

DATE OF REPORT: 19TH JULY 2019

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TEST REPORT No. APR19072.2

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

DATE OF TESTING: 30TH APRIL & 1ST MAY 2019

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 Pre-calcliner Plant Stack (Release Point 4B) at their Birkenhead Plant. The following parameters were monitored in replicate on each stack:

- Gas velocity and volume flow rate
- Temperature
- Moisture concentration
- Concentration of oxygen & 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 $\leq 2.5 \mu\text{m}$);
 - Carbon monoxide;
 - Nitrogen oxides (NO, NO₂, NO_x);
 - Sulphur dioxide;
 - Antimony and its compounds (as Sb);
 - Arsenic and its compounds (as As);
 - Barium and its compounds (as Ba);
 - Beryllium and its compounds (as Be);
 - Cadmium and its compounds (as Cd);
 - Chromium trivalent and its compounds (as Cr(III));
 - Chromium hexavalent and its compounds (as Cr(VI));
 - Copper Oxide fume (as CuO);
 - Iron oxide fume (as Fe₂O₃);
 - Lead and its compounds (as Pb);
 - Magnesium oxide fume (as MgO);
 - Manganese and its compounds (as Mn);
 - Mercury and its compounds - organic and inorganic (as Hg);
 - Nickel and its compounds (as Ni);
 - Zinc oxide fume (as ZnO);
 - Hydrogen chloride;
 - Fluoride (as HF);
 - Chlorine;
 - PAHs (as BaP toxic equivalent);
 - Polychlorinated Dibenzo-*p*-Dioxins & Polychlorinated Dibenzofurans (Dioxins & Furans);
 - Total Volatile Organic Compounds (TVOCs);
 - Benzene.

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. The Pre-calcliner Plant Stack (4B) and the Dry Process Kiln 4 Main Stack (4A) were tested between 30th April and 1st May 2019.

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 ensure 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.



TEST METHODS

All sampling was undertaken by Airlabs Environmental. Airlabs Environmental is NATA accredited for all sampling undertaken for this project (NATA Accredited Laboratory No. 15463). Analysis was undertaken by Airlabs Environmental and the National Measurement Institute (NMI, NATA Accreditation No. 198) in accordance with our terms of accreditation. Specific details of the test methods used are available upon request.

Table 2: Summary of Test Methods

Test Parameter	Test Method	Method Detection Limit	Estimated Measurement Uncertainty	NATA Accredited	
				Sampling	Analysis
Sample plane criteria	AS 4323.1	N/A	N/A	✓	N/A
Gas velocity	US EPA Method 2	3 m/s	± 10%	✓	N/A
Temperature	US EPA Method 2	273K (0°C)	± 1%	✓	N/A
Moisture content	US EPA Method 4	0.2%	± 5%	✓	✓
Oxygen & carbon dioxide	US EPA Method 3A	0.1%	± 2%	✓	✓
Dry molecular weight & gas density	US EPA Method 3	N/A	± 5%	✓	✓
Total solid particulates ¹	AS 4323.2	1 mg/Nm ³	± 15%	✓	✓
PM ₁₀ & PM _{2.5}	US EPA Method 201A	1 mg/Nm ³	± 15%	✓	✓
Sulfur dioxide	US EPA Method 6C	3 mg/Nm ³	± 5%	✓	✓
Carbon monoxide	US EPA Method 10	1 mg/Nm ³	± 5%	✓	✓
Nitrogen oxides (as NO ₂)	US EPA Method 7E	2 mg/Nm ³	± 5%	✓	✓
Chlorine, Chloride (as HCl) & Fluoride (as HF)	US EPA Method 26	0.1 mg/Nm ³	± 17%	✓	✓ ²
Total VOCs	US EPA Method 25A	0.1 mg/Nm ³	± 10%	✓	✓
Benzene	US EPA Method 18 / NSW EPA TM-34	0.05 mg/Nm ³	± 17%	✓	✓
Multi-Metals	US EPA Method 29	0.05 mg/Nm ³ (total metals)	± 17%	✓	✓ ³
Chromium VI	US EPA Method 0061	0.0001 mg/Nm ³	± 17%	✓	✓ ⁴
PAHs (as BaP-TEQ _{PAH})	US EPA SW-846 Method 0010 & CARB 429	0.000005 mg/Nm ³ (total BaP-TEQ _{PAH})	± 20%	✓	✓ ⁵
Dioxins and Furans (PCDD/Fs)	USEPA Method 23	0.0004 ng/Nm ³ as I-TEQ	± 25%	✓	✓ ⁶

- Total solid particulates were determined in conjunction with multi-metals, as the sampling procedure for the particulate phase of the metals train by USEPA 29 is identical to AS 4323.2. US EPA 29 states that 'This method may be used to determine particulate emissions in addition to the metals emissions if the prescribed procedures and precautions are followed'.
- Chloride and fluoride analyses were performed by NMI, with results included in their Report No. RN1231860.
- Multi-metal analysis was performed on the various sample components by NMI, with results included in their Report No. RN1231860.
- Hexavalent chromium analysis was performed by NMI, with results included in their Report No. RN1231860.
- PAH analysis was performed by NMI, with results included in their Analytical Certificate No. ORG19_026.
- Dioxin & furan analysis was performed by NMI, with results included in their Analytical Certificate No. DAU19_162.

DEFINITIONS

'SA EPA'	South Australian Environment Protection Authority.
'US EPA'	United States Environmental Protection Agency.
'NSW EPA'	New South Wales Environment Protection Authority.
'NMI'	National Measurement Institute (Australian Government), North Ryde, NSW.
'K'	Absolute temperature in Kelvin ($^{\circ}\text{C} + 273$).
'mB'	Pressure in millibars.
'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.
'Sm ³ '	Gas volume in dry cubic metres at STP and referenced to 11% oxygen concentration.
'<'	Less than. The value stated is the limit of detection.
'g'	Grams.
'mg'	Milligrams (10^{-3} grams).
' μg '	Micrograms (10^{-6} grams).
'ng'	Nanograms (10^{-9} grams).
'min'	Minute.
'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 $\leq 2.5 \mu\text{m}$.
'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, as defined in "Benzo(a)pyrene as a Toxic Air Contaminant", CARB/OEHHA Executive Summary, July 1994.
'BAP-TEQ _{PAH} '	Benzo(a)pyrene Toxic Equivalents.
'PCDDs'	Polychlorinated Dibenzo-p-Dioxins.
'PCDFs'	Polychlorinated Dibenzofurans.
'TCDF'	Tetrachlorodibenzofuran.
'TCDD'	Tetrachlorodibenzo-p-dioxin.
'PeCDF'	Pentachlorodibenzofuran.
'PeCDD'	Pentachlorodibenzo-p-dioxin.
'HxCDF'	Hexachlorodibenzofuran.
'HxCDD'	Hexachlorodibenzo-p-dioxin.
'HpCDF'	Heptachlorodibenzofuran.
'HpCDD'	Heptachlorodibenzo-p-dioxin.
'OCDF'	Octachlorodibenzofuran.
'OCDD'	Octachlorodibenzo-p-dioxin.
'NATO'	North Atlantic Treaty Organisation.
'WHO'	World Health Organisation.
'NATO ₈₉ I-TEF'	International Toxic Equivalency Factor for PCDDs & PCDFs (NATO 1989 basis).
'NATO ₈₉ I-TEQ'	International Toxic Equivalent for PCDDs & PCDFs, based on the 2,3,7,8-TCDD congener (NATO 1989 basis).
'WHO ₀₅ TEF'	International Toxic Equivalency Factor for PCDDs & PCDFs (WHO 2005 basis).
'WHO ₀₅ TEQ'	International Toxic Equivalent for PCDDs & PCDFs, based on the 2,3,7,8-TCDD congener (WHO 2005 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 3 below:

Table 3: 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.

Section 4.1 of AS 4323.1-1995 (Ideal Sampling Positions) states that the location of the sampling plane shall be such that it meets the following criteria:

- (a) The gas flow is basically in the same direction at all points along each sampling traverse.
- (b) The gas velocity at all sampling points is greater than 3 m/s.
- (c) The gas flow profile at the sampling plane shall be steady, evenly distributed and not have a cyclonic component which exceeds an angle of 15° to the duct axis, when measured near the periphery of a circular sampling plane.
- (d) The temperature difference between adjacent points of the survey along each sampling traverse is less than 10% of the absolute temperature, and the temperature at any point differs by less than 10% from the mean.
- (e) The ratio of the highest to lowest pitot pressure difference shall not exceed 9:1 and the ratio of highest to lowest gas velocities shall not exceed 3:1. For isokinetic testing with the use of impingers, the gas velocity ratio across the sampling plane should not exceed 1.6:1.
- (f) The gas temperature at the sampling plane should preferably be above the dewpoint.

The gas characteristics determined for the Dry Process Kiln 4 Main Stack (Release Point 4A) and the Pre-calciner Plant Stack (Release Point 4B) satisfied the requirements of AS 4323.1-1995 Section 4.1 (a) - (f), and as such the sampling location is considered to be ideal. The sampling plane details and required number of sampling points are given in Tables 4 and 5 below:

SUITABILITY OF SAMPLING PLANE Continued

Table 4: 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	1.2:1 (< 1.6:1)
Absolute Temperature Difference (K)	< 10%
Minimum Velocity at any Sample Point (m/s)	> 3



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

Table 5: Sampling Plane Details for the Precaliner 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	1.1:1 (< 1.6:1)
Absolute Temperature Difference (K)	< 10%
Minimum Velocity at any Sample Point (m/s)	> 3



Figure 2: Precaliner Plant Stack (RP 4B)

RESULTS – RELEASE POINT 4A – RUN 1

Company	Adelaide Brighton Cement
Site	Elder Rd, Birkenhead
Source Tested	Dry Process Kiln 4 Main Stack - Release Point 4A
Date of Tests	30 th April 2019
Sampling Period	10:00 – 22:30
Testing Officers	C. Clunies-Ross & P. Collins
Sampling Position	Four 4" BSP sample ports in circular stack

Table 6: Release Point 4A (Run 1) - Gas Flow Conditions

<i>Sampling Conditions</i>	<i>Average</i>
Stack diameter at sampling plane (m)	3.23
Average stack gas temperature (K)	377 (104°C)
Average barometric pressure (mB)	999.0
Average static pressure (mB)	-3.10
Average stack pressure (mB)	995.9
Average velocity at sampling plane (m/s)	21.0
Average velocity at sampling plane expressed at STP (m/s)	15.2
Actual gas flow rate (m ³ /min)	10,340
Average moisture content (%v/v)	8.59
Gas flow rate at STP, dry (Nm ³ /min)	6,730
Gas flow rate at STP, dry and referenced to 11% O ₂ (Sm ³ /min)	3,230
Average carbon dioxide concentration, dry basis (%v/v)	4.76
Average oxygen concentration, dry basis (%v/v)	16.1
Dry molecular weight of stack gas (g/g mole)	29.67
Dry gas density of stack gas (kg/m ³)	1.324

RESULTS – RELEASE POINT 4A – RUN 1 Continued

Table 7: Release Point 4A (Run 1) - Summary of Test Results

Parameter	Sampling Period	Concentration (mg/Nm ³)	Emission Rate (g/min)
Total Solid Particulates	09:36 – 11:36 (30/04/2019)	9.3	63
PM ₁₀ Particles	12:39 – 14:39 (30/04/2019)	7.6	51
PM _{2.5} Particles		4.1	28
Sulphur Dioxide		< 3	< 20
Carbon Monoxide	12:29 – 15:12 (30/04/2019)	28	190
Oxides of Nitrogen (as NO ₂) <i>Actual at STP</i>		943	6,350
Hydrogen Chloride		0.70	4.7
Chlorine	13:52 – 15:52 (30/04/2019)	0.44	3.0
Fluoride (as HF)		<0.1	<0.7
Total Volatile Organic Compounds (by FIA, as n-propane equivalent)	09:49 – 10:49 (30/04/2019)	0.28	1.9
Benzene (by activated carbon adsorption and GC/MS analysis)		< 0.09	< 0.6
Total Multi-Metals ^a	09:36 – 11:36 (30/04/2019)	0.60	4.1
Chromium VI and Compounds	14:43 – 16:43 (30/04/2019)	0.0015	0.010
Polycyclic Aromatic Hydrocarbons <i>Total BaP-TEQ_{PAH}</i> ^b		0.000018	0.00012
<i>Polychlorinated Dioxins and Furans</i> ^c Total tetra to octa PCDDs/Fs ^d WHO ₀₅ TEQ for PCDDs/Fs ^d NATO ₈₉ I-TEQ for PCDDs/Fs ^d	09:35 – 12:35 (30/04/2019)	0.020 ng/Nm ³ 0.0022 ng/Nm ³ 0.0020 ng/Nm ³	0.065 µg/min 0.0070 µg/min 0.0066 µg/min

Table 8: Comparison of Dioxin & Furan Concentration in 4A Stack (Run 1) with International Guideline

Parameter	Concentration in Stack Gas Emissions (ng/Nm ³)	Oxygen (O ₂) Reference Condition (%)	Concentration at O ₂ Reference Condition (ng/Sm ³)	International Guideline (ng/Sm ³) ^e	Compliance with International Guideline
Polychlorinated Dioxins & Furans (NATO ₈₉ I-TEQ)	0.0010	11	0.0020	0.1	YES

^a Individual metals and their compounds are provided in Table 9. Total solid particulates were determined in conjunction with multi-metals, as the sampling procedure for the particulate phase of the metals train by USEPA 29 is identical to AS 4323.2 (refer to Table 2 'Summary of Test Methods').

^b Individual BaP-TEQ_{PAH} contributions are given in Table 10, and the total BaP-TEQ_{PAH} in Table 12. This result includes half LOD values.

^c Tetra-octa chlorinated dioxin & furan congener profile, homologue groups and toxic equivalents are given in Table 13.

^d Result includes half LOD values.

^e The International Guideline for the Concentration of Polychlorinated Dioxins & Furans in Stack Gas Emissions is 0.1 ng/Sm³ I-TEQ referenced to 11% O₂.

RESULTS – RELEASE POINT 4A – RUN 1 Continued

Table 9: Release Point 4A (Run 1) - Metals and their Compounds

Metal	Concentration (mg/Nm³)	Emission Rate (g/min)
Antimony and its compounds	< 0.0003	< 0.002
Arsenic and its compounds	0.000076	0.00051
Barium (soluble compounds)	0.012	0.084
Beryllium and its compounds	< 0.0003	< 0.002
Cadmium and its compounds	0.000073	0.00049
Chromium (III) and its compounds	0.0026	0.017
Copper oxide fume (as CuO)	0.018	0.12
Iron oxide fume (as Fe ₂ O ₃)	0.47	3.2
Lead and its compounds	0.0017	0.011
Magnesium oxide fume (as MgO)	0.083	0.56
Manganese and its compounds	0.0093	0.062
Mercury and its compounds (as Hg)		
Organic:	< 0.00003	< 0.0002
Inorganic:	0.000059	0.00040
Total:	0.000059	0.00040
Nickel and its compounds	0.00079	0.0053
Zinc oxide fume (as ZnO)	0.0060	0.041
TOTAL METALS Excluding LOD values Including half LOD values	0.60	4.1

RESULTS – RELEASE POINT 4A – RUN 1 Continued

Table 10: Release Point 4A (Run 1) - 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	1.3	0.0	0.0	8.9
2-Methylnaphthalene	0.33	0.0	0.0	2.2
Acenaphthylene	0.027	0.0	0.0	0.18
Acenaphthene	<0.02	0.0	0.0	<0.1
Fluorene	0.024	0.0	0.0	0.16
Phenanthrene	0.091	0.0	0.0	0.61
Anthracene	<0.02	0.0	0.0	<0.1
Fluoranthene	<0.02	0.0	0.0	<0.1
Pyrene	<0.02	0.0	0.0	<0.1
Benz(a)anthracene	<0.02	0.1	0.0010	<0.1
Chrysene	<0.02	0.01	0.00010	<0.1
Benzo(b)fluoranthene	<0.02	0.1	0.0010	<0.1
Benzo(k)fluoranthene	<0.02	0.1	0.0010	<0.1
Benzo(e)pyrene	<0.02	0.0	0.0	<0.1
Benzo(a)pyrene	<0.02	1.0	0.010	<0.1
Perylene	<0.02	0.0	0.0	<0.1
Indeno(123-cd)pyrene	<0.02	0.1	0.0010	<0.1
Dibenz(ah)anthracene	<0.02	0.4	0.0041	<0.1
Benzo(ghi)perylene	<0.02	0.0	0.0	<0.1

Table 11: Release Point 4A (Run 1)- 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>	1.8	12
<i>Including half LOD values</i>	1.9	13

Table 12: Release Point 4A (Run 1) - Total PAH Toxic Equivalents (BaP-TEQ_{PAH})

Total PAH Toxic Equivalents (BaP-TEQ _{PAH}) ^f	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>	0.018	0.12

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

RESULTS – RELEASE POINT 4A – RUN 1 Continued

Table 13: Release Point 4A (Run 1) - PCDD/F Congener Profile

PCDD/F Congeners	Concentration (ng/Nm ³)	WHO ₀₅ TEF	WHO ₀₅ TEQ contribution (ng/Nm ³)	NATO ₈₉ I-TEF	NATO ₈₉ I-TEQ contribution (ng/Nm ³)
2378 TCDF	<0.0021	0.1	0.00011	0.1	0.00011
2378 TCDD	<0.0021	1	0.0011	1	0.0011
12378 PeCDF	<0.0019	0.03	0.000028	0.05	0.000047
23478 PeCDF	<0.0021	0.3	0.00032	0.5	0.00053
12378 PeCDD	<0.0015	1	0.00074	0.5	0.00037
123478 HxCDF	<0.0021	0.1	0.00011	0.1	0.00011
123678 HxCDF	<0.0021	0.1	0.00011	0.1	0.00011
234678 HxCDF	<0.0021	0.1	0.00011	0.1	0.00011
123789 HxCDF	<0.0021	0.1	0.00011	0.1	0.00011
123478 HxCDD	<0.0011	0.1	0.000053	0.1	0.000053
123678 HxCDD	<0.0011	0.1	0.000053	0.1	0.000053
123789 HxCDD	<0.0011	0.1	0.000053	0.1	0.000053
1234678 HpCDF	0.00095	0.01	0.0000095	0.01	0.0000095
1234789 HpCDF	<0.00063	0.01	0.0000032	0.01	0.0000032
1234678 HpCDD	<0.0021	0.01	0.000011	0.01	0.000011
OCDF	<0.00063	0.0003	0.000000095	0.001	0.00000032
OCDD	<0.0084	0.0003	0.0000013	0.001	0.0000042
PCDD/F Homologue Groups				Concentration (ng/Nm³)	
Total TCDF isomers				< 0.017	
Total TCDD isomers				< 0.015	
Total PeCDF isomers				< 0.015	
Total PeCDD isomers				< 0.0084	
Total HxCDF isomers				< 0.013	
Total HxCDD isomers				< 0.0042	
Total HpCDF isomers				0.0011	
Total HpCDD isomers				< 0.0021	
Polychlorinated Dioxins & Furans Results Summary				Concentration (ng/Nm³)	Emission Rate (µg/min)
Sum of PCDD/F congeners (Total of all Tetra to Octa congeners)					
Total PCDD/F (Excluding LOD values)				0.020	0.065
Total PCDD/F (Including half LOD values)				0.020	0.065
WHO ₀₅ TEQ (Total of WHO ₀₅ TEQ contribution for 17 toxic congeners)					
WHO ₀₅ TEQ (Excluding LOD values)				0.000020	0.000065
WHO ₀₅ TEQ (Including half LOD values)				0.0022	0.0070
NATO ₈₉ I-TEQ (Total of NATO ₈₉ I-TEQ contribution for 17 toxic congeners)					
NATO ₈₉ I-TEQ (Excluding LOD values)				0.000030	0.00010
NATO ₈₉ I-TEQ (Including half LOD values)				0.0020	0.0066

RESULTS – RELEASE POINT 4A – RUN 2

Company	Adelaide Brighton Cement
Site	Elder Rd, Birkenhead
Source Tested	Dry Process Kiln 4 Main Stack - Release Point 4A
Date of Tests	30 th April 2019
Sampling Period	10:00 – 22:30
Testing Officers	C. Clunies-Ross & P. Collins
Sampling Position	Four 4" BSP sample ports in circular stack

Table 14: Release Point 4A (Run 2) - Gas Flow Conditions

Sampling Conditions	Average
Stack diameter at sampling plane (m)	3.23
Average stack gas temperature (K)	377 (104°C)
Average barometric pressure (mB)	999.5
Average static pressure (mB)	-3.10
Average stack pressure (mB)	996.4
Average velocity at sampling plane (m/s)	21.4
Average velocity at sampling plane expressed at STP (m/s)	15.4
Actual gas flow rate (m ³ /min)	10,510
Average moisture content (%v/v)	8.35
Gas flow rate at STP, dry (Nm ³ /min)	6,850
Gas flow rate at STP, dry and referenced to 11% O ₂ (m ³ /min)	3,250
Average carbon dioxide concentration, dry basis (%v/v)	5.07
Average oxygen concentration, dry basis (%v/v)	16.2
Dry molecular weight of stack gas (g/g mole)	29.71
Dry gas density of stack gas (kg/m ³)	1.326

RESULTS – RELEASE POINT 4A – RUN 2 Continued

Table 15: Release Point 4A (Run 2) - Summary of Test Results

Parameter	Sampling Period	Concentration (mg/Nm ³)	Emission Rate (g/min)
Total Solid Particulates	11:41 -13:41 (30/04/2019)	8.4	58
PM ₁₀ Particles	16:49 – 18:49 (30/04/2019)	7.1	49
PM _{2.5} Particles		4.0	27
Sulphur Dioxide	15:13 – 17:58 (30/04/2019)	< 3	< 20
Carbon Monoxide		32	220
Oxides of Nitrogen (as NO ₂) <i>Actual at STP</i>		879	6,020
Hydrogen Chloride		0.11	0.95
Chlorine	16:00 – 18:00 (30/04/2019)	0.12	0.82
Fluoride (as HF)		< 0.08	< 0.5
Total Volatile Organic Compounds (by FIA, as n-propane equivalent)	11:56 – 12:56 (30/04/2019)	0.35	2.4
Benzene (by activated carbon adsorption and GC/MS analysis)		<0.09	<0.6
Total Multi-Metals ^g	11:41 -13:41 (30/04/2019)	0.68	4.7
Chromium VI and Compounds	16:48 – 18:48 (30/04/2019)	0.0010	0.0071
Polycyclic Aromatic Hydrocarbons <i>Total BaP-TEQ_{PAH}</i> ^h	13:45 – 16:45 (30/04/2019)	0.000018	0.00012
<i>Polychlorinated Dioxins and Furans</i> ⁱ		0.020 ng/Nm ³ 0.0022 ng/Nm ³ 0.0020 ng/Nm ³	0.065 µg/min 0.0070 µg/min 0.0066 µg/min
Total tetra to octa PCDDs/Fs ⁱ			
WHO ₀₅ TEQ for PCDDs/Fs ^d			
NATO ₈₉ I-TEQ for PCDDs/Fs ^d			

Table 16: Comparison of Dioxin & Furan Concentration in 4A Stack (Run 2) with International Guideline

Parameter	Concentration in Stack Gas Emissions (ng/Nm ³)	Oxygen (O ₂) Reference Condition (%)	Concentration at O ₂ Reference Condition (ng/Sm ³)	International Guideline (ng/Sm ³) ^k	Compliance with International Guideline
Polychlorinated Dioxins & Furans (NATO ₈₉ I-TEQ)	0.0010	11	0.0020	0.1	YES

^g Individual metals and their compounds are given in Table 17. Total solid particulates were determined in conjunction with multi-metals, as the sampling procedure for the particulate phase of the metals train by USEPA 29 is identical to AS 4323.2 (refer to Table 2 'Summary of Test Methods').

^h Individual BaP-TEQ_{PAH} contributions are given in Table 18, and the total BaP-TEQ_{PAH} in Table 20. This result includes half LOD values.

ⁱ Tetra-octa chlorinated dioxin & furan congener profile, homologue groups and toxic equivalents are given in Table 21.

^j Result includes half LOD values.

^k The International Guideline for the Concentration of Polychlorinated Dioxins & Furans in Stack Gas Emissions is 0.1 ng/Sm³ I-TEQ referenced to 11% O₂.

RESULTS – RELEASE POINT 4A – RUN 2 Continued

Table 17: Release Point 4A (Run 2) - Metals and their Compounds

Metal	Concentration (mg/Nm³)	Emission Rate (g/min)
Antimony and its compounds	< 0.0003	< 0.002
Arsenic and its compounds	0.000090	0.00062
Barium (soluble compounds)	0.013	0.087
Beryllium and its compounds	< 0.0003	< 0.002
Cadmium and its compounds	0.000080	0.00055
Chromium (III) and its compounds	0.0028	0.019
Copper oxide fume (as CuO)	0.020	0.14
Iron oxide fume (as Fe ₂ O ₃)	0.53	3.6
Lead and its compounds	0.0018	0.012
Magnesium oxide fume (as MgO)	0.10	0.68
Manganese and its compounds	0.010	0.071
Mercury and its compounds (as Hg)		
Organic:	< 0.00003	< 0.0002
Inorganic:	0.000066	0.00045
Total:	0.000066	0.00045
Nickel and its compounds	0.00087	0.0060
Zinc oxide fume (as ZnO)	0.0071	0.049
TOTAL METALS Excluding LOD values Including half LOD values	0.68	4.7

RESULTS – RELEASE POINT 4A – RUN 2 Continued

Table 18: Release Point 4A (Run 2) - 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	1.3	0.0	0.0	9.0
2-Methylnaphthalene	0.15	0.0	0.0	1.0
Acenaphthylene	<0.02	0.0	0.0	<0.1
Acenaphthene	0.082	0.0	0.0	0.56
Fluorene	0.033	0.0	0.0	0.22
Phenanthrene	0.19	0.0	0.0	1.3
Anthracene	<0.02	0.0	0.0	<0.1
Fluoranthene	0.12	0.0	0.0	0.84
Pyrene	0.069	0.0	0.0	0.47
Benz(a)anthracene	<0.02	0.1	0.0010	<0.1
Chrysene	<0.02	0.01	0.00010	<0.1
Benzo(b)fluoranthene	<0.02	0.1	0.0010	<0.1
Benzo(k)fluoranthene	<0.02	0.1	0.0010	<0.1
Benzo(e)pyrene	<0.02	0.0	0.0	<0.1
Benzo(a)pyrene	<0.02	1.0	0.010	<0.1
Perylene	0.041	0.0	0.0	0.28
Indeno(123-cd)pyrene	<0.02	0.1	0.0010	<0.1
Dibenz(ah)anthracene	<0.02	0.4	0.0041	<0.1
Benzo(ghi)perylene	<0.02	0.0	0.0	<0.1

Table 19: Release Point 4A (Run 2) - 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>	2.0	14
<i>Including half LOD values</i>	2.1	15

Table 20: Release Point 4A (Run 2) - Total PAH Toxic Equivalents (BaP-TEQ_{PAH})

Total PAH Toxic Equivalents (BaP-TEQ _{PAH}) ¹	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>	0.018	0.12

¹ Calculated using benzo(a)pyrene potency equivalency factors (BaP-PEF values).

RESULTS – RELEASE POINT 4A – RUN 2 Continued

Table 21: Release Point 4A (Run 2) - PCDD/F Congener Profile

PCDD/F Congeners	Concentration (ng/Nm ³)	WHO ₀₅ TEF	WHO ₀₅ TEQ contribution (ng/Nm ³)	NATO ₈₉ I-TEF	NATO ₈₉ I-TEQ contribution (ng/Nm ³)
2378 TCDF	<0.0015	0.1	0.000075	0.1	0.000075
2378 TCDD	<0.0017	1	0.00086	1	0.00086
12378 PeCDF	<0.0017	0.03	0.000026	0.05	0.000043
23478 PeCDF	<0.0013	0.3	0.00019	0.5	0.00032
12378 PeCDD	<0.0011	1	0.00054	0.5	0.00027
123478 HxCDF	<0.0015	0.1	0.000075	0.1	0.000075
123678 HxCDF	<0.0015	0.1	0.000075	0.1	0.000075
234678 HxCDF	<0.0015	0.1	0.000075	0.1	0.000075
123789 HxCDF	<0.0017	0.1	0.000086	0.1	0.000086
123478 HxCDD	<0.00086	0.1	0.000043	0.1	0.000043
123678 HxCDD	<0.00086	0.1	0.000043	0.1	0.000043
123789 HxCDD	<0.00086	0.1	0.000043	0.1	0.000043
1234678 HpCDF	0.0016	0.01	0.000016	0.01	0.000016
1234789 HpCDF	<0.00043	0.01	0.0000021	0.01	0.0000021
1234678 HpCDD	<0.0019	0.01	0.000010	0.01	0.000010
OCDF	<0.0013	0.0003	0.00000019	0.001	0.00000064
OCDD	0.013	0.0003	0.0000040	0.001	0.000013
PCDD/F Homologue Groups				Concentration (ng/Nm³)	
Total TCDF isomers				< 0.013	
Total TCDD isomers				0.00407	
Total PeCDF isomers				< 0.011	
Total PeCDD isomers				< 0.0064	
Total HxCDF isomers				< 0.0086	
Total HxCDD isomers				< 0.0021	
Total HpCDF isomers				0.0024	
Total HpCDD isomers				< 0.0019	
Polychlorinated Dioxins & Furans Results Summary				Concentration (ng/Nm³)	Emission Rate (µg/min)
Sum of PCDD/F congeners (Total of all Tetra to Octa congeners)					
Total PCDD/F (Excluding LOD values)				0.020	0.065
Total PCDD/F (Including half LOD values)				0.020	0.065
WHO ₀₅ TEQ (Total of WHO ₀₅ TEQ contribution for 17 toxic congeners)					
WHO ₀₅ TEQ (Excluding LOD values)				0.000020	0.000065
WHO ₀₅ TEQ (Including half LOD values)				0.0022	0.0070
NATO ₈₉ I-TEQ (Total of NATO ₈₉ I-TEQ contribution for 17 toxic congeners)					
NATO ₈₉ I-TEQ (Excluding LOD values)				0.000030	0.00010
NATO ₈₉ I-TEQ (Including half LOD values)				0.0020	0.0066

RESULTS – RELEASE POINT 4B – RUN 1

Company Adelaide Brighton Cement
Site Elder Rd, Birkenhead
Source Tested Precalciner Plant Stack - Release Point 4B
Date of Tests 1st May 2019
Sampling Period 07:45 – 20:15
Testing Officers C. Clunies-Ross & P. Collins
Sampling Position Four 4" BSP sample ports in circular stack

Table 22: Release Point 4B (Run 1) - Gas Flow Conditions

Sampling Conditions	Average
Stack diameter at sampling plane (m)	3.00
Average stack gas temperature (K)	377 (104 °C)
Average barometric pressure (mB)	1001.0
Static pressure (mB)	-1.80
Average stack pressure (mB)	998.9
Average velocity at sampling plane (m/s)	18.7
Average velocity at sampling plane expressed at STP (m/s)	13.5
Actual gas flow rate (m ³ /min)	7,940
Average moisture content (%v/v)	17.3
Gas flow rate at STP, dry (Nm ³ /min)	4,700
Gas flow rate at STP, dry and referenced to 11% O ₂ (Sm ³ /min)	4,980
Average carbon dioxide concentration, dry basis (%v/v)	19.5
Average oxygen concentration (%v/v), dry basis	10.4
Dry molecular weight of stack gas (g/g mole)	31.65
Dry gas density of stack gas (kg/m ³)	1.412

RESULTS – RELEASE POINT 4B – RUN 1 Continued

Table 23: Release Point 4B (Run 1) - Summary of Test Results

Parameter	Sampling Period	Concentration (mg/Nm ³)	Emission Rate (g/min)
Total Solid Particulates	07:18 – 09:18 (01/05/2019)	5.2	24
PM ₁₀ Particles	12:31 – 14:31 (01/05/2019)	4.1	19
PM _{2.5} Particles		2.0	9.4
Sulphur Dioxide	09:13:55 (01/05/2019)	<3	<10
Carbon Monoxide		490	2,300
Oxides of Nitrogen (as NO ₂) <i>Actual at STP</i>		610	2,870
Hydrogen Chloride	12:34 – 14:34 (01/05/2019)	0.35	1.6
Chlorine		0.12	0.56
Fluoride (as HF)		<0.2	<0.9
Total Volatile Organic Compounds (by FIA, as n-propane equivalent)	07:32 – 08:32 (01/05/2019)	0.28	1.3
Benzene (by activated carbon adsorption and GC/MS analysis)		<0.09	<0.4
Total Multi-Metals ^m	07:18 – 09:18 (01/05/2019)	0.77	3.6
Chromium VI and Compounds	07:20 – 09:20 (01/05/2019)	<0.0005	<0.002
Polycyclic Aromatic Hydrocarbons <i>Total BaP-TEQ_{PAH}</i> ⁿ	12:33 – 15:33 (01/05/2019)	0.00013	0.00061
Polychlorinated Dioxins and Furans ^o		0.030 ng/Nm ³ 0.0010 ng/Nm ³ 0.00089 ng/Nm ³	0.15 µg/min 0.0048 µg/min 0.0044 µg/min
Total tetra to octa PCDDs/Fs ^p			
WHO ₀₅ TEQ for PCDDs/Fs ^j			
NATO ₈₉ I-TEQ for PCDDs/Fs ^j			

Table 24: Comparison of Dioxin & Furan Concentration in 4B Stack (Run 1) with International Guideline

Parameter	Concentration in Stack Gas Emissions (ng/Nm ³)	Oxygen (O ₂) Reference Condition (%)	Concentration at O ₂ Reference Condition (ng/Sm ³)	International Guideline (ng/Sm ³) ^q	Compliance with International Guideline
Polychlorinated Dioxins & Furans (NATO ₈₉ I-TEQ)	0.00094	11	0.00089	0.1	YES

^m Individual metals and their compounds are given in Table 25. Total solid particulates were determined in conjunction with multi-metals, as the sampling procedure for the particulate phase of the metals train by USEPA 29 is identical to AS 4323.2 (refer to Table 2 'Summary of Test Methods').

ⁿ Individual BaP-TEQ_{PAH} contributions are given in Table 26, and the total BaP-TEQ_{PAH} in Table 28. This result includes half LOD values.

^o Tetra-octa chlorinated dioxin & furan congener profile, homologue groups and toxic equivalents are given in Table 29.

^p Result includes half LOD values.

^q The International Guideline for the Concentration of Polychlorinated Dioxins & Furans in Stack Gas Emissions is 0.1 ng/Sm³ I-TEQ referenced to 11% O₂.

RESULTS – RELEASE POINT 4B – RUN 1 Continued

Table 25: Release Point 4B (Run 1) – Metals and their Compounds

Metal	Concentration (mg/Nm³)	Emission Rate (g/min)
Antimony and its compounds	< 0.0003	< 0.001
Arsenic and its compounds	0.00059	0.0028
Barium (soluble compounds)	0.014	0.065
Beryllium and its compounds	< 0.0003	< 0.001
Cadmium and its compounds	0.000058	0.00027
Chromium (III) and its compounds	0.0017	0.0078
Copper oxide fume (as CuO)	0.015	0.070
Iron oxide fume (as Fe ₂ O ₃)	0.48	2.3
Lead and its compounds	0.00072	0.0034
Magnesium oxide fume (as MgO)	0.22	1.0
Manganese and its compounds	0.025	0.12
Mercury and its compounds (as Hg)		
Organic:	< 0.00003	< 0.0001
Inorganic:	0.000055	0.00026
Total [†] :	0.000055	0.00026
Nickel and its compounds	0.00089	0.0042
Zinc oxide fume (as ZnO)	0.010	0.046
TOTAL METALS Excluding LOD values Including half LOD values	0.77	3.6

[†] Total does not include 'less than limit of detection' value for organic mercury.

RESULTS – RELEASE POINT 4B – RUN 1 Continued

Table 26: Release Point 4B (Run 1) – 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	1.4	0.0	0.0	6.4
2-Methylnaphthalene	0.62	0.0	0.0	2.9
Acenaphthylene	0.088	0.0	0.0	0.41
Acenaphthene	0.047	0.0	0.0	0.22
Fluorene	0.063	0.0	0.0	0.30
Phenanthrene	0.29	0.0	0.0	1.4
Anthracene	0.029	0.0	0.0	0.14
Fluoranthene	0.17	0.0	0.0	0.82
Pyrene	0.15	0.0	0.0	0.69
Benz(a)anthracene	0.049	0.1	0.0049	0.23
Chrysene	0.028	0.01	0.00028	0.13
Benzo(b)fluoranthene	0.10	0.1	0.010	0.47
Benzo(k)fluoranthene	0.037	0.1	0.0037	0.17
Benzo(e)pyrene	<0.02	0.0	0.0	<0.09
Benzo(a)pyrene	0.10	1.0	0.10	0.47
Perylene	0.024	0.0	0.0	0.11
Indeno(123-cd)pyrene	0.037	0.1	0.0037	0.18
Dibenz(ah)anthracene	0.021	0.4	0.0084	0.10
Benzo(ghi)perylene	0.050	0.0	0.0	0.24

Table 27: Release Point 4B (Run 1) – Total USEPA Priority Pollutant PAHs

Total USEPA Priority Pollutant PAHs	Concentration ($\mu\text{g}/\text{Nm}^3$)	Emission Rate (mg/min)
Excluding LOD values	3.3	15
Including half LOD values	3.3	15

Table 28: Release Point 4B (Run 1) – Total PAH Toxic Equivalents (BaP-TEQ_{PAH})

Total PAH Toxic Equivalents (BaP-TEQ _{PAH}) ^s	Concentration ($\mu\text{g}/\text{Nm}^3$)	Emission Rate (mg/min)
Excluding LOD values	0.13	0.61
Including half LOD values	0.13	0.61

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

RESULTS – RELEASE POINT 4B – RUN 1 Continued

Table 29: Release Point 4B (Run 1) – PCDD/F Congener Profile

PCDD/F Congeners	Concentration (ng/Nm ³)	WHO ₀₅ TEF	WHO ₀₅ TEQ contribution (ng/Nm ³)	NATO ₈₉ I-TEF	NATO ₈₉ I-TEQ contribution (ng/Nm ³)
2378 TCDF	<0.00069	0.1	0.000034	0.1	0.000034
2378 TCDD	<0.00069	1	0.00034	1	0.00034
12378 PeCDF	<0.00052	0.03	0.0000077	0.05	0.000013
23478 PeCDF	<0.00052	0.3	0.000077	0.5	0.00013
12378 PeCDD	<0.00052	1	0.00026	0.5	0.00013
123478 HxCDF	<0.00060	0.1	0.000030	0.1	0.000030
123678 HxCDF	<0.00060	0.1	0.000030	0.1	0.000030
234678 HxCDF	<0.00060	0.1	0.000030	0.1	0.000030
123789 HxCDF	<0.00069	0.1	0.000034	0.1	0.000034
123478 HxCDD	<0.00052	0.1	0.000026	0.1	0.000026
123678 HxCDD	<0.00052	0.1	0.000026	0.1	0.000026
123789 HxCDD	<0.00052	0.1	0.000026	0.1	0.000026
1234678 HpCDF	0.00062	0.01	0.0000062	0.01	0.0000062
1234789 HpCDF	<0.00017	0.01	0.00000086	0.01	0.00000086
1234678 HpCDD	0.0019	0.01	0.000019	0.01	0.000019
OCDF	<0.00017	0.0003	0.000000026	0.001	0.000000086
OCDD	0.012	0.0003	0.0000036	0.001	0.000012
PCDD/F Homologue Groups				Concentration (ng/Nm³)	
Total TCDF isomers				0.0067	
Total TCDD isomers				0.0018	
Total PeCDF isomers				< 0.0034	
Total PeCDD isomers				0.0025	
Total HxCDF isomers				< 0.0034	
Total HxCDD isomers				0.0034	
Total HpCDF isomers				0.00070	
Total HpCDD isomers				0.0033	
Polychlorinated Dioxins & Furans Results Summary				Concentration (ng/Nm³)	Emission Rate (µg/min)
Sum of PCDD/F congeners (Total of all Tetra to Octa congeners)					
Total PCDD/F (Excluding LOD values)				0.030	0.15
Total PCDD/F (Including half LOD values)				0.030	0.15
WHO ₀₅ TEQ (Total of WHO ₀₅ TEQ contribution for 17 toxic congeners)					
WHO ₀₅ TEQ (Excluding LOD values)				0.000029	0.00014
WHO ₀₅ TEQ (Including half LOD values)				0.0010	0.0048
NATO ₈₉ I-TEQ (Total of NATO ₈₉ I-TEQ contribution for 17 toxic congeners)					
NATO ₈₉ I-TEQ (Excluding LOD values)				0.000037	0.00019
NATO ₈₉ I-TEQ (Including half LOD values)				0.00089	0.0044

RESULTS – RELEASE POINT 4B – RUN 2

Company	Adelaide Brighton Cement
Site	Elder Rd, Birkenhead
Source Tested	Precalciner Plant Stack - Release Point 4B
Date of Tests	1 st May 2019
Sampling Period	07:45 – 20:15
Testing Officers	C. Clunies-Ross & P. Collins
Sampling Position	Four 4" BSP sample ports in circular stack

Table 30: Release Point 4B (Run 2) - Gas Flow Conditions

<i>Sampling Conditions</i>	Average
Stack diameter at sampling plane (m)	3.00
Average stack gas temperature (K)	376 (103 °C)
Average barometric pressure (mB)	999.5
Static pressure (mB)	-1.90
Average stack pressure (mB)	997.6
Average velocity at sampling plane (m/s)	18.2
Average velocity at sampling plane expressed at STP (m/s)	12.9
Actual gas flow rate (m ³ /min)	7,730
Average moisture content (%v/v)	16.8
Gas flow rate at STP, dry (Nm ³ /min)	4,590
Gas flow rate at STP, dry and referenced to 11% O ₂ (Sm ³ /min)	5,010
Average carbon dioxide concentration, dry basis (%v/v)	19.6
Average oxygen concentration (%v/v), dry basis	10.1
Dry molecular weight of stack gas (g/g mole)	31.65
Dry gas density of stack gas (kg/m ³)	1.413

RESULTS – RELEASE POINT 4B – RUN 2 Continued

Table 31: Release Point 4B (Run 2) - Summary of Test Results

Parameter	Sampling Period	Concentration (mg/Nm ³)	Emission Rate (g/min)
Total Solid Particulates	09:24 – 11:24 (01/05/2019)	4.6	21
PM ₁₀ Particles	12:31 – 14:31 (01/05/2019)	3.7	17
PM _{2.5} Particles		1.8	8.3
Sulphur Dioxide	13:55 – 18:10 (01/05/2019)	<3	<10
Carbon Monoxide		580	2,660
Oxides of Nitrogen (as NO ₂) <i>Actual at STP</i>		550	2,520
Hydrogen Chloride		0.10	0.46
Chlorine	12:34 – 14:34 (01/05/2019)	0.11	0.50
Fluoride (as HF)		<0.07	<0.3
Total Volatile Organic Compounds (by FIA, as n-propane equivalent)	09:46 – 10:46 (01/05/2019)	0.25	1.1
Benzene (by activated carbon adsorption and GC/MS analysis)		<0.09	<0.4
Total Multi-Metals ^t	09:24 – 11:24 (01/05/2019)	0.86	3.9
Chromium VI and Compounds	09:27 – 11:27 (01/05/2019)	<0.0005	<0.002
Polycyclic Aromatic Hydrocarbons <i>Total BaP-TEQ_{PAH}</i> ^u	15:45 – 18:45 (01/05/2019)	0.000016	0.000073
<i>Polychlorinated Dioxins and Furans</i> ^v		0.0064 ng/Nm ³	0.032 µg/min
Total tetra to octa PCDDs/Fs ^w		0.00086 ng/Nm ³	0.0043 µg/min
WHO ₀₅ TEQ for PCDDs/Fs ^j		0.00082 ng/Nm ³	0.0041 µg/min
NATO ₈₉ I-TEQ for PCDDs/Fs ^j			

Table 32: Comparison of Dioxin & Furan Concentration in 4B Stack (Run 2) with International Guideline

Parameter	Concentration in Stack Gas Emissions (ng/Nm ³)	Oxygen (O ₂) Reference Condition (%)	Concentration at O ₂ Reference Condition (ng/Sm ³)	International Guideline (ng/Sm ³) ^x	Compliance with International Guideline
Polychlorinated Dioxins & Furans (NATO ₈₉ I-TEQ)	0.00090	11	0.00082	0.1	YES

^t Individual metals and their compounds are given in Table 33. Total solid particulates were determined in conjunction with multi-metals, as the sampling procedure for the particulate phase of the metals train by USEPA 29 is identical to AS 4323.2 (refer to Table 2 'Summary of Test Methods').

^u Individual BaP-TEQ_{PAH} contributions are given in Table 34, and the total BaP-TEQ_{PAH} in Table 36. This result includes half LOD values.

^v Tetra-octa chlorinated dioxin & furan congener profile, homologue groups and toxic equivalents are given in Table 37.

^w Result includes half LOD values.

^x The International Guideline for the Concentration of Polychlorinated Dioxins & Furans in Stack Gas Emissions is 0.1 ng/Sm³ I-TEQ referenced to 11% O₂.

RESULTS – RELEASE POINT 4B – RUN 2 Continued

Table 33: Release Point 4B (Run 2) - Metals and their Compounds

Metal	Concentration (mg/Nm³)	Emission Rate (g/min)
Antimony and its compounds	< 0.0003	< 0.001
Arsenic and its compounds	0.00058	0.0027
Barium (soluble compounds)	0.014	0.064
Beryllium and its compounds	< 0.0003	< 0.001
Cadmium and its compounds	0.000046	0.00021
Chromium (III) and its compounds	0.0016	0.0076
Copper oxide fume (as CuO)	0.014	0.063
Iron oxide fume (as Fe ₂ O ₃)	0.58	2.6
Lead and its compounds	0.0011	0.0050
Magnesium oxide fume (as MgO)	0.22	1.0
Manganese and its compounds	0.024	0.11
Mercury and its compounds (as Hg)		
Organic:	< 0.00003	< 0.0001
Inorganic:	0.000055	0.00025
Total ^y :	0.000055	0.00025
Nickel and its compounds	0.00090	0.0041
Zinc oxide fume (as ZnO)	0.0092	0.042
TOTAL METALS Excluding LOD values Including half LOD values	0.86	3.9

^y Total does not include 'less than limit of detection' value for organic mercury.

RESULTS – RELEASE POINT 4B – RUN 2 Continued

Table 34: Release Point 4B (Run 2) – 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	1.4	0.0	0.0	6.6
2-Methylnaphthalene	0.20	0.0	0.0	0.90
Acenaphthylene	0.021	0.0	0.0	0.094
Acenaphthene	0.57	0.0	0.0	2.6
Fluorene	0.14	0.0	0.0	0.66
Phenanthrene	0.17	0.0	0.0	0.78
Anthracene	<0.02	0.0	0.0	<0.08
Fluoranthene	0.043	0.0	0.0	0.20
Pyrene	0.052	0.0	0.0	0.24
Benz(a)anthracene	<0.02	0.1	0.00089	<0.08
Chrysene	<0.02	0.01	0.000089	<0.08
Benzo(b)fluoranthene	<0.02	0.1	0.00089	<0.08
Benzo(k)fluoranthene	<0.02	0.1	0.00089	<0.08
Benzo(e)pyrene	<0.02	0.0	0.0	<0.08
Benzo(a)pyrene	<0.02	1.0	0.0089	<0.08
Perylene	<0.02	0.0	0.0	<0.08
Indeno(123-cd)pyrene	<0.02	0.1	0.00089	<0.08
Dibenz(ah)anthracene	<0.02	0.4	0.0036	<0.08
Benzo(ghi)perylene	<0.02	0.0	0.0	<0.08

Table 35: Release Point 4B (Run 2) – Total USEPA Priority Pollutant PAHs

Total USEPA Priority Pollutant PAHs	Concentration ($\mu\text{g}/\text{Nm}^3$)	Emission Rate (mg/min)
Excluding LOD values	2.6	12
Including half LOD values	2.7	13

Table 36: Release Point 4B (Run 2) – Total PAH Toxic Equivalents (BaP-TEQ_{PAH})

Total PAH Toxic Equivalents (BaP-TEQ _{PAH}) ^z	Concentration ($\mu\text{g}/\text{Nm}^3$)	Emission Rate (mg/min)
Excluding LOD values	0.0	0.0
Including half LOD values	0.016	0.073

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

RESULTS – RELEASE POINT 4B – RUN 2 Continued

Table 37: Release Point 4B (Run 2) – PCDD/F Congener Profile

PCDD/F Congeners	Concentration (ng/Nm ³)	WHO ₀₅ TEF	WHO ₀₅ TEQ contribution (ng/Nm ³)	NATO ₈₉ I-TEF	NATO ₈₉ I-TEQ contribution (ng/Nm ³)
2378 TCDF	<0.00057	0.1	0.000029	0.1	0.000029
2378 TCDD	<0.00066	1	0.00033	1	0.00033
12378 PeCDF	<0.00057	0.03	0.0000086	0.05	0.000014
23478 PeCDF	<0.00057	0.3	0.000086	0.5	0.00014
12378 PeCDD	<0.00041	1	0.00020	0.5	0.00010
123478 HxCDF	<0.00074	0.1	0.000037	0.1	0.000037
123678 HxCDF	<0.00066	0.1	0.000033	0.1	0.000033
234678 HxCDF	<0.00066	0.1	0.000033	0.1	0.000033
123789 HxCDF	<0.00082	0.1	0.000041	0.1	0.000041
123478 HxCDD	<0.00033	0.1	0.000016	0.1	0.000016
123678 HxCDD	<0.00033	0.1	0.000016	0.1	0.000016
123789 HxCDD	<0.00033	0.1	0.000016	0.1	0.000016
1234678 HpCDF	0.00025	0.01	0.0000025	0.01	0.0000025
1234789 HpCDF	<0.00016	0.01	0.00000082	0.01	0.00000082
1234678 HpCDD	<0.00074	0.01	0.0000037	0.01	0.0000037
OCDF	<0.00025	0.0003	0.000000037	0.001	0.00000012
OCDD	0.0061	0.0003	0.0000018	0.001	0.0000061
PCDD/F Homologue Groups				Concentration (ng/Nm³)	
Total TCDF isomers				< 0.0049	
Total TCDD isomers				< 0.0041	
Total PeCDF isomers				< 0.0041	
Total PeCDD isomers				< 0.0025	
Total HxCDF isomers				< 0.0041	
Total HxCDD isomers				< 0.00082	
Total HpCDF isomers				0.00029	
Total HpCDD isomers				< 0.00074	
Polychlorinated Dioxins & Furans Results Summary				Concentration (ng/Nm³)	Emission Rate (µg/min)
Sum of PCDD/F congeners (Total of all Tetra to Octa congeners)					
Total PCDD/F (Excluding LOD values)				0.0064	0.032
Total PCDD/F (Including half LOD values)				0.0064	0.032
WHO ₀₅ TEQ (Total of WHO ₀₅ TEQ contribution for 17 toxic congeners)					
WHO ₀₅ TEQ (Excluding LOD values)				0.0000043	0.000021
WHO ₀₅ TEQ (Including half LOD values)				0.00086	0.0043
NATO ₈₉ I-TEQ (Total of NATO ₈₉ I-TEQ contribution for 17 toxic congeners)					
NATO ₈₉ I-TEQ (Excluding LOD values)				0.0000085	0.000043
NATO ₈₉ I-TEQ (Including half LOD values)				0.00082	0.0041

END OF REPORT