

**DATE OF REPORT:** 16<sup>TH</sup> JANUARY, 2015



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**TEST REPORT No. OCT14181.2**

**AIR EMISSIONS MONITORING OF  
RELEASE POINTS 4A & 4B AT  
ADELAIDE BRIGHTON CEMENT LTD  
IN BIRKENHEAD**

**DATE OF TESTING:** 22<sup>ND</sup> – 24<sup>TH</sup> OCTOBER 2014

**ACCREDITATION:**



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## INTRODUCTION

Airlabs Environmental Pty Ltd was commissioned by Adelaide Brighton Cement Ltd to conduct air emissions testing of the Dry Process Kiln 4 Main Stack (Release Point 4A) and the Precalciner Plant Stack (Release Point 4B) at their Birkenhead Plant. The following parameters were monitored on each stack:

- Temperature, Gas Velocity and Volume Flow Rate
- Moisture Concentration
- Concentration of Oxygen and Carbon Dioxide
- Dry Molecular Weight and Dry Gas Density
- Concentration and Mass Emission Rate of:
  - Total Solid Particulates
  - PM<sub>10</sub> (Particulate matter with a nominal aerodynamic diameter  $\leq 10 \mu\text{m}$ )
  - PM<sub>2.5</sub> (Particulate matter with a nominal aerodynamic diameter  $\leq 2.5 \mu\text{m}$ )
  - Sulphur Dioxide
  - Carbon Monoxide
  - Nitrogen Oxides (as NO<sub>2</sub>)
  - Hydrogen Chloride<sup>a</sup>
  - Chlorine
  - Fluoride<sup>b</sup>
  - Total Volatile Organic Compounds (VOCs)
  - Benzene (triplicate samples)
  - Multi-Metals<sup>c</sup>
  - Chromium VI and compounds
  - Polycyclic Aromatic Hydrocarbons (PAHs as BaP).
  - Dioxins and Furans (PCDD's and PCDF's)

Combustion gases (O<sub>2</sub>, CO, CO<sub>2</sub>, SO<sub>2</sub> and NO<sub>x</sub>) were monitored semi-continuously and the average values reported. Average normalised flow rates were used to calculate the mass emission rates. All testing was conducted on 22<sup>nd</sup> – 24<sup>th</sup> October 2014.

## QUALITY STATEMENT

AirLabs Environmental is committed to providing the highest quality data to all our clients, as reflected in our ISO 17025 (NATA) accreditation. This requires strict adherence to and continuous improvement of all our processes and test work. Our goal is to exceed the QA/QC requirements as set by our clients and appropriate governmental entities and to insure that all data generated is scientifically valid and defensible.

Airlabs Environmental is NATA accredited for all sampling undertaken for this project. Analysis was undertaken by the National Measurement Institute (NATA Accreditation No. 198) and Airlabs Environmental in accordance with our terms of accreditation.

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<sup>a</sup> Chlorides expressed as HCl.

<sup>b</sup> Fluorides expressed as HF.

<sup>c</sup> Antimony and compounds, Arsenic and compounds, Barium (soluble compounds), Beryllium and compounds, Cadmium and compounds, Chromium (III) and compounds, Copper oxide fume (as CuO), Iron oxide fume (as Fe<sub>2</sub>O<sub>3</sub>), Lead and compounds, Magnesium oxide fume (as MgO), Manganese and compounds, Mercury - organic, Mercury - inorganic, Nickel and compounds, Zinc oxide fume (as ZnO).

[Redacted content]

## TEST METHODS

### Gas Velocity, Volume Flow Rate and Temperature

Stack gas velocity and volumetric flow rates were determined in accordance with USEPA Method 2 'Determination of stack gas velocity and volumetric flow rate (type s pitot tube)'. Pressure differential and temperature profiles were obtained across the sampling plane at transverse points as specified in AS4323.1-1995 'Stationary Source Emissions, Method 1: Selection of Sampling Provisions'. Gas velocity and volume flow rates were then calculated in accordance with USEPA Method 2.

The estimated measurement uncertainty for temperature is  $\pm 1\%$ . The estimated measurement uncertainty for gas velocity and volume flow rate is  $\pm 10\%$ .

### Water Vapour (Moisture Content)

Stack gas moisture content was determined in accordance with USEPA Method 4 'Determination of Moisture Content in Stack Gases'. A measured volume of stack gas was drawn through a series of chilled impingers each containing 100 mls of water and then through a silica gel tube.

The total change in volume of water in the impingers and the weight change of the silica gel tube were used to calculate the percentage moisture in the stack. The estimated measurement uncertainty is  $\pm 5\%$ .

## TEST METHODS Continued

### Oxygen and Carbon Dioxide

Oxygen (O<sub>2</sub>) and carbon dioxide (CO<sub>2</sub>) concentrations were monitored in accordance with USEPA Method 3A 'Determination of Oxygen and Carbon Dioxide Concentrations in Emissions from Stationary Sources (Instrumental Analyser Procedure)'. The sample gas was withdrawn continuously from the gas stream and portions were conveyed to a Paramagnetic O<sub>2</sub> analyser and a Non Dispersive Infrared (NDIR) CO<sub>2</sub> analyser.

Each analyser was zeroed using dry nitrogen and calibrated in accordance with the method using ambient air for O<sub>2</sub> as well as NATA certified span gases for O<sub>2</sub> and CO<sub>2</sub>. The estimated measurement uncertainty is  $\pm 2\%$ .

### Dry Molecular Weight and Stack Gas Density

The dry molecular weight and density of source gases was determined in accordance with USEPA Method 3 'Gas analysis for Carbon Dioxide, Oxygen, Excess Air and Dry Molecular Weight'. A stack gas sample was withdrawn from the stack, conditioned for the removal of moisture and particulate matter. The conditioned gas was then analysed for CO<sub>2</sub>, O<sub>2</sub>, CO and N<sub>2</sub>. This determination was required for calculating isokinetic sampling rates. The estimated measurement uncertainty is  $\pm 5\%$ .

### Oxides of Nitrogen (NO, NO<sub>2</sub> and NO<sub>x</sub> as NO<sub>2</sub>)

Nitric oxide (NO) and nitrogen dioxide (NO<sub>2</sub>) concentrations were monitored in accordance with USEPA Method 7E 'Determination of Nitrogen Oxides Emissions from Stationary Sources (Instrumental Analyser Procedure)'. In accordance with this method, sample gas was withdrawn continuously from the source and analysed using a chemiluminescent NO/NO<sub>2</sub> analyser.

The analyser was calibrated in accordance with the method using NATA certified NO and NO<sub>2</sub> span gases and zeroed with dry nitrogen. Total nitrogen oxides (NO<sub>x</sub>) are expressed as nitrogen dioxide (NO<sub>2</sub>). The estimated measurement uncertainty is  $\pm 5\%$ .

### Carbon Monoxide

Carbon monoxide (CO) was monitored in accordance with USEPA Method 10 'Determination of Carbon Monoxide Emissions from Stationary Sources'. The sample gas was withdrawn continuously from the gas stream and conveyed to a Non Dispersive Infrared (NDIR) CO analyser.

The instrument was calibrated using NATA certified CO span gas and zeroed with dry nitrogen. The estimated measurement uncertainty is  $\pm 5\%$ .

### Sulphur Dioxide

Sulphur dioxide (SO<sub>2</sub>) was monitored in accordance with USEPA Method 6C 'Determination of Sulphur Dioxide Emissions from Stationary Sources (Instrumental Analyser Procedure)'. The sample gas was withdrawn continuously from the gas stream and a portion was conveyed to a Non Dispersive Infrared SO<sub>2</sub> analyser.

The instrument was calibrated using NATA certified SO<sub>2</sub> span gas and zeroed with dry nitrogen. The estimated measurement uncertainty is  $\pm 5\%$ .

## TEST METHODS Continued

### Total Solid Particles

Monitoring for solid particles was conducted in accordance with Australian Standard 4323.2 - 1995 'Stationary Source Emissions, Method 2: Determination of Total Particulate Matter - Isokinetic Manual Sampling - Gravimetric Method'.

Stack gas was withdrawn isokinetically through a nozzle, which had a sharp and tapered leading edge. Particulate matter was collected on a pre-weighed glass fibre filter located in a holder downstream of the nozzle. Gases were then conditioned (for removal of moisture) and finally metered for flow rate and sample volume.

The weight change of the filter was determined using an Ohaus electronic balance and this figure used to calculate the concentration of particulate matter. The estimated measurement uncertainty is  $\pm 15\%$ .

### PM<sub>10</sub> & PM<sub>2.5</sub> Particulate Matter

Monitoring for PM<sub>10</sub> and PM<sub>2.5</sub> particulate matter was conducted in accordance with USEPA Method 201A 'Determination of PM<sub>10</sub> and PM<sub>2.5</sub> Emissions from Stationary Sources (Constant Sampling Rate Procedure)'. This method is used to determine particulate matter emissions equal to or less than a nominal aerodynamic diameter of 10 $\mu$ m (PM<sub>10</sub>) and 2.5 $\mu$ m (PM<sub>2.5</sub>).

In accordance with this method, a sample of stack gas was extracted at a predetermined constant flow rate through two in-stack cyclones in series producing aerodynamic diameters of cut sizes 10 $\mu$ m and 2.5 $\mu$ m. An in-stack filter was used to capture the smaller fraction of particles.

To minimize variations in the isokinetic sampling conditions, testing was conducted within well-defined limits. Gases were then conditioned (for removal of moisture) and finally metered for flow rate and sample volume.

The particulate mass for each size fraction was determined using gravimetric analysis. As the cyclones were connected in series, the total mass of PM<sub>10</sub> was the combination of the PM<sub>10</sub> and PM<sub>2.5</sub> size fractions. The estimated measurement uncertainty is  $\pm 15\%$ .

### Chlorine, Chlorides and Fluorides

Sampling and analysis were performed in accordance with USEPA Method 26A 'Determination of Hydrogen Halide and Halogen Emissions from Stationary Sources – Isokinetic Method'. Gaseous and particulate pollutants were withdrawn isokinetically from the source and collected on a filter and in absorbing solutions.

The filter collected particulate matter including halide salts. Acidic and alkaline absorbing solutions collected the gaseous hydrogen halides and halogens, respectively. Samples were analysed using ion chromatography. The estimated measurement uncertainty is  $\pm 15\%$ .

## TEST METHODS Continued

### Total (Volatile) Organic Compounds

Sampling and analysis were performed in accordance with Method 25A 'Determination of Total Gaseous Organic Concentration using a Flame Ionization Analyzer'. A gas sample was extracted from the source through a heated sample line and glass fibre filter to a flame ionization analyser (FIA).

Monitoring was conducted over 60 minutes, and the average response is reported as concentration equivalents to an *n*-propane calibration gas. The estimated measurement uncertainty is  $\pm 10\%$ .

### Benzene

Sampling and analysis for benzene was conducted in accordance with USEPA Method 18 'Measurement of Gaseous Organic Compound Emissions by Gas Chromatography – Adsorption Tube Procedure'. A measured volume of stack gas was drawn through an activated carbon tube, which retained volatile organic compounds (including benzene) present in the sample gas stream.

The sample was extracted using organic solvents, and the extract analysed using gas chromatography-mass spectrometry (GC-MS). The estimated measurement uncertainty is  $\pm 20\%$ .

### Multi-Metals

Monitoring for metals was performed in accordance with USEPA Method 29 'Determination of Metal Emissions from Stationary Sources'. A representative sample of stack gas was withdrawn isokinetically from the source. Particulate matter was collected on the internal surfaces of the probe and on a heated filter. Metals present in the gas phase were collected downstream in an aqueous acidic solution of hydrogen peroxide and an aqueous acidic solution of potassium permanganate.

Samples were recovered from the probe, filter, and aqueous acidic solution of hydrogen peroxide and analysed for all metals (including Hg). The aqueous acidic solution of potassium permanganate was analysed only for Hg by cold vapour atomic absorption spectroscopy (CVAAS). All other metals were determined using inductively coupled argon plasma emission spectroscopy - mass spectrometry (ICAP-MS). The estimated measurement uncertainty is  $\pm 20\%$ .

### Hexavalent Chromium

Hexavalent chromium ( $\text{Cr}^{+6}$ ) was monitored in accordance with USEPA Method 0061 'Determination of Hexavalent Chromium Emissions from Stationary Sources'. A representative sample of stack gas was withdrawn isokinetically from the source through a series of impingers containing a 0.1 N solution of potassium hydroxide. To eliminate the possibility of  $\text{Cr}^{+6}$  reduction between the nozzle and impinger, the emission sample was collected from a recirculatory train where the impinger reagent was continuously recirculated to the nozzle.

Recovery procedures included a post-sampling purge and filtration. The impinger train samples were analysed for  $\text{Cr}^{+6}$  using an ion chromatograph equipped with a post-column reactor (IC/PCR) and a visible wavelength detector. The IC/PCR separated the  $\text{Cr}^{+6}$  as chromate ( $\text{CrO}_4^{-2}$ ) from other diphenylcarbazide reactions that occurred in the post-column reactor. To increase the sensitivity to trace levels of chromium, a pre-concentration system was used in conjunction with the IC/PCR. The estimated measurement uncertainty is  $\pm 20\%$ .



## TEST METHODS Continued

### Polycyclic Aromatic Hydrocarbons (PAHs)

Sampling for Polycyclic Aromatic Hydrocarbons (PAHs) was conducted in accordance with USEPA SW-846 Method 0010 'Modified Method 5 Sampling Train'.

The XAD-2 resin was spiked prior to sampling with isotopically labelled PAH surrogate standards. In the laboratory recovery standards were added to the sample components. The filter, resin and impinger solutions were extracted with organic solvents, and the extract purified by chemical treatment and solid phase chromatographic techniques.

Measurement of PAHs was performed using high-resolution gas chromatography with low-resolution mass spectrometry in accordance with the California EPA Air Resources Board Method 429 'Determination of Polycyclic Aromatic Hydrocarbon (PAH) Emissions from Stationary Sources'. The total of USEPA Priority Pollutant PAHs is given. The PAH total toxic equivalent was calculated using toxic equivalency factors based on benzo(a)pyrene as defined in 'Benzo(a)pyrene as a Toxic Air Contaminant', CARB/OEHHA Executive Summary, July 1994. The estimated measurement uncertainty is  $\pm 20\%$ .

### Dioxins and Furans (PCDD's and PCDF's)

Sampling was performed in accordance with US EPA Method 23 – 'Determination of Polychlorinated Dibenzo-p-Dioxins and Polychlorinated Dibenzofurans from Stationary Sources', using a US EPA Modified Method 5 sampling train.

Prior to sampling the XAD-2 resin trap was prepared and spiked with isotopically labelled PCDD/PCDF surrogate standards by the analysing laboratory.

Stack gas was withdrawn isokinetically through a glass nozzle and a glass lined heated probe. Particulate matter was collected on a glass fibre filter located on a PTFE holder in a heated box. Sampled gases were then chilled prior to passing through the XAD-2 resin trap before the gases passed through a series of chilled impingers for the collection of moisture before being metered for flow rate and sample volume.

After the completion of the sampling, the XAD-2 resin trap was sealed, the filter was recovered from the filter holder and all sampling parts up to the resin trap were rinsed with toluene and then acetone for subsequent analysis.

In the analysing laboratory, PCDD and PCDF recovery standards were added to the sample components. The filter, resin and rinse solutions were extracted with organic solvents and the extract purified by chemical treatment and solid phase chromatographic techniques.

Measurement of PCDDs and PCDFs was performed using high resolution gas chromatography with high resolution electron impact mass spectrometry in accordance with US EPA Method 1613A. The total toxic equivalent (TEQ) for each PCDD/F congener was calculated using international toxic equivalency factors (TEFs). Results have been expressed using the NATO 1989 TEFs and include half Limit of Detections (LODs) values and reported to 1989 NATO guidelines. The analysis results were related to the sample volume to calculate the concentration of metals.

The estimated measurement uncertainty is  $\pm 25\%$ .

## DEFINITIONS

'SA EPA'	South Australian Environment Protection Authority.
'USEPA'	United States Environmental Protection Agency.
'tph'	Tonnes per hour.
'K'	Absolute temperature in Kelvin ( $^{\circ}\text{C} + 273$ ).
'mB'	Pressure in millibars.
'lpm'	Gas flow rate in litres per minute.
'STP'	Standard temperature and pressure (273K and 101.3 kPa).
'm <sup>3</sup> '	Actual gas volume in cubic metres at stack conditions.
'Nm <sup>3</sup> '	Gas volume in dry cubic metres at STP.
'<'	Less than. The value stated is the limit of detection.
'g'	Grams.
'mg'	Milligrams ( $10^{-3}$ grams).
' $\mu\text{g}$ '	Micrograms ( $10^{-6}$ grams).
'min'	Minute.
'LOD'	Limit of detection.
'FIA'	Flame ionisation analyser.
'VOC'	Volatile organic compound. A VOC is defined as any chemical compound based on carbon chains or rings with a vapour pressure greater than 2 mm of mercury (0.27 kPa) at 25 $^{\circ}\text{C}$ . These compounds may contain hydrogen, oxygen, nitrogen and other elements, but specifically excluded are methane, carbon monoxide, carbon dioxide, carbonic acid, metallic carbides and carbonate salts.
'PAHs'	Polycyclic aromatic hydrocarbons.
'CARB'	California Air Resources Board.
'OEHHA'	Office of Environmental Health Hazard Assessment (US).
'BaP-PEF'	Benzo(a)pyrene Potency Equivalent Factor.
'BAP-TEQ <sub>PAH</sub> '	Benzo(a)pyrene Toxic Equivalents.
'N/A'	Not applicable.
'PM <sub>10</sub> '	Particulate matter with a nominal aerodynamic diameter $\leq 10\mu\text{m}$ .
'PM <sub>2.5</sub> '	Particulate matter with a nominal aerodynamic diameter $\leq 2.5\mu\text{m}$ .
'PCDDs'	Polychlorinated dibenzo-p-dioxins.
'PCDFs'	Polychlorinated dibenzofurans.
'NATA'	National Association of Testing Authorities, Australia.
'NATO'	North Atlantic Treaty Organisation.
'WHO'	World Health Organisation.
'I-TEF'	Toxic Equivalency Factor (NATO basis).
'I-TEQ'	Toxic Equivalent based on the 2,3,7,8-TCDD congener (NATO basis).
'TEF'	Toxic Equivalency Factor (WHO basis).
'TEQ'	Toxic Equivalent based on the 2,3,7,8-TCDD congener (WHO basis).

## SUITABILITY OF SAMPLING PLANE

The criteria for sampling planes as specified in AS4323.1-1995 'Stationary Source Emissions, Method 1: Selection of Sampling Provisions' states that, in the absence of cyclonic flow activity, ideal sampling plane conditions are found to exist at the positions given in Table 1 below:

**Table 1:** Criteria for the Selection of Sampling Planes

Type of flow disturbance	Minimum distance upstream from disturbance, diameters (D)	Minimum distance downstream from disturbance, diameters (D)
Bend, connection, junction, direction change	>2D	>6D
Louvre, butterfly damper (partially closed or closed)	>3D	>6D
Axial fan	>3D	>8D (see Note)
Centrifugal fan	>3D	>6D

**NOTE:** The plane should be selected as far as practicable from a fan. Flow straighteners may be required to ensure the position chosen meets the check criteria listed in Items (a) to (f) below.

The Sampling Plane Details for the Dry Process Kiln 4 Main Stack (Release Point 4A) and the Precalciner Plant Stack (Release Point 4B) are given below:

**Table 2:** Sampling Plane Details for the Kiln 4 Main Stack

Parameter	
Stack Shape	Circular
Actual Stack Internal Diameter (m)	3.23
Stack Exit Diameter (m)	3.23
Direction of Discharge to Air	Vertical
Type of Disturbance, Upstream	Centrifugal Fan
Distance from Upstream Disturbance	> 6 D
Type of Disturbance, Downstream	Stack Exit
Distance to Downstream Disturbance	> 2 D
Compliance with AS4323.1, Ideal Conditions	Yes
Stack Height Above Ground Level (m)	75.5
Standard No. of Sampling Points per Traverse	12
Number of Traverses	2
Correction Factor	N/A
Corrected No. of Sampling Points per Traverse	N/A
Total No. of Sampling Points	24
Stratified	No
Cyclonic	No (< 15°)
Velocity Difference	1.6:1 (< 1.6:1)
Absolute Temperature Difference (K)	< 10%
Compliance with AS4323.1, Non-Ideal Conditions	N/A

**Figure 1:** Kiln 4 Main Stack (RP 4A)

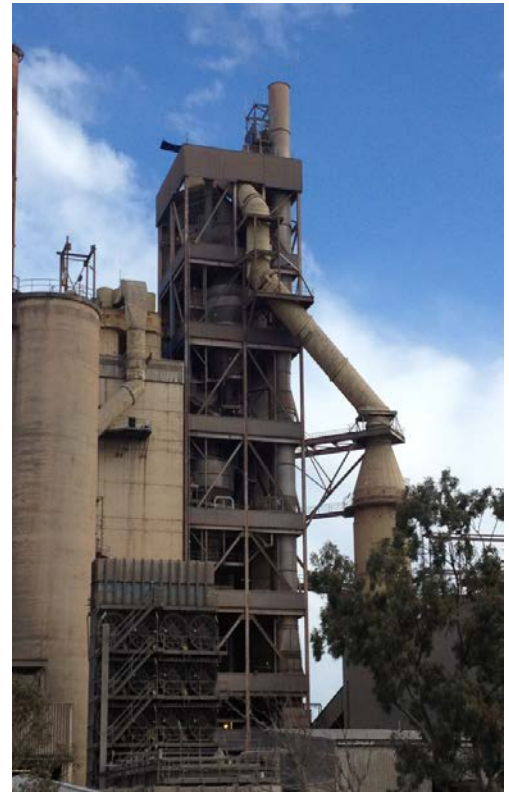


## SUITABILITY OF SAMPLING PLANE Continued

**Table 3:** Sampling Plane Details for the Precalciner Plant Stack

Parameter	
Stack Shape	Circular
Actual Stack Internal Diameter (m)	3.00
Stack Exit Diameter (m)	3.00
Direction of Discharge to Air	Vertical
Type of Disturbance, Upstream	Centrifugal Fan
Distance from Upstream Disturbance	> 6 D
Type of Disturbance, Downstream	Stack Exit
Distance to Downstream Disturbance	> 2 D
Compliance with AS4323.1, Ideal Conditions	Yes
Stack Height Above Ground Level (m)	96
Standard No. of Sampling Points per Traverse	12
Number of Traverses	2
Correction Factor	N/A
Corrected No. of Sampling Points per Traverse	N/A
Total No. of Sampling Points	24
Stratified	No
Cyclonic	No (< 15°)
Velocity Difference	1.5:1 (< 1.6:1)
Absolute Temperature Difference (K)	< 10%
Compliance with AS4323.1, Non-Ideal Conditions	N/A

**Figure 2:** Precalciner Plant Stack (RP 4B)



## RESULTS – RELEASE POINT 4A

<b>Company</b>	Adelaide Brighton Cement
<b>Site</b>	Birkenhead
<b>Source Tested</b>	Dry Process Kiln 4 Main Stack - Release Point 4A
<b>Date of Tests</b>	22 <sup>nd</sup> – 23 <sup>rd</sup> October 2014
<b>Sampling Period</b>	10:10 (22/10) - 17:27 (23/10) <sup>d</sup>
<b>Testing Officer</b>	A. Williams & L. Taylor
<b>Sampling Position</b>	Four 4" BSP sample ports in circular stack

**Table 4:** Release Point 4A - Sampling Conditions

<b>Sampling Conditions</b>	<b>Start</b>	<b>Finish</b>	<b>Average</b>
Stack diameter at sampling plane (m)	3.23	3.23	3.23
Average stack gas temperature (K)	376 (103°C)	375 (102°C)	376 (103°C)
Average barometric pressure (hPa)	1008	1009	1009
Average static pressure (mB)	-1.0	-1.1	-1.1
Average velocity at sampling plane (m/s)	20.4	20.1	20.3
Average velocity at sampling plane expressed at STP (m/s)	14.8	14.6	14.7
Actual gas flow rate (m <sup>3</sup> /min)	10,000	9,860	9,930
Average moisture content (%v/v)	8.47	9.22	8.85
Gas flow rate at STP, dry (Nm <sup>3</sup> /min)	6,630	6,480	6,560
Average carbon dioxide concentration, dry basis (%v/v)	5.19	5.47	5.33
Average oxygen concentration, dry basis (%v/v)	16.7	16.3	16.5
Dry molecular weight of stack gas (g/g mole)	29.50	29.53	29.51
Dry gas density of stack gas (kg/m <sup>3</sup> )	1.317	1.318	1.317

<sup>d</sup> All sampling was conducted during normal operating conditions. No sampling was conducted during abnormal plant conditions.

## RESULTS – RELEASE POINT 4A Continued

**Table 5:** Release Point 4A – Test Results

Parameter	Sampling Period	Concentration (mg/Nm <sup>3</sup> ) <sup>e</sup>	Emission Rate (g/min) <sup>e</sup>
Total Solid Particulates	09:40 – 11:48 (23/10/14)	31.3	205
PM <sub>10</sub> Particles	15:20 – 17:27 (23/10/14)	19.7	129
PM <sub>2.5</sub> Particles		5.2	34
Sulphur Dioxide	16:40 – 17:40 (22/10/14)	37 – 69 (Av. 49)	240 - 450 (Av. 320)
Carbon Monoxide		18 – 29 (Av. 22)	120 - 190 (Av. 140)
Oxides of Nitrogen (as NO <sub>2</sub> ) <i>Actual at STP At 7% O<sub>2</sub></i>		360 – 490 (Av. 420) 1,300 – 1,740 (Av. 1,510)	2,360 – 3,210 (Av. 2,760)
Hydrogen Chloride	16:20 – 18:29 (22/10/14)	0.91	6.0
Chlorine		0.030	0.20
Fluoride (as HF)		< 0.03	< 0.2
Total Volatile Organic Compounds (by FIA, as n-propane equivalent)	12:54 – 13:24	0.21	1.4
	13:26 – 13:56	0.18	1.2
	13:58 – 14:28	0.25	1.6
	(22/10/14)	(Av. 0.21)	(Av. 1.4)
Benzene	12:54 – 13:24	0.057	0.37
	13:26 – 13:56	0.050	0.33
	13:58 – 14:28	0.060	0.39
	(22/10/14)	(Av. 0.056)	(Av. 0.37)
Total Multi-Metals <sup>f</sup>	10:50 – 13:04 (22/10/14)	0.72	4.7
Chromium VI and Compounds	13:26 – 15:34 (22/10/14)	0.00097	0.0064
Polycyclic Aromatic Hydrocarbons <i>Total BaP-TEQ<sub>PAH</sub> <sup>g</sup></i>	12:01 – 15:10 (23/10/14)	0.0000059	0.000039
Polychlorinated Dioxins and Furans <sup>h</sup> <i>Total tetra to octa PCDD/Fs <sup>i</sup> WHO<sub>05</sub> TEQ for PCDDs /Fs <sup>j</sup> NATO<sub>89</sub> I-TEQ for PCDDs /Fs <sup>j</sup></i>	12:01 – 15:10 (23/10/14)	0.036 ng/Nm <sup>3</sup> 0.00089 ng/Nm <sup>3</sup> 0.0010 ng/Nm <sup>3</sup>	0.24 µg/min 0.0058 µg/min 0.0066 µg/min

<sup>e</sup> Unless otherwise stated.

<sup>f</sup> Individual metals and their compounds are given in Table 6.

<sup>g</sup> Individual BaP-TEQ<sub>PAH</sub> contributions are given in Table 7, and the total BaP-TEQ<sub>PAH</sub> in Table 9. This result includes half LOD values.

<sup>h</sup> Tetra-octa chlorinated dioxin & furan congener profile, homologue groups and toxic equivalents are given in Table 10.

<sup>i</sup> Total does not include limit of detection (LOD) values.

<sup>j</sup> This result includes half LOD values.

**RESULTS – RELEASE POINT 4A Continued**

**Table 6:** Release Point 4A – Individual Metals and their Compounds

<b>Metal</b>	<b>Concentration (mg/Nm<sup>3</sup>)</b>	<b>Emission Rate (g/min)</b>
Antimony and its compounds	< 0.00018	< 0.0012
Arsenic and its compounds	< 0.00019	< 0.0012
Barium (soluble compounds)	0.0021	0.014
Beryllium and its compounds	< 0.000097	< 0.00064
Cadmium and its compounds	0.00051	0.0033
Chromium (III) and its compounds	0.0026	0.017
Copper oxide fume (as CuO)	0.0045	0.030
Iron oxide fume (as Fe <sub>2</sub> O <sub>3</sub> )	0.47	3.1
Lead and its compounds	0.0077	0.051
Magnesium oxide fume (as MgO)	0.17	1.1
Manganese and its compounds	0.0052	0.034
Mercury and its compounds (as Hg)		
Organic:	< 0.0015	< 0.0098
Inorganic:	0.000027	0.00018
Total:	< 0.0015	< 0.0098
Nickel and its compounds	0.0015	0.0098
Zinc oxide fume (as ZnO)	0.053	0.35
<b>TOTAL METALS</b>		
Excluding LOD values	<b>0.72</b>	<b>4.7</b>
Including half LOD values	<b>0.72</b>	<b>4.7</b>

## RESULTS – RELEASE POINT 4A Continued

**Table 7:** Release Point 4A – Individual USEPA Priority Pollutant PAHs

Individual USEPA Priority Pollutant PAHs	Concentration of PAHs ( $\mu\text{g}/\text{Nm}^3$ )	BaP-PEF value	BaP-TEQ <sub>PAH</sub> Contribution	Emission Rate of PAHs (mg/min)
Naphthalene	6.1	0.0	0	40
2-Methylnaphthalene	0.90	0.0	0	5.9
Acenaphthylene	0.029	0.0	0	0.19
Acenaphthene	<0.0064	0.0	0	<0.042
Fluorene	0.014	0.0	0	0.092
Phenanthrene	0.038	0.0	0	0.25
Anthracene	0.0090	0.0	0	0.059
Fluoranthene	0.012	0.0	0	0.082
Pyrene	0.015	0.0	0	0.099
Benz(a)anthracene	<0.0064	0.1	0.00032	<0.042
Chrysene	<0.0064	0.01	0.000032	<0.042
Benzo(b)fluoranthene	<0.0064	0.1	0.00032	<0.042
Benzo(k)fluoranthene	<0.0064	0.1	0.00032	<0.042
Benzo(e)pyrene	<0.0064	0.0	0.0	<0.042
Benzo(a)pyrene	<0.0064	1.0	0.0032	<0.042
Perylene	<0.0064	0.0	0.0	<0.042
Indeno(1 23-cd)pyrene	<0.0067	0.1	0.00034	<0.044
Dibenz(ah)anthracene	<0.0067	0.4	0.0013	<0.044
Benzo(ghi)perylene	<0.0083	0.0	0.0	<0.055

**Table 8:** Release Point 4A – Total USEPA Priority Pollutant PAHs

Total USEPA Priority Pollutant PAHs	Concentration ( $\mu\text{g}/\text{Nm}^3$ )	Emission Rate (mg/min)
<i>Excluding LOD values</i>	7.1	47
<i>Including half LOD values</i>	7.1	47

**Table 9:** Release Point 4A – Total PAH Toxic Equivalents (BaP-TEQ<sub>PAH</sub>)

Total PAH Toxic Equivalents (BaP-TEQ <sub>PAH</sub> ) <sup>k</sup>	Concentration ( $\mu\text{g}/\text{Nm}^3$ )	Emission Rate (mg/min)
<i>Excluding LOD values</i>	0.0	0.0
<i>Including half LOD values</i>	0.0059	0.039

<sup>k</sup> Calculated using benzo(a)pyrene potency equivalency factors (BaP-PEF values).



**RESULTS – RELEASE POINT 4A Continued**

**Table 10:** Release Point 4A – PCDD/F Congener Profile

PCDD/F Congeners	Concentration (ng/Nm <sup>3</sup> )	WHO <sub>05</sub> TEF	WHO <sub>05</sub> TEQ contribution (ng/Nm <sup>3</sup> )	NATO <sub>89</sub> I-TEF	NATO <sub>89</sub> I-TEQ contribution (ng/Nm <sup>3</sup> )
2378 TCDF	0.00090	0.1	0.000090	0.1	0.000090
2378 TCDD	<0.00032	1	0.00016	1	0.00016
12378 PeCDF	0.00064	0.03	0.000019	0.05	0.000032
23478 PeCDF	0.00096	0.3	0.00029	0.5	0.00048
12378 PeCDD	<0.00032	1	0.00016	0.5	0.000080
123478 HxCDF	<0.00064	0.1	0.000032	0.1	0.000032
123678 HxCDF	0.00045	0.1	0.000045	0.1	0.000045
234678 HxCDF	<0.00064	0.1	0.000032	0.1	0.000032
123789 HxCDF	<0.00032	0.1	0.000016	0.1	0.000016
123478 HxCDD	<0.00022	0.1	0.000011	0.1	0.000011
123678 HxCDD	<0.00019	0.1	0.0000096	0.1	0.0000096
123789 HxCDD	<0.00022	0.1	0.000011	0.1	0.000011
1234678 HpCDF	0.00080	0.01	0.0000080	0.01	0.0000080
1234789 HpCDF	<0.00032	0.01	0.0000016	0.01	0.0000016
1234678 HpCDD	<0.00032	0.01	0.0000016	0.01	0.0000016
OCDF	<0.00032	0.0003	0.000000048	0.001	0.00000016
OCDD	<0.0029	0.0003	0.00000043	0.001	0.0000014
<b>PCDD/F Homologue Groups</b>				<b>Concentration (ng/Nm<sup>3</sup>)</b>	
Total TCDF isomers				0.019	
Total TCDD isomers				0.0042	
Total PeCDF isomers				0.0077	
Total PeCDD isomers				< 0.0019	
Total HxCDF isomers				0.0045	
Total HxCDD isomers				< 0.0013	
Total HpCDF isomers				0.0014	
Total HpCDD isomers				< 0.00064	
<b>Polychlorinated Dioxins &amp; Furans Summary Results</b>				<b>Concentration (ng/Nm<sup>3</sup>)</b>	<b>Emission Rate (µg/min)</b>
Sum of PCDD/F congeners (Total of all Tetra to Octa congeners)					
Total PCDD/F (Excluding LOD values)				0.036	0.24
WHO <sub>05</sub> TEQ (Total of WHO <sub>05</sub> TEQ contribution for 17 toxic congeners)					
WHO <sub>05</sub> TEQ (Excluding LOD values)				0.00045	0.0030
WHO <sub>05</sub> TEQ (Including half LOD values)				0.00089	0.0058
NATO <sub>89</sub> I-TEQ (Total of NATO <sub>89</sub> I-TEQ contribution for 17 toxic congeners)					
NATO <sub>89</sub> I-TEQ (Excluding LOD values)				0.00065	0.0043
NATO <sub>89</sub> I-TEQ (Including half LOD values)				0.0010	0.0066

## RESULTS – RELEASE POINT 4B

<b>Company</b>	Adelaide Brighton Cement
<b>Site</b>	Birkenhead
<b>Source Tested</b>	Precalciner Plant Stack - Release Point 4B
<b>Date of Tests</b>	23 <sup>rd</sup> - 24 <sup>th</sup> October 2014
<b>Sampling Period</b>	08:50 (23/10) - 20:02 (24/10) <sup>1</sup>
<b>Testing Officers</b>	A. Williams & L. Taylor
<b>Sampling Position</b>	Four 4" BSP sample ports in circular stack

**Table 11:** Release Point 4B - Sampling Conditions

<b>Sampling Conditions</b>	<b>Start</b>	<b>Finish</b>	<b>Average</b>
Stack diameter at sampling plane (m)	3.00	3.00	3.00
Average stack gas temperature (K)	377 (104°C)	379 (106°C)	378 (105°C)
Average barometric pressure (hPa)	1009	1002	1006
Static pressure (mB)	-1.3	-1.1	-1.2
Average velocity at sampling plane (m/s)	18.6	18.3	18.5
Average velocity at sampling plane expressed at STP (m/s)	13.5	13.2	13.4
Actual gas flow rate (m <sup>3</sup> /min)	7,900	7,760	7,830
Average moisture content (%v/v)	18.1	17.9	18.0
Gas flow rate at STP, dry (Nm <sup>3</sup> /min)	4,660	4,540	4,600
Average carbon dioxide concentration, dry basis (%v/v)	19.5	19.8	19.7
Average oxygen concentration (%v/v), dry basis	11.0	11.2	11.1
Dry molecular weight of stack gas (g/g mole)	31.56	31.62	31.59
Dry gas density of stack gas (kg/m <sup>3</sup> )	1.409	1.411	1.410

<sup>1</sup> All sampling was conducted during normal operating conditions. No sampling was conducted during abnormal plant conditions.

## RESULTS – RELEASE POINT 4B Continued

**Table 12:** Release Point 4B – Test Results

Parameter	Sampling Period	Concentration (mg/Nm <sup>3</sup> ) <sup>m</sup>	Emission Rate (g/min) <sup>m</sup>
Total Solid Particulates	15:47 – 17:52 (24/10/14)	8.9	41
PM <sub>10</sub> Particles	17:58 – 20:02 (24/10/14)	7.3	34
PM <sub>2.5</sub> Particles		3.1	14
Sulphur Dioxide		< 3	< 14
Carbon Monoxide	08:50 – 10:50 (23/10/14)	164 – 404 (Av. 231)	754 – 1,860 (Av. 1,060)
Oxides of Nitrogen (as NO <sub>2</sub> ) <i>Actual at STP At 7% O<sub>2</sub></i>		526 – 665 (Av. 583) 722 – 913 (Av. 800)	2,420 – 3,060 (Av. 2,680)
Hydrogen Chloride		0.91	4.2
Chlorine	11:22 – 13:27 (24/10/14)	0.11	0.5
Fluoride (as HF)		< 0.04	< 0.2
Total Volatile Organic Compounds (by FIA, as n-propane equivalent)	08:48 – 09:28 09:30 – 10:05 10:07 – 10:42 (23/10/14)	0.30 0.42 0.39 (Av. 0.37)	1.4 1.9 1.8 (Av. 1.7)
Benzene	08:48 – 09:28 09:30 – 10:05 10:07 – 10:42 (23/10/14)	0.068 0.11 0.11 (Av. 0.096)	0.31 0.51 0.51 (Av. 0.44)
Total Multi-Metals <sup>n</sup>	09:10 – 11:14 (24/10/14)	0.46	2.1
Chromium VI and Compounds	13:37 – 15:40 (24/10/14)	0.00022	0.0010
Polycyclic Aromatic Hydrocarbons <i>Total BaP-TEQ<sub>PAH</sub></i> <sup>o</sup>	18:00 – 21:05 (23/10/14)	0.0000077	0.000035
Polychlorinated Dioxins and Furans <sup>p</sup> <i>Total tetra to octa PCDD/Fs</i> <sup>q</sup> <i>WHO<sub>05</sub> TEQ for PCDDs /Fs</i> <sup>r</sup> <i>NATO<sub>89</sub> I-TEQ for PCDDs /Fs</i> <sup>r</sup>	18:00 – 21:05 (23/10/14)	0.032 ng/Nm <sup>3</sup> 0.0011 ng/Nm <sup>3</sup> 0.0012 ng/Nm <sup>3</sup>	0.15 µg/min 0.0050 µg/min 0.0056 µg/min

<sup>m</sup> Unless otherwise stated.

<sup>n</sup> Individual metals and their compounds are given in Table 13.

<sup>o</sup> Individual BaP-TEQ<sub>PAH</sub> contributions are given in Table 14, and the total BaP-TEQ<sub>PAH</sub> in Table 16. This result includes half LOD values.

<sup>p</sup> Tetra-octa chlorinated dioxin & furan congener profile, homologue groups and toxic equivalents are given in Table 17.

<sup>q</sup> Total does not include limit of detection (LOD) values.

<sup>r</sup> This result includes half LOD values.

RESULTS – RELEASE POINT 4B Continued

**Table 13:** Release Point 4B – Individual Metals and their Compounds

Metal	Concentration (mg/Nm <sup>3</sup> )	Emission Rate (g/min)
Antimony and its compounds	< 0.00018	< 0.00083
Arsenic and its compounds	< 0.00018	< 0.00083
Barium (soluble compounds)	0.0036	0.017
Beryllium and its compounds	< 0.00016	< 0.00074
Cadmium and its compounds	< 0.000074	< 0.00034
Chromium (III) and its compounds	0.0025	0.012
Copper oxide fume (as CuO)	0.0018	0.0083
Iron oxide fume (as Fe <sub>2</sub> O <sub>3</sub> )	0.31	1.4
Lead and its compounds	0.0018	0.0083
Magnesium oxide fume (as MgO)	0.13	0.60
Manganese and its compounds	0.0027	0.012
Mercury and its compounds (as Hg)		
Organic:	< 0.0053	< 0.024
Inorganic:	0.000013	0.000060
Total:	< 0.0053	< 0.024
Nickel and its compounds	0.0014	0.0064
Zinc oxide fume (as ZnO)	0.0063	0.029
<b>TOTAL METALS</b>		
Excluding LOD values	<b>0.46</b>	<b>2.1</b>
Including half LOD values	<b>0.47</b>	<b>2.2</b>

## RESULTS – RELEASE POINT 4B Continued

**Table 14:** Release Point 4B – Individual USEPA Priority Pollutant PAHs

Individual USEPA Priority Pollutant PAHs	Concentration of PAHs ( $\mu\text{g}/\text{Nm}^3$ )	BaP-PEF value	BaP-TEQ Contribution	Emission Rate of PAHs (mg/min)
Naphthalene	13	0.0	0	58
2-Methylnaphthalene	2.8	0.0	0	13
Acenaphthylene	0.15	0.0	0	0.67
Acenaphthene	0.026	0.0	0	0.12
Fluorene	0.029	0.0	0	0.13
Phenanthrene	0.080	0.0	0	0.37
Anthracene	0.012	0.0	0	0.056
Fluoranthene	0.011	0.0	0	0.050
Pyrene	0.015	0.0	0	0.067
Benz(a)anthracene	<0.0084	0.1	0.00042	<0.038
Chrysene	<0.0084	0.01	0.000042	<0.038
Benzo(b)fluoranthene	<0.0084	0.1	0.00042	<0.038
Benzo(k)fluoranthene	<0.0084	0.1	0.00042	<0.038
Benzo(e)pyrene	<0.0084	0.0	0.0	<0.038
Benzo(a)pyrene	<0.0084	1.0	0.0042	<0.038
Perylene	<0.0084	0.0	0.0	<0.038
Indeno(1 23-cd)pyrene	<0.0088	0.1	0.00044	<0.040
Dibenz(ah)anthracene	<0.0088	0.4	0.0018	<0.040
Benzo(ghi)perylene	<0.011	0.0	0.0	<0.050

**Table 15:** Release Point 4B – Total USEPA Priority Pollutant PAHs

Total USEPA Priority Pollutant PAHs	Concentration ( $\mu\text{g}/\text{Nm}^3$ )	Emission Rate (mg/min)
Excluding LOD values	16	72
Including half LOD values	16	72

**Table 16:** Release Point 4B – Total PAH Toxic Equivalents (BaP-TEQ<sub>PAH</sub>)

Total PAH Toxic Equivalents (BaP-TEQ <sub>PAH</sub> ) <sup>s</sup>	Concentration ( $\mu\text{g}/\text{Nm}^3$ )	Emission Rate (mg/min)
Excluding LOD values	0.0	0.0
Including half LOD values	0.0077	0.035

<sup>s</sup> Calculated using benzo(a)pyrene potency equivalency factors (BaP-PEF values).

## RESULTS – RELEASE POINT 4B Continued

**Table 17:** Release Point 4B – PCDD/F Congener Profile

PCDD/F Congeners	Concentration (ng/Nm <sup>3</sup> )	WHO <sub>05</sub> TEF	WHO <sub>05</sub> TEQ contribution (ng/Nm <sup>3</sup> )	NATO <sub>89</sub> I-TEF	NATO <sub>89</sub> I-TEQ contribution (ng/Nm <sup>3</sup> )
2378 TCDF	0.00059	0.1	0.000059	0.1	0.000059
2378 TCDD	<0.00038	1	0.00019	1	0.00019
12378 PeCDF	0.00092	0.03	0.000028	0.05	0.000046
23478 PeCDF	0.0011	0.3	0.00033	0.5	0.00054
12378 PeCDD	<0.00029	1	0.00015	0.5	0.000073
123478 HxCDF	0.0010	0.1	0.00010	0.1	0.00010
123678 HxCDF	0.0010	0.1	0.00010	0.1	0.00010
234678 HxCDF	<0.00084	0.1	0.000042	0.1	0.000042
123789 HxCDF	<0.00038	0.1	0.000019	0.1	0.000019
123478 HxCDD	<0.00017	0.1	0.0000084	0.1	0.0000084
123678 HxCDD	<0.00017	0.1	0.0000084	0.1	0.0000084
123789 HxCDD	<0.00017	0.1	0.0000084	0.1	0.0000084
1234678 HpCDF	0.0010	0.01	0.000010	0.01	0.000010
1234789 HpCDF	<0.00017	0.01	0.00000084	0.01	0.00000084
1234678 HpCDD	<0.00042	0.01	0.0000021	0.01	0.0000021
OCDF	<0.00029	0.0003	0.000000044	0.001	0.00000015
OCDD	<0.0033	0.0003	0.00000050	0.001	0.0000017
<b>PCDD/F Homologue Groups</b>				<b>Concentration (ng/Nm<sup>3</sup>)</b>	
Total TCDF isomers				0.010	
Total TCDD isomers				0.0032	
Total PeCDF isomers				0.0096	
Total PeCDD isomers				< 0.0017	
Total HxCDF isomers				0.0080	
Total HxCDD isomers				< 0.0017	
Total HpCDF isomers				0.0010	
Total HpCDD isomers				< 0.0013	
<b>Polychlorinated Dioxins &amp; Furans Summary Results</b>				<b>Concentration (ng/Nm<sup>3</sup>)</b>	<b>Emission Rate (µg/min)</b>
Sum of PCDD/F congeners (Total of all Tetra to Octa congeners)					
Total PCDD/F (Excluding LOD values)				0.032	0.15
WHO <sub>05</sub> TEQ (Total of WHO <sub>05</sub> TEQ contribution for 17 toxic congeners)					
WHO <sub>05</sub> TEQ (Excluding LOD values)				0.00063	0.0029
WHO <sub>05</sub> TEQ (Including half LOD values)				0.0011	0.0050
NATO <sub>89</sub> I-TEQ (Total of NATO <sub>89</sub> I-TEQ contribution for 17 toxic congeners)					
NATO <sub>89</sub> I-TEQ (Excluding LOD values)				0.00086	0.0040
NATO <sub>89</sub> I-TEQ (Including half LOD values)				0.0012	0.0056

## APPENDICES

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Individual Volatile Organic Compounds (VOCs) in the Stack Gas Samples

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**Appendix A: Individual VOCs determined by GC/MS in the 4A Stack on 22<sup>nd</sup> October 2014**

Compound	Concentration (mg/m <sup>3</sup> )		
	Run 1 (12:54 – 13:24)	Run2 (13:26 – 13:56)	Run 3 (13:58 – 14:28)
<b>Monocyclic Aromatic Hydrocarbons Screen</b>			
Benzene	0.057	0.050	0.060
Toluene	< 0.03	< 0.03	< 0.03
Ethylbenzene	< 0.03	< 0.03	< 0.03
m & p-Xylenes	< 0.07	< 0.07	< 0.07
o-Xylene	< 0.03	< 0.03	< 0.03
Styrene	< 0.03	< 0.03	< 0.03
Isopropylbenzene	< 0.03	< 0.03	< 0.03
n-Propylbenzene	< 0.03	< 0.03	< 0.03
1,3,5-Trimethylbenzene	< 0.03	< 0.03	< 0.03
tert-Butylbenzene	< 0.03	< 0.03	< 0.03
1,2,4-Trimethylbenzene	< 0.03	< 0.03	< 0.03
sec-Butylbenzene	< 0.03	< 0.03	< 0.03
4-Isopropyltoluene	< 0.03	< 0.03	< 0.03
n-Butylbenzene	< 0.03	< 0.03	< 0.03
<b>Halogenated Aliphatics Hydrocarbons Screen</b>			
Dichlorodifluoromethane	< 0.03	< 0.03	< 0.03
Chloromethane	< 0.03	< 0.03	< 0.03
Vinyl chloride	< 0.03	< 0.03	< 0.03
Bromomethane	< 0.03	< 0.03	< 0.03
Chloroethane	< 0.03	< 0.03	< 0.03
Trichlorofluoromethane	< 0.03	< 0.03	< 0.03
1,1-Dichloroethane	< 0.03	< 0.03	< 0.03
Dichloromethane	< 0.03	< 0.03	< 0.03
trans-1,2-Dichloroethene	< 0.03	< 0.03	< 0.03
1,1-Dichloroethene	< 0.03	< 0.03	< 0.03
2,2-Dichloropropane	< 0.03	< 0.03	< 0.03
cis-1,2-Dichloroethene	< 0.03	< 0.03	< 0.03
Bromochloromethane	< 0.03	< 0.03	< 0.03
1,1,1-Trichloroethane	< 0.03	< 0.03	< 0.03
Carbon tetrachloride	< 0.03	< 0.03	< 0.03
1,1-Dichloropropene	< 0.03	< 0.03	< 0.03
1,2-Dichloroethane	< 0.03	< 0.03	< 0.03
Trichloroethene	< 0.03	< 0.03	< 0.03
1,2-Dichloropropane	< 0.03	< 0.03	< 0.03
Dibromomethane	< 0.03	< 0.03	< 0.03
cis-1,3-Dichloropropene	< 0.03	< 0.03	< 0.03
trans-1,3-Dichloropropene	< 0.03	< 0.03	< 0.03
1,1,2-Trichloroethane	< 0.03	< 0.03	< 0.03
Tetrachloroethene	< 0.03	< 0.03	< 0.03
1,3-Dichloropropane	< 0.03	< 0.03	< 0.03
1,2-Dibromoethane	< 0.03	< 0.03	< 0.03
1,1,1,2-Tetrachloroethane	< 0.03	< 0.03	< 0.03
1,1,2,2-Tetrachloroethane	< 0.03	< 0.03	< 0.03
1,2,3-Trichloropropane	< 0.03	< 0.03	< 0.03
1,2-Dibromo-3-chloropropane	< 0.03	< 0.03	< 0.03
Hexachlorobutadiene	< 0.03	< 0.03	< 0.03
<b>Halogenated Aromatics Hydrocarbons Screen</b>			
Chlorobenzene	< 0.03	< 0.03	< 0.03
Bromobenzene	< 0.03	< 0.03	< 0.03
2-Chlorotoluene	< 0.03	< 0.03	< 0.03
4-Chlorotoluene	< 0.03	< 0.03	< 0.03
1,3-Dichlorobenzene	< 0.03	< 0.03	< 0.03
1,4-Dichlorobenzene	< 0.03	< 0.03	< 0.03
1,2-Dichlorobenzene	< 0.03	< 0.03	< 0.03
1,2,4-Trichlorobenzene	< 0.03	< 0.03	< 0.03
1,2,3-Trichlorobenzene	< 0.03	< 0.03	< 0.03
<b>Trihalomethanes</b>			
Chloroform	< 0.03	< 0.03	< 0.03
Bromodichloromethane	< 0.03	< 0.03	< 0.03
Dibromochloromethane	< 0.03	< 0.03	< 0.03
Bromoform	< 0.03	< 0.03	< 0.03
<b>Polycyclic Aromatic Hydrocarbons (Volatile) Screen</b>			
Naphthalene	< 0.03	< 0.03	< 0.03



**Appendix B: Individual VOCs determined by GC/MS in the 4B Stack on 22<sup>nd</sup> October 2014**

Compound	Concentration (mg/m <sup>3</sup> )		
	Run 1 (08:48 – 09:28)	Run2 (09:30 – 10:05)	Run 3 (10:07 – 10:42)
<b>Monocyclic Aromatic Hydrocarbons Screen</b>			
Benzene	0.068	0.11	0.11
Toluene	0.030	0.057	0.051
Ethylbenzene	< 0.03	< 0.03	< 0.03
m & p-Xylenes	< 0.05	< 0.06	< 0.06
o-Xylene	< 0.03	< 0.03	< 0.03
Styrene	< 0.03	< 0.03	< 0.03
Isopropylbenzene	< 0.03	< 0.03	< 0.03
n-Propylbenzene	< 0.03	< 0.03	< 0.03
1,3,5-Trimethylbenzene	< 0.03	< 0.03	< 0.03
tert-Butylbenzene	< 0.03	< 0.03	< 0.03
1,2,4-Trimethylbenzene	< 0.03	< 0.03	< 0.03
sec-Butylbenzene	< 0.03	< 0.03	< 0.03
4-Isopropyltoluene	< 0.03	< 0.03	< 0.03
n-Butylbenzene	< 0.03	< 0.03	< 0.03
<b>Halogenated Aliphatics Hydrocarbons Screen</b>			
Dichlorodifluoromethane	< 0.03	< 0.03	< 0.03
Chloromethane	< 0.03	< 0.03	< 0.03
Vinyl chloride	< 0.03	< 0.03	< 0.03
Bromomethane	< 0.03	< 0.03	< 0.03
Chloroethane	< 0.03	< 0.03	< 0.03
Trichlorofluoromethane	< 0.03	< 0.03	< 0.03
1,1-Dichloroethane	< 0.03	< 0.03	< 0.03
Dichloromethane	< 0.03	< 0.03	< 0.03
trans-1,2-Dichloroethene	< 0.03	< 0.03	< 0.03
1,1-Dichloroethene	< 0.03	< 0.03	< 0.03
2,2-Dichloropropane	< 0.03	< 0.03	< 0.03
cis-1,2-Dichloroethene	< 0.03	< 0.03	< 0.03
Bromochloromethane	< 0.03	< 0.03	< 0.03
1,1,1-Trichloroethane	< 0.03	< 0.03	< 0.03
Carbon tetrachloride	< 0.03	< 0.03	< 0.03
1,1-Dichloropropene	< 0.03	< 0.03	< 0.03
1,2-Dichloroethane	< 0.03	< 0.03	< 0.03
Trichloroethene	< 0.03	< 0.03	< 0.03
1,2-Dichloropropane	< 0.03	< 0.03	< 0.03
Dibromomethane	< 0.03	< 0.03	< 0.03
cis-1,3-Dichloropropene	< 0.03	< 0.03	< 0.03
trans-1,3-Dichloropropene	< 0.03	< 0.03	< 0.03
1,1,2-Trichloroethane	< 0.03	< 0.03	< 0.03
Tetrachloroethene	< 0.03	< 0.03	< 0.03
1,3-Dichloropropane	< 0.03	< 0.03	< 0.03
1,2-Dibromoethane	< 0.03	< 0.03	< 0.03
1,1,1,2-Tetrachloroethane	< 0.03	< 0.03	< 0.03
1,1,2,2-Tetrachloroethane	< 0.03	< 0.03	< 0.03
1,2,3-Trichloropropane	< 0.03	< 0.03	< 0.03
1,2-Dibromo-3-chloropropane	< 0.03	< 0.03	< 0.03
Hexachlorobutadiene	< 0.03	< 0.03	< 0.03
<b>Halogenated Aromatics Hydrocarbons Screen</b>			
Chlorobenzene	< 0.03	< 0.03	< 0.03
Bromobenzene	< 0.03	< 0.03	< 0.03
2-Chlorotoluene	< 0.03	< 0.03	< 0.03
4-Chlorotoluene	< 0.03	< 0.03	< 0.03
1,3-Dichlorobenzene	< 0.03	< 0.03	< 0.03
1,4-Dichlorobenzene	< 0.03	< 0.03	< 0.03
1,2-Dichlorobenzene	< 0.03	< 0.03	< 0.03
1,2,4-Trichlorobenzene	< 0.03	< 0.03	< 0.03
1,2,3-Trichlorobenzene	< 0.03	< 0.03	< 0.03
<b>Trihalomethanes</b>			
Chloroform	< 0.03	< 0.03	< 0.03
Bromodichloromethane	< 0.03	< 0.03	< 0.03
Dibromochloromethane	< 0.03	< 0.03	< 0.03
Bromoform	< 0.03	< 0.03	< 0.03
<b>Polycyclic Aromatic Hydrocarbons (Volatile) Screen</b>			
Naphthalene	< 0.03	< 0.03	< 0.03