

DATE OF REPORT: 31ST AUGUST, 2015



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TEST REPORT NO. JUN15093.2

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

DATE OF TESTING: 18TH – 20TH JUNE, 2015

ACCREDITATION:



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TABLE OF CONTENTS

	<i>Page</i>
INTRODUCTION	4
QUALITY STATEMENT	4
OPERATING CONDITIONS	5
TEST METHODS	5 - 9
Temperature, Gas Velocity and Volume Flow Rate	5
Water Vapour (Moisture Content)	5
Oxygen and Carbon Dioxide	6
Dry Molecular Weight and Dry Gas Density	6
Oxides of Nitrogen (NO, NO ₂ and NO _x as NO ₂)	6
Carbon Monoxide	6
Sulphur Dioxide	6
Total Solid Particles	7
PM ₁₀ & PM _{2.5} Particulate Matter	7
Chlorine, Chlorides and Fluorides	7
Total (Volatile) Organic Compounds	8
Benzene	8
Multi-Metals	8
Hexavalent Chromium	8
Polycyclic Aromatic Hydrocarbons (PAH's)	9
DEFINITIONS	10
SUITABILITY OF SAMPLING PLANE	11 - 12
RESULTS – RELEASE POINT 4A	13 - 16
RESULTS - RELEASE POINT 4B	17 - 20
LIST OF TABLES	
Table 1: Criteria for Selection of Sampling Planes	11
Table 2: Sampling Plane Details for the Kiln 4 Main Stack	11
Table 3: Sampling Plane Details for the Precalciner Plant Stack	12
Table 4: Release Point 4A - Sampling Conditions	13
Table 5: Release Point 4A - Test Results	13
Table 6: Release Point 4A - Individual Metals and their Compounds	15
Table 7: Release Point 4A - Individual USEPA Priority Pollutant PAHs	16
Table 8: Release Point 4A - Total USEPA Priority Pollutant PAHs	16
Table 9: Release Point 4A - Total PAH Toxic Equivalents (BaP-TEQ _{PAH})	16

TABLE OF CONTENTS Continued

LIST OF TABLES Continued

Page

Table 10: Release Point 4B - Sampling Conditions	17
Table 11: Release Point 4B - Test Results	18
Table 12: Release Point 4B - Individual Metals and their Compounds	19
Table 13: Release Point 4B - Individual USEPA Priority Pollutant PAHs	20
Table 14: Release Point 4B - Total USEPA Priority Pollutant PAHs	20
Table 15: Release Point 4B - Total PAH Toxic Equivalents (BaP-TEQ _{PAH})	20

LIST OF FIGURES

Figure 1: Kiln 4 Main Stack (RP 4A)	11
Figure 2: Precalciner Plant Stack (RP 4B)	12

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
 - PM₁₀ (Particulate matter with a nominal aerodynamic diameter $\leq 10 \mu\text{m}$)
 - PM_{2.5} (Particulate matter with a nominal aerodynamic diameter $\leq 2.5 \mu\text{m}$)
 - Sulphur Dioxide
 - Carbon Monoxide
 - Nitrogen Oxides (as NO₂)
 - Hydrogen Chloride^a
 - Chlorine
 - Fluoride^b
 - Total Volatile Organic Compounds (VOCs)
 - Benzene
 - Multi-Metals^c
 - Chromium VI and compounds
 - Polycyclic Aromatic Hydrocarbons (PAHs as BaP).

Combustion gases (O₂, CO, CO₂, SO₂ and NO_x) 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 18th – 20th June 2015.

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.

^a Chlorides expressed as HCl.

^b Fluorides expressed as HF.

^c 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 Fe₂O₃), Lead and compounds, Magnesium oxide fume (as MgO), Manganese and compounds, Mercury - organic, Mercury - inorganic, Nickel and compounds, Zinc oxide fume (as ZnO).



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 (O₂) and carbon dioxide (CO₂) 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 O₂ analyser and a Non Dispersive Infrared (NDIR) CO₂ analyser.

Each analyser was zeroed using dry nitrogen and calibrated in accordance with the method using ambient air for O₂ as well as NATA certified span gases for O₂ and CO₂. 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 CO₂, O₂, CO and N₂. This determination was required for calculating isokinetic sampling rates. The estimated measurement uncertainty is $\pm 5\%$.

Oxides of Nitrogen (NO, NO₂ and NO_x as NO₂)

Nitric oxide (NO) and nitrogen dioxide (NO₂) 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/NO₂ analyser.

The analyser was calibrated in accordance with the method using NATA certified NO and NO₂ span gases and zeroed with dry nitrogen. Total nitrogen oxides (NO_x) are expressed as nitrogen dioxide (NO₂). 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 (SO₂) 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 SO₂ analyser.

The instrument was calibrated using NATA certified SO₂ 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 $\pm 15\%$.

PM₁₀ & PM_{2.5} Particulate Matter

Monitoring for PM₁₀ and PM_{2.5} particulate matter was conducted in accordance with USEPA Method 201A 'Determination of PM₁₀ and PM_{2.5} 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 μ m (PM₁₀) and 2.5 μ m (PM_{2.5}).

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 μ m and 2.5 μ 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 PM₁₀ was the combination of the PM₁₀ and PM_{2.5} 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 (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 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 Cr^{+6} using an ion chromatograph equipped with a post-column reactor (IC/PCR) and a visible wavelength detector. The IC/PCR separated the Cr^{+6} as chromate (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 $\pm 20\%$.

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 ³ '	Actual gas volume in cubic metres at stack conditions.
'Nm ³ '	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).
' μg '	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 _{PAH} '	Benzo(a)pyrene Toxic Equivalents.
'N/A'	Not applicable.
'PM ₁₀ '	Particulate matter with a nominal aerodynamic diameter $\leq 10\mu\text{m}$.
'PM _{2.5} '	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)

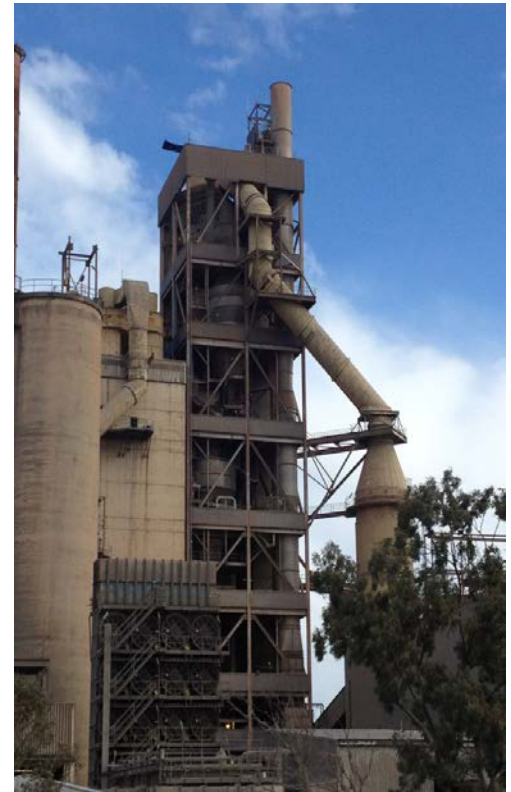


SUITABILITY OF SAMPLING PLANE Continued

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

Company	Adelaide Brighton Cement
Site	Birkenhead
Source Tested	Dry Process Kiln 4 Main Stack - Release Point 4A
Date of Tests	18 th – 19 th June 2015
Sampling Period	07:16 (18/06/15) - 18:33 (19/06/15) ^d
Testing Officer	A. Williams & J. Moazzam
Sampling Position	Four 4" BSP sample ports in circular stack

Table 4: Release Point 4A - Sampling Conditions

Sampling Conditions	Start	Finish	Average
Stack diameter at sampling plane (m)	3.23	3.23	3.23
Average stack gas temperature (K)	99.0	101	100
Average barometric pressure (hPa)	1017	1016	1017
Average static pressure (mB)	-0.90	-1.0	-0.90
Average velocity at sampling plane (m/s)	19.2	19.3	19.3
Average velocity at sampling plane expressed at STP (m/s)	14.2	14.1	14.2
Actual gas flow rate (m ³ /min)	9,450	9,490	9,470
Average moisture content (%v/v)	8.39	8.18	8.29
Gas flow rate at STP, dry (Nm ³ /min)	6,400	6,390	6,390
Average carbon dioxide concentration, dry basis (%v/v)	5.89	5.60	5.74
Average oxygen concentration, dry basis (%v/v)	17.5	17.3	17.4
Dry molecular weight of stack gas (g/g mole)	29.64	29.59	29.61
Dry gas density of stack gas (kg/m ³)	1.323	1.320	1.322

^d 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 ³) ^e	Emission Rate (g/min) ^e
Total Solid Particulates	11:46 - 13:51 (18/06/15)	2.2	14
PM ₁₀ Particles	14:02 - 16:05 (18/06/15)	1.5	9.6
PM _{2.5} Particles		0.47	3.0
Sulphur Dioxide		8.6 – 40 (Av. 20)	55 – 260 (Av. 130)
Carbon Monoxide		56 – 130 (Av. 91)	360 - 830 (Av. 580)
Oxides of Nitrogen (as NO ₂) <i>Actual at STP At 7% O₂</i>	07:50 - 10:50 (18/06/15)	707 – 1,060 (Av. 873) 2,810 – 4,210 (Av. 3,470)	4,520 – 6,770 (Av. 5,580)
Hydrogen Chloride		4.5	29
Chlorine	16:30 - 18:33 (19/06/15)	0.035	0.22
Fluoride (as HF)		< 0.07	< 0.4
Total Volatile Organic Compounds (by FIA, as n-propane equivalent)	09:45 - 10:45 (18/06/15)	0.31	2.0
Benzene	09:49 - 10:49 (18/06/15)	< 0.05	< 0.3
Total Multi-Metals ^f	07:16 - 09:21 (18/06/15)	0.25	1.6
Chromium VI and Compounds	14:16 - 16:18 (19/06/15)	0.00020	0.0013
Polycyclic Aromatic Hydrocarbons <i>Total BaP-TEQ_{PAH} ^g</i>	09:32 - 11:36 (18/06/15)	0.000011	0.000072

^e Unless otherwise stated.

^f Individual metals and their compounds are given in Table 6.

^g Individual BaP-TEQ_{PAH} contributions are given in Table 7, and the total BaP-TEQ_{PAH} in Table 9. This result includes half LOD values.

RESULTS – RELEASE POINT 4A Continued

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

Metal	Concentration (mg/Nm³)	Emission Rate (g/min)
Antimony and its compounds	< 0.0004	< 0.002
Arsenic and its compounds	< 0.00007	< 0.0005
Barium (soluble compounds)	0.0006	0.0036
Beryllium and its compounds	< 0.00006	< 0.0004
Cadmium and its compounds	< 0.0002	< 0.001
Chromium (III) and its compounds	0.0020	0.013
Copper oxide fume (as CuO)	0.018	0.12
Iron oxide fume (as Fe ₂ O ₃)	0.14	0.90
Lead and its compounds	0.0011	0.0070
Magnesium oxide fume (as MgO)	0.060	0.38
Manganese and its compounds	0.0017	0.011
Mercury and its compounds (as Hg)		
Organic:	0.0076	0.049
Inorganic:	0.000056	0.00036
Total:	0.0077	0.049
Nickel and its compounds	0.0019	0.012
Zinc oxide fume (as ZnO)	0.015	0.096
TOTAL METALS		
Excluding LOD values	0.25	1.6
Including half LOD values	0.25	1.6

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 _{PAH} Contribution	Emission Rate of PAHs (mg/min)
Naphthalene	0.39	0.0	0.0	2.5
2-Methylnaphthalene	< 0.12	0.0	0.0	< 0.75
Acenaphthylene	0.025	0.0	0.0	0.16
Acenaphthene	< 0.012	0.0	0.0	< 0.075
Fluorene	0.033	0.0	0.0	0.21
Phenanthrene	0.13	0.0	0.0	0.83
Anthracene	< 0.012	0.0	0.0	< 0.075
Fluoranthene	0.028	0.0	0.0	0.18
Pyrene	0.022	0.0	0.0	0.14
Benz(a)anthracene	< 0.012	0.1	0.00059	< 0.075
Chrysene	< 0.012	0.01	0.000059	< 0.075
Benzo(b)fluoranthene	< 0.012	0.1	0.00059	< 0.075
Benzo(k)fluoranthene	< 0.012	0.1	0.00059	< 0.075
Benzo(e)pyrene	< 0.012	0.0	0.0	< 0.075
Benzo(a)pyrene	< 0.012	1.0	0.0059	< 0.075
Perylene	< 0.012	0.0	0.0	< 0.075
Indeno(1 23-cd)pyrene	< 0.012	0.1	0.00059	< 0.075
Dibenz(ah)anthracene	< 0.015	0.4	0.0031	< 0.098
Benzo(ghi)perylene	< 0.012	0.0	0.0	< 0.075

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>	0.62	4.0
<i>Including half LOD values</i>	0.76	4.8

Table 9: Release Point 4A – Total PAH Toxic Equivalents (BaP-TEQ_{PAH})

Total PAH Toxic Equivalents (BaP-TEQ _{PAH}) ^h	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>	0.011	0.072

^h Calculated using benzo(α)pyrene potency equivalency factors (BaP-PEF values).

RESULTS – RELEASE POINT 4B

Company	Adelaide Brighton Cement
Site	Birkenhead
Source Tested	Precalciner Plant Stack - Release Point 4B
Date of Tests	19 th – 20 th June 2015
Sampling Period	15:00 (19/06/15) - 13:20 (20/06/15) ⁱ
Testing Officers	A. Williams & J. Moazzam
Sampling Position	Four 4" BSP sample ports in circular stack

Table 10: Release Point 4B - Sampling Conditions

Sampling Conditions	Start	Finish	Average
Stack diameter at sampling plane (m)	3.00	3.00	3.00
Average stack gas temperature (K)	103	102	103
Average barometric pressure (hPa)	1018	1020	1019
Static pressure (mB)	-1.2	-1.0	-1.1
Average velocity at sampling plane (m/s)	18.5	18.2	18.4
Average velocity at sampling plane expressed at STP (m/s)	13.5	13.3	13.4
Actual gas flow rate (m ³ /min)	7,860	7,720	7,790
Average moisture content (%v/v)	18.86	17.03	17.9
Gas flow rate at STP, dry (Nm ³ /min)	4,660	4,700	4,680
Average carbon dioxide concentration, dry basis (%v/v)	19.3	19.6	19.4
Average oxygen concentration (%v/v), dry basis	11.3	11.3	11.3
Dry molecular weight of stack gas (g/g mole)	31.54	31.58	31.56
Dry gas density of stack gas (kg/m ³)	1.408	1.410	1.409

ⁱ All sampling was conducted during normal operating conditions. No sampling was conducted during abnormal plant conditions.

RESULTS – RELEASE POINT 4B Continued

Table 11: Release Point 4B – Test Results

Parameter	Sampling Period	Concentration (mg/Nm ³) ^j	Emission Rate (g/min) ^m
Total Solid Particulates	17:15 - 19:18 (19/06/15)	1.4	6.5
PM ₁₀ Particles	15:02 - 17:04 (19/06/15)	0.80	3.7
PM _{2.5} Particles		0.35	1.6
Sulphur Dioxide		< 3	< 10
Carbon Monoxide		< 1 – 210 (Av. 160)	< 5 – 980 (Av. 750)
Oxides of Nitrogen (as NO ₂) Actual at STP At 7% O ₂	15:00 - 17:00 (19/06/15)	549 – 748 (Av. 650) 795 – 1,080 (Av. 941)	2,570 – 3,500 (Av. 3,040)
Hydrogen Chloride		2.3	11
Chlorine	09:00 - 11:03 (20/06/15)	0.057	0.27
Fluoride (as HF)		< 0.1	< 0.6
Total Volatile Organic Compounds (by FIA, as n-propane equivalent)	20:18 - 21:18 (19/06/15)	0.52	2.4
Benzene	20:26 - 21:26 (19/06/15)	0.16	0.75
Total Multi-Metals ^k	21:47 - 23:51 (19/06/15)	0.45	2.1
Chromium VI and Compounds	11:16 - 13:20 (20/06/15)	0.00020	0.00094
Polycyclic Aromatic Hydrocarbons Total BaP-TEQ _{PAH} ^l	19:31 - 21:35 (19/06/15)	0.0000085	0.000040

^j Unless otherwise stated.

^k Individual metals and their compounds are given in Table 12.

^l Individual BaP-TEQ_{PAH} contributions are given in Table 13, and the total BaP-TEQ_{PAH} in Table 15. This result includes half LOD values.

RESULTS – RELEASE POINT 4B Continued

Table 12: Release Point 4B – Individual Metals and their Compounds

Metal	Concentration (mg/Nm³)	Emission Rate (g/min)
Antimony and its compounds	< 0.0002	< 0.0007
Arsenic and its compounds	< 0.0002	< 0.0008
Barium (soluble compounds)	0.0010	0.0047
Beryllium and its compounds	< 0.0002	< 0.0007
Cadmium and its compounds	< 0.00003	< 0.0001
Chromium (III) and its compounds	0.0021	0.0098
Copper oxide fume (as CuO)	0.0014	0.0065
Iron oxide fume (as Fe ₂ O ₃)	0.26	1.2
Lead and its compounds	0.00040	0.0019
Magnesium oxide fume (as MgO)	0.17	0.80
Manganese and its compounds	0.0040	0.019
Mercury and its compounds (as Hg)		
Organic:	0.0025	0.012
Inorganic:	0.00011	0.00051
Total:	0.0026	0.012
Nickel and its compounds	0.0017	0.0080
Zinc oxide fume (as ZnO)	0.0089	0.042
TOTAL METALS		
Excluding LOD values	0.45	2.1
Including half LOD values	0.45	2.1

RESULTS – RELEASE POINT 4B Continued

Table 13: 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	0.57	0.0	0.0	2.7
2-Methylnaphthalene	0.092	0.0	0.0	0.43
Acenaphthylene	0.18	0.0	0.0	0.84
Acenaphthene	0.022	0.0	0.0	0.11
Fluorene	0.030	0.0	0.0	0.14
Phenanthrene	0.11	0.0	0.0	0.51
Anthracene	< 0.0088	0.0	0.0	< 0.041
Fluoranthene	0.014	0.0	0.0	0.064
Pyrene	0.017	0.0	0.0	0.080
Benz(a)anthracene	< 0.0088	0.1	0.00044	< 0.041
Chrysene	< 0.0088	0.01	0.000044	< 0.041
Benzo(b)fluoranthene	< 0.0088	0.1	0.00044	< 0.041
Benzo(k)fluoranthene	< 0.0088	0.1	0.00044	< 0.041
Benzo(e)pyrene	0.053	0.0	0.0	0.25
Benzo(a)pyrene	< 0.0088	1.0	0.0044	< 0.041
Perylene	0.039	0.0	0.0	0.18
Indeno(1 23-cd)pyrene	< 0.0088	0.1	0.00044	< 0.041
Dibenz(ah)anthracene	< 0.011	0.4	0.0023	< 0.053
Benzo(ghi)perylene	< 0.0088	0.0	0.0	< 0.041

Table 14: 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	1.1	5.3
Including half LOD values	1.2	5.5

Table 15: Release Point 4B – Total PAH Toxic Equivalents (BaP-TEQ_{PAH})

Total PAH Toxic Equivalents (BaP-TEQ _{PAH}) ^m	Concentration ($\mu\text{g}/\text{Nm}^3$)	Emission Rate (mg/min)
Excluding LOD values	0.0	0.0
Including half LOD values	0.0085	0.040

^m Calculated using benzo(a)pyrene potency equivalency factors (BaP-PEF values).