | % | 1.5 |
| Leak | % | 0 |
| Calibration Gas Uncertainty | % | <2 % |
| | | |
| **Parameter** | **Units** | **Run 1** |
| Combined uncertainty | $mg.m^{-3}$ | 9.43 |
| Expanded uncertainty | $mg.m^{-3}$ | 18.86 |
| | | |
| **Uncertainty corrected to std conds.** | $mg.m^{-3}$ | 58.76 |
| | | |
| **Expanded uncertainty expressed with a level of confidence of 95%** | % of ELV | - |
| **Expanded uncertainty expressed with a level of confidence of 95%** | $mg.m^{-3}$ | 58.76 |
| | | |
| **Expanded uncertainty expressed with a level of confidence of 95%** | % of value | 8.86 |
| | | |
| **Requirement in standard is for uncertainty to be < 10% at ELV at standard conditions** | | |